

KLAMATH COMMUNITY COLLEGE
CHILDCARE LEARNING CENTER

Project Manual

VOLUME 2: DIV 21-33

Bid and Permit Set

August 1, 2025

**SECTION 21 0000
GENERAL REQUIREMENTS FOR FIRE PROTECTION**

PART 1 GENERAL

1.01 GENERAL

- A. The fire protection system is design build; the fire protection contractor will be responsible for providing and installing a complete and operational fire suppression system under the supervision of an Engineer of Record (EOR). Comply with all current Federal, State, City and local codes, standards and ordinances, including supplements, utility company standards, insurance carrier requirements, and local authorities including all referenced standards.
- B. The General Conditions and Supplementary General Conditions are hereby a part of this Section as fully as if repeated herein.

1.02 SCOPE

- A. The work includes, but is not necessarily limited to, the furnishing of all labor, materials, equipment, and services necessary for, and reasonably incidental to, providing and installing complete fire protection systems, and other work as shown or indicated in the Fire Protection Drawings and Specifications.
- B. Consult all other Sections to determine the extent and character of this work specified elsewhere.
- C. Make all connections to equipment requiring service from systems installed under this Section.

1.03 COORDINATION

- A. Before submitting a bid for the fire protection work the Contractor shall visit the site and become familiar with all the work on other related Drawings and Specifications, and plan the work to provide the best possible assembly of the combined work of all trades. No additional costs will be considered for work which has to be relocated due to conflicts with other trades.
- B. If, after examination of the bidding documents relating to the work, the Contractor has queries concerning the nature and scope of the work or intent of the Specifications, he/she shall promptly request clarification from the Architect. After contract award, claims of ignorance of the intent and scope of the contract shall not be allowed.
- C. Contractor is responsible for coordinating the schedule of inspections by Architect/Owner at appropriate stages of construction such as rough-in, pre-final, and final, and at other times required by the Specifications or by the construction. Notify Architect and Owner seven (7) days in advance of proposed site visit. Notification constitutes certification that construction is, or will be, complete and ready for inspection.
- D. The contractor shall prepare and submit, for review, large scale (minimum 1/8" = 1'-0") coordination drawings showing location and elevations of all equipment, ducts, piping, cable trays, conduits, structural, and other items in the area. These shall be fully coordinated with all other trades and Owner supplied items. Check routing and elevations of all piping, ductwork, conduit and equipment before fabricating. Report any conflicts that cannot be solved in the field to the Architect/Owner. Extra charges shall not be allowed due to lack of coordination prior to, or during, construction. These drawings shall be distributed to, and coordinated with, all other trades that are affected.
 - 1. In addition to plan view, indicate heights to clarify clearances from structure and from other trades. Use partial sections where necessary.
 - 2. Provide proper clearances for access to and service of all equipment and items requiring adjustment including shutoff valves.
 - 3. Coordinate the location of access panels in the hard ceiling areas to ensure all equipment and devices have proper access for servicing and adjusting.
 - 4. The coordination drawings shall be reviewed and checked for completeness by the general contractor. Review by the architect and engineer is to assist the contractor and to

attempt to point out obvious errors. Responsibility for proper coordination shall remain with the contractor.

- E. Differences or disputes concerning coordination, interference, or extent of work between sections shall be decided by general contractor.
- F. Extra charges shall not be allowed due to lack of coordination (or lack of coordination drawings) prior to or during construction.
- G. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work. Indicate the proposed locations of ductwork, piping, conduit, equipment, and materials. Include the following:
 - 1. Clearances for installing and maintaining insulation, including clearances for servicing and maintaining equipment, and space for equipment disassembly required for periodic maintenance.
 - 2. Clearances for electrical and control components and panels.
 - 3. Equipment connections and support details.
 - 4. Exterior wall and foundation penetrations.
 - 5. Interior floor penetrations
 - 6. Fire rated wall and floor penetrations.
 - 7. Sizes and location of required concrete pads and bases.
 - 8. Support, bracing and anchor locations for equipment and conduit.
- H. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
- I. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
- J. Prepare reflected ceiling plans to coordinate and integrate installations, access panel and door locations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling mounted items where ceilings are to be installed.

1.04 SAFETY

- A. Contractors must conduct a weekly safety meeting with their employees and provide documentation as to attendance and topics of discussion. Engineer's construction support services do not constitute review or approval of Contractor's safety procedures. Contractor shall comply with all OSHA regulations. Contractor is required to obtain and pay for insurance required to cover all activities within Contractor's Scope of Work.

1.05 BUILDING LAWS

- A. Fire Protection work shall conform to all requirements prescribed by governmental bodies having jurisdiction and is to be in accordance with the state building codes; all federal, state, and local codes and ordinances; all OSHA requirements; state plumbing code, state mechanical code, state fire code, and National Fire Protection Association; and State energy conservation standards.
- B. Should any part of the design fail to comply with such requirements, the discrepancy shall be called to the attention of the Architect prior to submitting bid.
- C. Should there be any direct conflict between the Drawings and/or Specifications and the above rules and regulations, the rules and regulations shall take precedence. However, when the indicated material, workmanship, arrangement, or construction is of a superior quality or capacity to that required by above rules and regulations, the Drawings and/or Specifications shall take precedence. Rulings and interpretations of enforcing agencies shall be considered as part of the regulations.
- D. After a Contract is awarded, if minor changes or additions are required by the aforementioned authorities, even though such work is not shown on Drawings or overtly covered in the Specifications, they must be included at the Contractor's expense.

- E. The Contractor is responsible to coordinate and make adjustments in his/her work with the full set of Contract Drawings and Specifications.
- F. All piping, and equipment shall be securely anchored to building structure as required herein and by the state building code and NFPA 13.

1.06 UNDERGROUND CONNECTIONS

- A. See Section 21 10 00 for Underground Fire Service connection requirements.
- B. See section 21 05 00 for Buried Pipe Requirements
- C. Pipe joints shall not be located under foundation footings. The pipe under the building or building foundation shall not contain mechanical joints.
- D. Piping within 5-0 of the building shall be listed Ductile Iron or listed Stainless steel single-piece in building riser installed per local codes and with polyethelyene enasement where approed. Pipe or in-building riser shall be restrained with mechanical fittings and thrust blocking.

1.07 TEMPORARY CONSTRUCTION WATER

- A. The Contractor shall make all arrangements and provide necessary facilities for the temporary construction water from the Owner's source. Costs for the temporary construction water shall be paid for by Owner.

1.08 DESIGN DESCRIPTION

- A. This section of the specification combined with any of the contract drawings are intended as a guide to establish a basis of design for the systems required.
- B. Contractor shall examine the full set of contract drawings, layout and install a completely hydraulically sized sprinkler system protecting all areas as required by NFPA 13 and local fire codes. Space shall be provided for any valving and equipment to be used.
- C. System shall start at the P.O.C to the fire protection underground supply 5-0 from the building foundation and extend throughout the building.
- D. The building shall be served with a wet type sprinkler system throughout all spaces that will be maintained above 40°F. Dry barrel sprinkler heads installed on the wet system may protect areas where the minimum dry barrel length required by NFPA 13 for interior temperatures of 40°F is used. A dry pipe system shall supply protection for any areas that require sprinkler protection which are not maintained above 40°F, and that cannot be protected using dry-barrel sprinklers. Dry pipe systems shall be filled with 98% Nitrogen or use other listed systems providing equivalent or better internal corrosion resistance.
- E. Add Alternate: Contractor shall include a fire pump if required to meet system pressure requirements, including design and all associated components necessary for a fully operational system.

1.09 HYDRAULIC DESIGN

- A. The wet system shall be a tree, looped or gridded system per NFPA 13. The dry system shall be a sloped tree system per NFPA 13.
- B. Total Combined Inside & Outside Hose Allowances: Hydraulic calculations shall include an allowance for hose streams, added at the point of connection to the water supply.
- C. Safety Factor: A minium of 10 Psi, or 10 percent of static pressure, whichever is greater. Where local codes or owner requirements specify a different safety margin, the the highest safety margin shall be required.
- D. Velocity: Velocities indicated in the hydraulic calculations for all new pipe shall be kept at or below 20 feet per second.
- E. Flex drops: Calculations for flexible sprinkler drops shall be based on the UL listed equivalent lengths. The model number, maximum length, equivalent length, and maximum bends shall be indicated or detailed on the drawings.
- F. Density and Design Areas

1. Light Hazard Areas: Water density of 0.10 GPM per square foot calculated for an area of 1500 square feet in the most remote location.
 2. Ordinary Group I Hazard Areas: Water density of 0.15 GPM per square foot calculated for an area of 1500 square feet in the most remote locations.
 3. Ordinary Group II Hazard Areas: Water density of 0.20 GPM per square foot calculated for an area of 1500 square feet in the most remote locations.
 4. Design area increases for sloped ceilings and dry systems shall be applied to the calculated areas where applicable in accordance with NFPA 13.
 5. Quick Response area reductions shall only be permitted for Light Hazard Occupancies with Unobstructed Construction and no ceiling pockets that also meet the requirements indicated by NFPA 13.
 6. Quick Response area reductions shall not be permitted for shell spaces.
 7. Special design areas per NFPA 13 or sprinkler listings shall have the criteria used clearly indicated on the drawings and hydraulic calculations.
- G. Head Spacing
1. Head spacing shall not exceed the limits described in NFPA 13. or the product listing as permitted by NFPA 13.
 2. Head spacing proven by hydraulic calculations shall be clearly indicated on submittal and installation drawings. Spacing shall not exceed that proven by calculations.
 3. Interstitial spaces using specific application sprinklers: maximum and minimum spacing and maximum area of coverage per manufacturer's listing
 4. Attic spaces using specific application sprinklers: maximum and minimum spacing and maximum area of coverage per manufacturer's listing.
 5. Light Hazard: - Finished Spaces 225 sq. ft max (for standard spray sprinklers under smooth ceilings).
 6. Ordinary Hazard - Finished Spaces: 130 sq. ft. max (for standard spray sprinklers)
- H. Maximum floor areas protected by any one sprinkler system riser:
1. Light Hazard: 52,000 sq. ft.
 2. Ordinary Hazard: 52,000 sq. ft.
- I. Flow Data: Contractor is to obtain flow data (static pressure, residual pressure and GPM flowing) available at site and provide design for available pressure and flow, from within 1 year of permit documents.

1.10 QUALITY ASSURANCE

- A. The Contractor for the fire protection installation shall be duly qualified Fire Protection Contractor, experienced and regularly engaged in the installation of fire protection systems. Where local authorities require additional licensing of the Fire Protection Contractor, and/or workmen, such a license shall be mandatory for a prospective Contractor.
1. Contractor is to verify flow data (static pressure, residual pressure and GPM flowing) available at site and provide design for available pressure and flow.
 2. The Fire Protection contractor shall be the Engineer of Record for the automatic sprinkler system.
 3. Permits - The Fire Protection Contractor shall obtain permits for the installation or construction as required for approval and installation of the fire protection system. The Fire Protection Contractor shall submit working plans to the authorities having jurisdiction to obtain approval.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01. Handle components carefully to prevent damage, denting, and scoring. Do not install damaged components. Damaged components shall be replaced with new components.
1. Store/protect products under provisions of Division 01. Store components in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage.

1.12 GUARANTEE

- A. Provide a one-year (12 months) guarantee under provisions of Division 01. The guarantee shall include parts, shipping, labor, travel costs, living expenses, required fees, and any other associated cost or expense to repair or replace products or systems. The guarantee period is to begin on the date of acceptance of the fire protection installation by the Owner.

1.13 PAINTING

- A. Exposed piping as approved by Owner/Architect will be painted to architectural requirements.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All materials used shall be new unless indicated otherwise. Inspect all materials and immediately remove defective materials from the site.
- B. All electrical materials shall bear the label of, or be listed by, the Underwriters' Laboratories (UL), unless the material is of a type for which label or listing service is not provided.
- C. Substitution:
 - 1. No substitute materials or equipment may be installed without the written approval of the Architect.
 - 2. Use of substitute materials or equipment may require changes in associated materials and equipment. Contractor shall submit detailed Shop Drawings and installation instructions of substitute materials and equipment to Architect for approval. Such submittals shall address all changes required in other items.
 - 3. All additional costs incurred by the substitution of material or equipment, or the installation thereof whether Architectural, Structural, Mechanical, Plumbing, or Electrical shall be borne by the Contractor who substitutes the materials or equipment in place of the items specified.
- D. Quality of Materials: Pipe fittings and equipment may be taken from stock but the Contractor will be required to submit manufacturer's certificates identifying the material and equipment furnished as conforming with these Specifications and such codes and standards as apply to the equipment specified. Any material on the site which cannot be identified by manufacturer's mark shall be removed from the site at Architect's request.

2.02 SUBMITTALS

- A. The review of submittals and approval thereof by the Architect does not relieve the Contractor from compliance with the requirements and intentions of the Drawings and Specifications to which the submittals pertain. The contractor acknowledges its responsibility to submit complete shop drawings and other required submittals. Incomplete submittals will be returned to the contractor unreviewed.
- B. Working Plans: Prepare scaled working plans for fire protection pipe and fittings including, but not necessarily limited to, pipe and tube sizes, locations, and elevations and slopes of horizontal runs, wall and floor penetrations, and connections. Indicate interface between and spatial relationship to piping and adjacent equipment. Lettering shall be minimum 1/8" high. All design work shall be done under supervision of licensed engineer.
 - 1. Spacing of fire sprinklers shall be coordinated with lights, air conditioning outlets, sound speakers, architectural reflected ceiling plan; obstruction from light fixtures and other architectural features; and sprinkler piping shall be coordinated with HVAC ductwork & piping, plumbing, electrical conduit, cable trays and structure prior to the installation. Drawings shall be composite type including mechanical, plumbing and lighting equipment with sprinkler and sprinkler drain piping.
- C. Submittal Drawings: Submit shop drawings to Agency having jurisdiction for approval bearing engineer of record stamp bearing preparer's NICET stamp. Submit six approved copies, bearing stamp and/or signature of authority having jurisdiction to the Engineer for review and comment.
 - 1. Contractor shall submit sprinkler head locations to architect for approval.

2. Each calculation shall include legible schematic of system showing all hydraulic reference points.
- D. Hydraulic Calculations: Prepare hydraulic calculations of fire protection systems. Submit to authority having jurisdiction for approval. Submit six approved copies, bearing stamp, and/or signature of Agency having jurisdiction to Owner's representative for review and comment.
- E. Certificate of Installation: Submit certificate upon completion of fire protection piping work, which indicates that work has been tested in accordance with NFPA 13, and also that system is operational, complete, and has no defects.
- F. Maintenance Data: Submit maintenance data and parts lists for fire protection materials and products. Include this data, product data, shop drawings, approval drawings, approval calculation, certificate of installation, and record drawings in maintenance manual; in accordance with requirements of the General Conditions and of Division 01.
- G. Operating and Maintenance Instructions: Provide the Owner with one set of operating and maintenance instructions covering completely the operation and maintenance of sprinkler equipment and controls.
- H. Material List: An itemized list of material and equipment which the Contractor proposes to use shall be submitted to the Architect with number of copies indicated and within time indicated.
- I. Shop Drawings and Product Data:
 1. Submit all required Shop Drawings, product data, etc. at one time. Submittals shall be bound, tabbed, and properly indexed by Specification Section.
 2. Each item shall be identified by manufacturer, brand, and trade name; model number, size, rating, and whatever other data is necessary to properly identify and verify the materials and equipment. The words "AS SPECIFIED" will not be considered sufficient information.
 3. Each submittal shall bear the Contractor's stamp and mark indicating the Contractor has reviewed and approved the submittal.
 4. Each submitted item shall refer to the Specification Section and paragraph in which the item is specified.
 5. Accessories, controls, finish, etc. not required to be submitted or identified with the submitted equipment shall be furnished and installed as specified.
 6. Submittals shall be all inclusive with all items requiring submittals being submitted at the same time; individual submittals will not be accepted.
 7. Place orders for all equipment in time to prevent any delay in construction schedule or completion of project. If any materials or equipment are not ordered in time, additional charges made by equipment manufacturers to complete their equipment in time to meet construction schedule, together with any special handling charges, shall be borne by Contractor.

PART 3 EXECUTION

3.01 RECORD DRAWINGS

- A. Record Drawings shall be maintained at all times showing the exact location of piping mains, branches, valves, drains, etc. installed under all Sections. Obtain from the Architect, at cost, a complete set of prints. On these prints systematically and accurately keep a dimensional record of all work installed different from those shown on Drawings. Have these Drawings readily available for reference.
- B. Record Set: When above information is complete and acceptable to the Architect transfer this information accurately to reproducible tracings, purchased at cost from the Architect for this purpose, and deliver to the Architect for final review.
- C. Upon completion of the Architect's review of the Record Set the Contractor shall incorporate changes, as noted on the record set, including dimensions such as elevations, valves, etc. Deliver transparencies with one (1) set of prints to the Architect. Deliver one (1) complete set of prints to building Owner within ninety (90) days of issuance of final occupancy report.

- D. Inspector's Approval: Where a full-time inspector is employed by the Owner, the Record Drawing information shall be reviewed by the inspector during the course of construction and shall have the inspector's approval before submission to the Architect.

3.02 ACCEPTANCE TESTS

- A. Documentation on standard NFPA Acceptance forms and inspection documents shall be submitted to the Architect and AHJ Inspector of Record (where required).
- B. The required acceptance documents shall be signed by a state licensed Fire Protection Contractor.

3.03 DAMAGE

- A. Repair any damage to the building, premises, and equipment occasioned by the work under this Section.
- B. Repair all damage to any part of the building or premises caused by leaks or breaks in pipe, or malfunctions of equipment furnished or installed under this Section until the warranty period expiration date.

3.04 COMPLETE WORKING INSTALLATION

- A. The Drawings and Specifications do not attempt to list every item that must be installed. When an item is necessary for the satisfactory operation of equipment, is required by the equipment manufacturer, or accepted as good practice, furnish without change in Contract cost.

3.05 STORAGE

- A. Provide proper protection and storage of all items and tools required for this work.

3.06 QUALITY OF WORK

- A. The quality of work shall be of a standard generally accepted in the respective trade. Use only experienced, competent, and properly equipped workers. Replace work falling below this standard as directed by the Architect.
- B. Systems shall be worked into a complete and integrated arrangement with like elements arranged to make a neat appearing and finished piece of work, with adequate head room and passageway free from obstructions. Such systems shall be installed by laborers experienced in the respective trades involved.

3.07 CONCRETE WALLS AND CONCRETE FOOTINGS

- A. Where pipes must pass through concrete walls and footings, they shall pass through Schedule 40 galvanized pipe sleeves set in place at time of construction. The sleeves shall provide clearance in accordance with NFPA 13
- B. Coordinate core drilled openings with Architect and General Contractor. Coordination shall include location, size, and spacing of openings. No slot openings will be allowed. Coordinate openings to avoid critical structural items such as reinforcing bars, tensioning tendons, etc.
- C. Also see Paragraph 3.15.

3.08 ELECTRICAL REQUIREMENTS - CONTROLS AND COORDINATION WITH ELECTRICAL CONTRACTOR

- A. The Fire Protection Contractor shall coordinate with the Electrical Contractor on furnishing and installing of controls, motors, starters, etc. Coordinate means informing Electrical Contractor of items requiring electrical connection, providing copies of submittal data, installation data, scheduling work to ensure efficient progress, and promptly supplying those items to be installed by Electrical Contractor.
- B. The specific requirements for electrical power and/or devices for each and every piece of fire protection equipment requiring electrical service, supplied and/or installed under this Contract, shall be coordinated and verified with the Fire Protection Drawings, Fire Protection Sections of these Specifications, and with the manufacturers of the equipment supplied. This shall include the voltage, phase, and ampacity; conduit requirements; and exact location and type of

disconnect, control, and/or connection required. Any changes from the Drawings and Specifications required as a result of this coordination shall be part of this Contract.

- C. Electrical Contractor shall furnish and install the following for all mechanical equipment:
 - 1. Conduit and wiring for line voltage power to the equipment.
 - 2. Disconnect switches.
 - 3. Manual motor starters.
 - 4. Magnetic motor starters when part of a motor control center. See Division 16 and Drawings for further information.
- D. The work under this Section shall include furnishing and installing all controls on low and manual line voltage, including thermostats, auxiliary switches, relay wiring, interlock wiring; equipment control panels and transformers; and controls conduit unless specifically indicated as part of other work. Materials and methods of the control installation shall be in accordance with the Electrical Specifications.
- E. The Fire Protection Contractor shall review all wiring connections which have any influence on this equipment or work and verify that these connections are correct before permitting any equipment to be operated which is furnished, installed, or modified under this Contract.

3.09 ELECTRICAL REQUIREMENTS - MOTORS AND EQUIPMENT FURNISHED UNDER THIS SECTION

- A. Motors and motor control equipment shall conform to the standards of the National Electrical Manufacturer's Association (NEMA). Motors and motor control equipment shall be as specified below. The work under this Section shall include:
 - 1. Furnishing all motors, magnetic starters and automatic control devices for equipment furnished and installed by this Contractor. Electrical Contractor shall provide magnetic starters at motor control center where indicated.
 - 2. Installation of the above motors and control devices. Manual motor starters shall be furnished and installed by Electrical Contractor in accordance with Electrical Specifications.
 - 3. Furnishing and installing line and/or low voltage interlock wiring shall be by the Mechanical Contractor. Installation of wire includes the connection of devices. All work shall be in accordance with the materials and methods specified in the Electrical Specifications.
 - 4. Furnishing and installing completely wired equipment control panels with complete controls for automatic operation where indicated or when supplied with equipment.
 - 5. Furnishing and installing all control and interlock wiring from equipment control panels to related remote devices, fans, motors, heaters, and controls.
 - 6. Wire mounted on heat producing appliances shall be Type RHH or THHN (90°C).
 - 7. Except as noted above, disconnect switches, power circuits from electrical panelboard to disconnect switch, starters, and motors shall be furnished and installed under the Electrical Specifications.

3.10 ELECTRICAL EQUIPMENT ROOM PRECAUTIONS

- A. Piping shall not be installed in any switchgear room, transformer vault, telephone room or electric closet except as indicated. In any case, no piping shall be installed in the space equal to the width and depth of any electrical service equipment, switchboards, panel boards, or motor control centers and extending from the floor to a height of six feet above the equipment or to the structural ceiling, whichever is lower. Only sprinkler piping serving the room may be installed in those rooms.

3.11 CUTTING AND REPAIRING

- A. No cutting shall be done except with Architect's approval. Cutting of structural members or footings is prohibited without the prior written consent of the Structural Engineer.
- B. Where cutting of paving, walls, ceilings, etc. is necessary for the installation of the mechanical work, it shall be done under the direction of this Section. Damage caused by this cutting shall

be repaired to match original and adjacent surfaces without additional expense to the Owner. Cutting of new construction shall be by the installing Contractor of that construction as directed by this Contractor.

3.12 PIPE AND VALVE IDENTIFICATION

- A. Identify all piping contents with letter legend on color background identifying hazard or use of material.
- B. The pipe marker system shall conform completely with "The Scheme for Identification of Piping Systems" (ANSI A13.1). More specifically, the pipe marker must possess the following:
 - 1. ANSI specified color coded background.
 - 2. ANSI specified color of legend in relation to background color.
 - 3. ANSI specified legend letter size.
 - 4. ANSI specified length of color field (marker length).

- C. The following tables will serve to clarify the above mentioned requirements:

Outside Diameter of Pipe or Covering	Length of Color Field	Size of Letters
3/4" to 1 1/4"	8"	1/2"
1 1/2" to 2"	8"	3/4"
2 1/2" to 6"	12"	1 1/4"
8" to 10"	24"	2 1/2"
Over 10"	32"	3 1/2"

- D. All pipes 3/4" I.D. and smaller shall be marked with 1 1/2" brass tags equivalent to valve tags.
- E. Provide flow markers consisting of labels similar to pipe markers with a large black arrow printed on same background color to indicate direction of flow.
- F. Place pipe marker and flow marker on each pipe on both sides of walls or floors through which pipes pass. Place markers adjacent to valves and fittings or branch take-off and for exposed piping locate markers to be clearly visible to person standing on floor, and at not over 30'-0" intervals on all straight runs of pipe.
- G. All valves under 3/4" I.D.: 18 gauge brass identification tags 1 1/2" in diameter with depressed 1/2" high black filled letters above 1/2" black filled numbers. Tags shall be fastened securely at specified locations. Valve tags shall show valve number, purpose, and normal condition (open or closed).
- H. Tag Locations:
 - 1. Adjacent to each valve and fitting except on plumbing fixtures and equipment.
 - 2. At each branch and riser take-off.
 - 3. At each pipe passage through wall, floor, and ceiling construction.
 - 4. At each pipe passage to underground.
 - 5. On all horizontal pipe runs, marked every 25'-0".

3.13 VALVE TAGS AND CHART

- A. Furnish and install in each mechanical room a single typed valve chart identifying all valves with their respective tag numbers, size, manufacturer, model number, service, and indicating whether each valve is normally open or normally closed. Chart shall be mounted in a neat sheetmetal frame with glass front. The frame shall be arranged so that valve chart is removable. Provide three (3) additional copies of valve chart in maintenance manuals.

3.14 SLEEVES AND SEALING

- A. Provide sleeves for all pipes passing through new floors, walls, partitions, and any other building construction, of adequate diameter to allow minimum clearance all around between sleeve and pipe as required by NFPA 13.
- B. Lay out work prior to concrete forming. Reinforce sleeves to prevent collapse during forming and curing.
- C. All floor sleeves required shall extend 1" above finished floor except through mechanical equipment room floors and shafts where sleeves shall extend 2" above finished floor level. Sleeves through roof shall extend 8" above roof. Wall sleeves shall be flush with face of wall unless otherwise indicated. Waste stacks using carriers shall have sleeves flush with floor and sealed.
- D. Sleeves shall permit free thermal expansion of pipe without binding or contact with structure.
- E. Do not support pipes by resting pipe clamps on floor sleeves. Supplementary members shall be provided so pipes are floor supported.
- F. Special sleeves detailed on Drawings shall take precedence over this Section.
- G. Pipe sleeves as scheduled below unless otherwise indicated:
 - 1. Plaster or Drywall:
 - 2. Schedule 40 galvanized steel pipe.
 - 3. Concrete or Masonry Walls and Concrete Bases:
 - 4. See Paragraph 3.8.
 - 5. Waterproof membraned floors, walls, concrete pits, foundation walls, etc. as detailed or specified in other Sections.

3.15 SUPPORTS

- A. All supports and bracing shall comply with NFPA 13.
- B. All equipment and piping shall be mounted on, or suspended from, foundations and supports as specified and indicated, and seismically braced to structure.
- C. Seismic restraints shall be provided in accordance with NFPA 13.
- D. All piping and equipment shall be securely anchored to building structure as required by the Specifications, state building code(s), and NFPA 13.
- E. Earthquake restraints shall be capable of resisting the gravity lateral loads required by NFPA 13.
- F. Supplemental Supports: Provide supplemental supports to span building structural elements as necessary for equipment foundations and supports. Provide Shop Drawings to Mechanical and Structural Engineers for approval prior to installation.

3.16 ACCESSIBILITY

- A. General: Valves, pressure gauges, and indicating equipment or specialties requiring reading, adjusting, inspection, repairing, removal, or replacement shall be conveniently and accessibly located with reference to finished building. Gauges shall be installed to be easily read from floor.
- B. Panels: No unions, flanges, valves, controls, or equipment shall be placed in a location that will be inaccessible after the system is complete. Access panels or doors shall be provided where required whether or not shown on Drawings.
- C. Access Panels in Walls or Ceilings:
 - 1. Provide access panels in walls or ceilings where indicated and where required to provide access to valves, dampers, and other appurtenances. Panels shall be style as selected by Architect and as directed by wall or ceiling construction. Panel size shall be 24" x 24" unless indicated otherwise. Panels in acoustical barriers shall have same transmission loss as barrier. Panels in rated construction shall have same rating as construction in which installed.

2. Door panels shall be no lighter than 14 gauge steel. Doors shall be equipped with concealed spring hinges and flush, screwdriver operated locks, except that key operated locks shall be used for all access doors in walls where door is within 6'-0" of floor. Locks for all key operated doors shall be keyed alike.
 3. Doors in ceramic tile surfaces shall be stainless steel or chrome plated. Doors in other finished surfaces shall be prime coated.
- D. Equipment Spaces: Provide aisles between equipment and piping, electrical gear, etc. for complete service and inspection of equipment. Maintain minimum 6'-6" headroom in all access aisles. Maintain minimum 36" clearance at all service panels. Provide minimum clearances at electrical equipment per NEC. Provide 36" wide, 3/4" thick plywood covered catwalks in attics from access door to equipment.

3.17 TESTING

- A. Test all piping, equipment, and systems as called for in the Specifications. Notify Architect and inspection authorities prior to testing so that they may be witnessed. Protect all personnel and equipment during testing. Where Specifications do not cover specific points or methods, conform to manufacturer's specifications.

3.18 EQUIPMENT

- A. All equipment shall be accurately set and leveled. Supports shall be neatly placed and properly fastened. All equipment shall be fastened in place with bolts.
- B. Keep all openings closed with plugs or caps to prevent entrance of foreign matter. Protect all piping, ductwork, fixtures, and equipment against dirt, water, chemical, or mechanical damage both before and after installation. Any equipment or apparatus damaged prior to final acceptance shall be restored to original condition or replaced at the Architect's discretion and at no additional cost to the Owner.
- C. Start-Up: Equipment shall be adjusted, lubricated, aligned, etc. prior to start-up. Inspect each piece of equipment prior to start-up. Start each piece of equipment in accordance with manufacturer's directions and warranty requirements.
- D. Finish: Protect all equipment and materials until in use. Any visible rust or corrosion shall be removed as directed prior to installation. All damaged factory painted finishes shall be cleaned and painted with manufacturer provided paint.

3.19 MANUFACTURER'S DIRECTIONS

- A. Materials and equipment shall be installed in accordance with manufacturer's application and recommendations, requirements, and instructions, and in accordance with Contract Documents. Where manufacturer's instructions differ from those indicated or specified, they shall be brought to Architect's attention for resolution prior to equipment ordering and installation.
- B. Where requirements indicated in Contract Documents exceed manufacturer's requirements, Contract Documents shall govern.

3.20 FURRING AND PIPE SPACES

- A. Spaces provided in the design of the building shall be utilized and the work shall be kept within the furring lines established on the Drawings.
- B. Layout: Maintain maximum head room under piping and equipment. Contractor to coordinate line locations with beams, windows, etc. to provide maximum clearance. From Drawings, ascertain heights of suspended ceilings and size of pipe shafts in which piping is concealed, and location and size of structural members in and adjacent to pipe shafts. Coordinate piping installation with ductwork, lighting, and other equipment. Ensure necessary clearances on trim plates at exposed penetrations of walls and floors. If sufficient room is not available above suspended ceiling or vertical shafts obtain clarification from Architect before work is started.

3.21 SEISMIC RESTRAINTS

- A. General: All work, materials and methods used shall conform to the Drawings and Specifications. NFPA 13 Guidelines shall be followed when specific details are not shown on the Drawings. Anchorage of equipment for which specific details are not shown on the Drawings shall be adequate to resist the forces based on the required "CP" factor. Such anchorage shall be approved by the Architect, Structural Engineer, and AHJ.
- B. All supports shall be in accordance with NFPA 13 and state building code(s).
- C. Piping:
 - 1. Pipe bracing system shall conform to the Drawings and to Specification requirements hereinafter listed, or shall be a pre-approved manufacturer's system such as Tolco Seismic Bracing System, or approved equal.
 - 2. The Contractor shall submit Shop Drawings indicating the location of all seismic braces and provide a legend giving load information and model specifications prior to installation. Such prearranged system shall conform to requirements of the Specifications.
 - 3. Brace all pipes with 2 1/2" I.D. and larger in accordance with NFPA 13.
 - 4. Transverse bracings at 40'-0" on center maximum (minimum of one brace per direction of run).
 - 5. Longitudinal bracings at 80'-0" on center maximum (minimum of one brace per direction of run).
 - 6. Transverse bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24" of the elbow or tee and is connected to the largest pipe.
 - 7. Do not use branch lines to brace main lines.
 - 8. Provide flexibility in joints where pipes pass through building seismic or expansion joints or where rigidly supported pipes connect to equipment with vibration isolators.
 - 9. At vertical pipe risers, support the weight of the riser at a point or points above the center of gravity of the riser wherever possible. Provide lateral guides at the top and bottom of the riser and at intermediate points not to exceed 30'-0" on center.
 - 10. Provide large enough pipe sleeves through walls or floors to allow for anticipated differential movements.
 - 11. Do not fasten one rigid piping system to two dissimilar parts of the building that may respond in a different mode during an earthquake (e.g., a wall and a roof).
 - 12. Cast iron piping systems are included in these requirements.
 - 13. All trapeze hangers shall be braced.

3.22 CLEAN-UP

- A. During the course of work under this Section, all rubbish, debris, surplus materials, tools, etc. resulting from this work shall be removed from work area and shall be disposed of off-site at the end of each working day. The Owner's premises shall be left clean and in a condition acceptable to the Architect.
- B. Clean all work installed under this Contract to satisfaction of Owner and submit documentation that each system has been cleaned and results witnessed by the Architect's representative.

3.23 ENGRAVED NAMEPLATES

- A. Furnish and install plastic laminated engraved nameplates in accordance with NFPA 13, the local Fire Marshal and AHJ.

3.24 FINAL INSPECTION

- A. The Contractor shall furnish the Architect with certificates of final inspection and approval from the inspection authorities having jurisdiction.

3.25 GUARANTEE

- A. The Contractor shall guarantee the quality of all work and the quality of equipment and materials in accordance with the provisions of the General Conditions and Special Conditions.

Should any defects occur during this period, the Contractor shall promptly repair or replace defective items as directed by the Architect, without cost to the Owner.

3.26 OPERATING AND MAINTENANCE MANUALS

- A. Complete sets of bound instructions containing the manufacturer's operating and maintenance instructions in accordance with specification section 21 0500 Overhead Fire Protection System:
- B. Field Instructions: Upon completion of the work and at a time designated by the Owner the services of one or more competent Engineers shall be provided by the Contractor to instruct a representative of the Owner in the operation and maintenance of the systems. These field instructions shall cover all the items contained in the bound instructions and shall be of a sufficient length and detailed nature, in the Engineer's judgment, to insure safe and efficient operation.

END OF SECTION

**SECTION 21 0500
COMMON WORK RESULTS FOR FIRE SUPPRESSION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Above ground piping.
- B. Buried piping.
- C. Escutcheons.
- D. Expansions - hose and braid.
- E. Mechanical couplings.
- F. Pipe sleeves.
- G. Pipe sleeve-seal systems.

1.02 RELATED REQUIREMENTS

- A. Section 078413 - Penetration Firestopping
- B. Section 210000 - General Requirements For Fire Protection
- C. Section 21 0523 - General-Duty Valves for Water-Based Fire-Suppression Piping.
- D. Section 21 0553 - Identification for Fire Suppression Piping and Equipment: Piping identification.
- E. Section 21 1300 - Fire-Suppression Sprinkler Systems: Sprinkler systems design.

1.03 REFERENCE STANDARDS

- A. ASME A112.18.1 - Plumbing Supply Fittings; 2018, with Errata.
- B. 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; 2021.
- C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- D. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- E. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2021.
- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- G. ASTM A135/A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe; 2021.
- H. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use; 2021.
- I. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).
- J. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2017, with Errata (2018).
- K. FM (AG) - FM Approval Guide; current edition.
- L. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog information. Indicate valve data and ratings.
- B. Operation and Maintenance Data: Include installation instructions and spare parts lists.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Sprinkler-based System:
 - 1. Comply with NFPA 13.
 - 2. See Section 21 1300.
- B. Water supply and treatment:
 - 1. Water supplies and environmental conditions shall be evaluated for the existence of microbes and conditions that contribute to microbiologically influenced corrosion (MIC). Test and treat in accordance with 2019 NFPA 13 section 5.1.5 and 7.8

2.02 BURIED PIPING

- A. Ductile Iron Pipe: AWWA C151/A21.51.
 - 1. Fittings: AWWA C110/A21.10, standard thickness.
 - 2. Joints: AWWA C111/A21.11, styrene-butadiene rubber (SBR) or vulcanized SBR gasket.
 - 3. Mechanical Couplings: Shaped composition sealing gasket, steel bolts, nuts, and washers.
- B. In-Building Riser:
 - 1. Ames series IBR, 304 stainless steel, UL/FM approved.
 - 2. Restrain with thrust block and mechanical restraint

2.03 ABOVE GROUND PIPING

- A. Manufacturers
 - 1. Wheatland Tube Company[<>]: www.wheatland.com/#sle.
 - 2. Yongstown Tube: www.yongstowntube.com
 - 3. Bull Moose: www.bullmoosetube.com
 - 4. State Pipe: www.statepipe.com
- B. Steel Pipe: ASTM A53 Schedule 40 or ASTM A795 Schedule 40 UL/FM Listed for Fire Protection with anti-MIC coating, Schedule 10, Black-Steel Pipe: UL/FM Listed, ASTM A795/A795M, Schedule 10 in NPS 2 and larger; and NFPA 13-specified wall thickness in NPS 8 to NPS 10, with.
 - 1. Piping Schedule:
 - a. Standard-pressure, wet pipe sprinkler system, NPS 1-1/2 and smaller shall be one of the following:
 - 1) Standard-weight or Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2) Standard-weight, or Schedule 40 galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints for exterior piping. or roll or cut groove ends with listed groove couplings and fittings for steel piping.
 - b. Standard-pressure, wet-pipe sprinkler system, NPS 2 to NPS 6, shall be one of the following:
 - 1) Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 2) Standard-weight or Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints, or roll or cut groove ends with grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

- 3) Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints for exterior piping.
- c. Standard-pressure, dry-pipe sprinkler system, shall be one of the following:
 - 1) Standard-weight or Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints, or grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 2) Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints for exterior piping.
- d. Drain piping shall be Schedule 40, galvanized-steel pipe with threaded or grooved ends and galvanized MI threaded or galvanized grooved fittings.
2. Steel Fittings: ASME B16.5 steel flanges and fittings.
3. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings and ASME B16.4, threaded fittings.
4. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
5. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe. 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.
6. Mechanical Grooved Fittings / Grooved-Joint, Steel-Pipe Appurtenances:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - 2) Victaulic Company.
 - 3) Anvil / Gruvlok brands of ASC Engineered Solutions
 - b. Pressure Rating: 175-psig minimum.
 - c. Galvanized and Painted Grooved-End Fittings for Steel Piping: ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.

2.04 PIPE SLEEVES

- A. Vertical Piping:
 1. Sleeve Length: 1 inch (25 mm) above finished floor.
 2. Provide sealant for watertight joint.
- B. Plastic, Sheet Metal, or Moisture-Resistant Fiber: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- C. 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.
- D. Pipe Passing Through Quarry Tile, Terrazzo, or Ceramic Tile Floors:
 1. Brass pipe.
 2. Connect sleeve with floor plate.
- E. Pipe Passing Through Concrete Beam Flanges, except where Brass Pipe Sleeves are Specified:
 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 2. Connect sleeve with floor plate except in mechanical rooms.
- F. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 2. Connect sleeve with floor plate except in mechanical rooms.

- G. Clearances:
1. Provide allowance for insulated piping.
 2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch (25 mm) greater than external; pipe diameter.
 3. Rated Openings: Caulked tight with firestopping material complying with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.05 PIPE SLEEVE-SEAL SYSTEMS

- A. Manufacturers:
1. Advance Products & Systems, Inc: www.apsonline.com/#sle.
 2. GPT, a company of Enpro Industries, Inc: www.gptindustries.com/#sle.
 3. CALPICO, Inc : www.calpicoinc.com/.
 4. Metraflex
- B. Modular Mechanical Seals:
1. Elastomer-based interlocking links to 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.
- C. Wall Sleeve: Steel material with waterstop collar, and nailer end caps.
- D. Sleeve-Forming Disk: Nonconductive plastic-based material, 3 inch (76.2 mm) thick.
- E. Pipeline-Casing Seals:
1. End Seals: 1/8 inch (3.1 mm), pull-on type, rubber or synthetic rubber based.

2.06 ESCUTCHEONS

- A. Manufacturers:
1. Fire Protection Products, Inc: www.fppi.com/#sle.com/#sle.
 2. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
 3. Viking Group Inc: www.vikinggroupinc.com/#sle.
 4. BrasCraft Manufacturing Co.; a Masco company.: www.brascraft.com.
- B. Material:
1. Coordinate finish with architect.
 2. Metals and Finish: Comply with ASME A112.18.1.

2.07 MECHANICAL COUPLINGS

- A. Manufacturers:
1. Anvil International; _____: www.anvilintl.com/#sle.
 2. Tyco Fire Protection Products; ____: www.tyco-fire.com/#sle.
 3. Victaulic Company; FireLock Style 009H: www.victaulic.com/#sle.
- B. Rigid Mechanical Couplings for Grooved Joints:
1. UL listed AND FM approved for fire protection.
 2. Dimensions and Testing: Comply with AWWA C606.
 3. Minimum Working Pressure: 300 psig (2065 kPa).
 4. Housing Material: Fabricate of ductile iron complying with ASTM A536.
 5. Housing Coating: Factory applied orange enamel.
 6. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F (minus 34 degrees C) to 230 degrees F (110 degrees C).
 7. Bolts and Nuts: Hot-dipped-galvanized or zinc-electroplated steel.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and foreign material, from inside and outside, before assembly.

3.02 INSTALLATION

- A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
- B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- C. Install piping to conserve building space, to not interfere with use of space and other work.
- D. Coordinate sprinkler layout and exposed pipe routing with Architect.
- E. Coordinate system layout with other trades
- F. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.
- G. Structural Considerations:
 - 1. Do not penetrate building structural members unless coordinated with Structural Engineer of Record.
- H. 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. Use UL listed fire caulk and sleeve assemblies to maintain wall or floor ratings.
- I. 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 watertight seal.
 - 6. Install in accordance with manufacturer's recommendations.
- J. Escutcheons:
 - 1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
 - 2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
 - 3. Use escutcheons with architect approved finish in occupied spaces and to conceal openings in construction.
- K. 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, unions, 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.

- C. See Section 01 7419 - Construction Waste Management and Disposal for additional requirements.

END OF SECTION

SECTION 21 0523
GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Two-piece ball valves with indicators.
- B. Bronze butterfly valves with indicators.
- C. Iron butterfly valves with indicators.
- D. Check valves.
- E. Bronze OS&Y gate valves.
- F. Iron OS&Y gate valves.
- G. NRS gate valves.
- H. Indicator posts.
- I. Trim and drain valves.

1.02 RELATED REQUIREMENTS

- A. Section 210000 General Requirements for Fire Protection
- B. Section 21 0500 - Common Work Results for Fire Suppression: Pipe and fittings.
- C. Section 21 0553 - Identification for Fire Suppression Piping and Equipment.
- D. Section 21 1300 - Fire-Suppression Sprinkler Systems.

1.03 ABBREVIATIONS AND ACRONYMS

- A. EPDM: Ethylene-propylene diene monomer.
- B. NRS: Non-rising stem.
- C. OS&Y: Outside screw and yoke.
- D. PTFE: Polytetrafluoroethylene.
- E. SBR: Styrene-butadiene rubber.

1.04 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- C. ASME B31.9 - Building Services Piping; 2020.
- D. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 48-In. (50-mm Through 1,200-mm) NPS; 2025.
- E. AWWA C606 - Grooved and Shouldered Joints; 2015.
- F. FM (AG) - FM Approval Guide; current edition.
- G. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL (DIR) - Online Certifications Directory; Current Edition.
- I. UL 312 - Check Valves for Fire-Protection Service; Current Edition, Including All Revisions.
- J. UL 1091 - Standard for Butterfly Valves for Fire-Protection Service; Current Edition, Including All Revisions.

1.05 SUBMITTALS

- A. See Section 013300 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. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 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. Where listed products are specified, provide products listed, classified, and labeled by FM (AG), UL (DIR), or testing firm acceptable to authorities having jurisdiction as suitable for the purpose indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads and flange faces.
 - 3. Protect threads, flange faces, and weld ends.
 - 4. Set valves open to minimize exposure of functional surfaces.
- 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 and maintain at higher than ambient dew point temperature.
 - b. If outdoor storage is unavoidable, store valves off the ground in watertight enclosures.
- C. Use the following precautions for handling:
 - 1. Use sling to handle large valves, rigged to avoid damage to exposed parts.
 - 2. Do not use operating handles or stems as lifting or rigging points.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain each type of valve from single manufacturer.

2.02 GENERAL REQUIREMENTS

- A. UL Listed: Provide valves listed in UL (DIR) under following headings and bearing UL mark:
 - 1. Main Level: HAMV - Fire Main Equipment.
 - a. Level 1: HCBZ - Indicator Posts, Gate Valve.
 - b. Level 3: HLUG - Ball Valves, System Control.
 - c. Level 3: HLXS - Butterfly Valves.
 - d. Level 3: HMER - Check Valves.
 - e. Level 3: HMRZ - Gate Valves.
 - 2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.
 - a. Level 1: VQGU - Valves, Trim, and Drain.
- B. FM Global Approved: Provide valves listed in FM (AG) Approval Guide under the following headings:
 - 1. Automated Sprinkler Systems:
 - a. Indicator posts.
 - b. Valves:
 - 1) Gate valves.
 - 2) Single check valves.
 - 3) Miscellaneous valves.
- C. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
 2. ASME B1.20.1 for threads on threaded-end valves.
 3. ASME B31.9 for building services piping valves.
- D. Comply with AWWA C606 for grooved-end connections.
- E. Comply with NFPA 13 for valves.
- F. Valve Pressure Ratings: Not less than minimum pressure rating indicated or higher as required.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. Valve Actuator Types:
1. Worm-gear actuator with handwheel for quarter-turn valves, except trim and drain valves.
 2. Handwheel: For other than quarter-turn trim and drain valves.
 3. Hand-lever: For quarter-turn trim and drain valves 2 NPS (50 DN) and smaller.

2.03 TWO-PIECE BALL VALVES WITH INDICATORS

- A. Manufacturers:
1. FNW: www.fnw.com/#sle.
 2. Ames Fire & Waterworks; A WATTS Brand: www.watts.com/our-story/brands/ames-fire-and-waterworks.
 3. NIBCO Inc.: <https://www.nibco.com>.
 4. Victaulic Company: www.victaulic.com
- B. UL 1091, except with ball instead of disc and FM (AG) standard listing for indicating valves (butterfly or ball type), Class Number 1112.
- C. Description:
1. Minimum Pressure Rating: 175 psig (1200 kPa).
 2. Body Design: Two piece.
 3. Body Material: Forged brass or bronze.
 4. Port Size: Full or standard.
 5. Seat: PTFE.
 6. Stem: Bronze or stainless steel.
 7. Ball: Chrome-plated brass.
 8. Actuator: Worm gear or traveling nut.
 9. Supervisory Switch: Internal or external.
 10. End Connections for Valves 1 NPS (25 DN) through 2 NPS (50 DN): Threaded ends.
 11. End Connections for Valves 2-1/2 NPS (65 DN): Grooved ends.

2.04 BRONZE BUTTERFLY VALVES WITH INDICATORS

- A. Manufacturers:
1. FNW: www.fnw.com/#sle.
 2. NIBCO Inc.: <https://www.nibco.com>.
 3. Victaulic Company: www.victaulic.com.
- B. UL 1091 and FM (AG) standard listing for indicating valves, (butterfly or ball type), Class Number 1112.
- C. Minimum Pressure Rating: 175 psig (1200 kPa).
- D. Body Material: Bronze.
- E. Seat: EPDM.
- F. Stem: Bronze or stainless steel.
- G. Disc: Bronze with EPDM coating.
- H. Actuator: Worm gear or traveling nut.
- I. Supervisory Switch: Internal or external.

2.05 IRON BUTTERFLY VALVES WITH INDICATORS

- A. Manufacturers:
 - 1. FNW: www.fnw.com/#sle.
 - 2. Kennedy Valve: www.kennedyvalve.com/#sle.
 - 3. NIBCO Inc.: <https://www.nibco.com>.
 - 4. Victaulic Company: www.victaulic.com
- B. UL 1091 and FM (AG) standard listing for indicating valves (butterfly or ball type), Class Number 112.
- C. Minimum Pressure Rating: 175 psig (1200 kPa).
- D. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, polyamide, or _____ coating.
- E. Seat: EPDM.
- F. Stem: Stainless steel.
- G. Disc: Ductile iron, nickel plated and EPDM or SBR coated.
- H. Actuator: Worm gear or traveling nut.
- I. Supervisory Switch: Internal or external.
- J. Body Design: Grooved-end connections.

2.06 CHECK VALVES

- A. Manufacturers:
 - 1. Kennedy Valve; AWWA Compliant: www.kennedyvalve.com/#sle.
 - 2. NIBCO Inc.: <https://www.nibco.com>.
 - 3. FEBCO; A WATTS Brand.
 - 4. Kennedy Valve Company; a division of McWane, Inc.
 - 5. Mueller Co.
 - 6. Reliable Automatic Sprinkler Co., Inc. (The).
 - 7. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - 8. Victaulic Company.
- B. UL 312 and FM (AG) standard listing for check valves, Class Number 1045.
- C. AWWA C508 compliant check valves.
- D. Minimum Pressure Rating: 175 psig (1200 kPa).
- E. Type: Center guided check valve.
- F. Body Material: Cast iron, ductile iron.
- G. Center guided check with elastomeric seal.
- H. Hinge Spring: Stainless steel.
- I. End Connections: Flanged, grooved, or threaded.

2.07 BRONZE OS&Y GATE VALVES

- A. Manufacturers:
 - 1. Kennedy Valve Company; a division of McWane, Inc.
 - 2. Mueller Co.
 - 3. NIBCO INC.
 - 4. Victaulic Company.
 - 5. Zurn Industries, LLC.
- B. UL 262 and FM (AG) standard listing for fire-service water control valves (OS&Y and NRS-type gate valves).

2.08 IRON OS&Y GATE VALVES

- A. Manufacturers:
 - 1. Kennedy Valve; Ken-Seal Series, AWWA Compliant: www.kennedyvalve.com/#sle.
 - 2. Mueller Co.
 - 3. NIBCO INC.
 - 4. Victaulic Company.
- B. Listed and Body Marked: AWWA C509, FM (AG), and UL 262.
- C. End Connections: Flanged.

2.09 NRS GATE VALVES

- A. Manufacturers:
 - 1. Clow Valve Company; a subsidiary of McWane, Inc.
 - 2. Kennedy Valve Company; a division of McWane, Inc.
 - 3. Mueller Co.
 - 4. NIBCO INC.
 - 5. Victaulic Company.
- B. UL 262 and FM (AG) standard listing for fire-service water control valves (OS&Y and NRS-type gate valves).
- C. Body and Bonnet Material: Cast or ductile iron.
- D. Wedge: Cast or ductile iron with elastomeric coating.
- E. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.

2.10 INDICATOR POSTS

- A. Manufacturers:
 - 1. Kennedy Valve: www.kennedyvalve.com/#sle.
 - 2. Clow Valve Company; a subsidiary of McWane, Inc.
 - 3. Mueller Co.
 - 4. Victaulic .
- B. UL 789 and FM (AG) standard listing for indicator posts.
- C. Type: Wall or Underground.

2.11 TRIM AND DRAIN VALVES

- A. Ball Valves:
 - 1. Manufacturers:
 - 2. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - 3. Fire-End & Croker Corporation.
 - 4. Jomar Valve.
 - 5. Milwaukee Valve Company.
 - 6. NIBCO INC.
 - 7. Potter Roemer LLC; a Division of Morris Group International.
 - 8. Red-White Valve Corp.
 - 9. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - 10. Victaulic Company.
 - 11. Description:
 - a. Pressure Rating: 175 psig (1200 kPa).
 - b. Body Design: Two piece.
 - c. Body Material: Forged brass or bronze.
 - d. Port Size: Full or standard.
 - e. Seat: PTFE.
 - f. Stem: Bronze or stainless steel.

- g. Ball: Chrome-plated brass.
 - h. Actuator: Hand-lever.
 - i. End Connections for Valves 1 NPS (25 DN) through 2-1/2 NPS (65 DN): Threaded ends.
 - j. End Connections for Valves 1-1/4 NPS (32 DN) and 2-1/2 NPS (65 DN): Grooved ends.
- B. Angle Valves:
- 1. Description:
 - a. Pressure Rating: 175 psig (1200 kPa).
 - 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. Manufacturers:
 - a. NIBCO INC.
 - b. United Brass Works, Inc.
 - 2. Description:
 - a. Pressure Rating: 175 psig (1200 kPa).
 - 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.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Confirm valve interior to be free of foreign matter and corrosion.
- B. Remove packing materials.
- C. Examine guides and seats by operating valves from the fully open position to the fully closed position.
- D. Examine valve threads and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage.
 - 1. Check bolting for proper size, length, and material.
 - 2. Verify gasket for size, defects, damage, and suitable material composition for service.
 - 3. Replace all defective valves with new valves.

3.02 INSTALLATION

- A. Comply with specific valve installation requirements and application in the following Sections:
 - 1. Section 21 1300 for application of valves in wet and dry pipe, fire-suppression sprinkler systems.
- B. Install listed fire protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections.
 - 1. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install double-check valve in water supply connections and backflow preventer at potable water supply connections where not provided under civil sections. Backflow preventer shall be DCDA, or RPDA, as required by local authority, and UL/FM/USC listed/approved for fire protection.

Backflow shall meet or exceed local water authority requirements. Provide 2.5" hose valves to forward flow test backflow prevention assembly at calculated sprinkler system flow demand.

Provide one 2.5" hose valve for every 250 GPM of system demand. Assembly shall be selected and sized so that sprinkler system demand is at or below the rated flow rate.

- D. Valves with threaded connections to have unions or grooved couplings at equipment arranged for easy access, service, maintenance, and equipment removal without system shutdown.
- E. Valves in horizontal piping installed with stem at or above the pipe center.
- F. Position valves to allow full stem movement.
- G. Install valve tags. Comply with Section 21 0553 requirements for valve tags, schedules, and signs on surfaces concealing valves; and the appropriate NFPA standard applying to the piping system in which valves are installed.

END OF SECTION

**SECTION 21 0529
HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Fastener systems.
 - 5. Equipment supports.
- B. Related Requirements:
 - 1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Section 21 05 48 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for vibration isolation devices and seismic restraints.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. 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 engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Include design calculations for designing trapeze hangers.

1.04 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.05 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

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," 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 NFPA 13.
 - 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 authorities having jurisdiction.
- C. NFPA Compliance: Comply with NFPA 13.
- D. UL Compliance: Comply with UL 203.

2.02 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 galvanized carbon steel.

2.03 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.

2.04 METAL FRAMING SYSTEMS

- A. Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-line; Eaton, Electrical Sector.
 - b. Flex-Strut Inc.
 - c. G-Strut.
 - d. Unistrut; Atkore International.
 2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
 4. Channels: Continuous slotted galvanized carbon-steel channel with inturned lips.
 5. Channel Width: Selected for applicable load criteria.
 6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 7. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized carbon steel.
 8. Metallic Coating: Pregalvanized G90.

2.05 FASTENER SYSTEMS

- A. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-line; Eaton, Electrical Sector.
 - b. Empire Tool and Manufacturing Co., Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - e. MKT Fastening, LLC.
 2. Indoor Applications: Zinc-coated or Stainless steel.
 3. Outdoor Applications: Stainless steel.

2.06 EQUIPMENT SUPPORTS

- A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.07 MATERIALS

- A. Aluminum: ASTM B221.
- 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

3.01 APPLICATION

- A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

3.02 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 and NFPA 13. 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 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, and strainers, [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.

3.03 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.

3.04 METAL FABRICATIONS

- A. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- B. 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.

3.05 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.

3.06 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.

3.07 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections. All pipe hangers and pipe stands shall meet the requirements of NFPA 13.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- E. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- F. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

2. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 3. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 4. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 5. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 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): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Comply with NFPA requirements.
- I. Building Attachments: Comply with NFPA requirements. Coordinate hanging and bracing loads on Building Structure with Structural Engineer of Record.
- J. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

END OF SECTION

SECTION 21 0548

VIBRATION AND SEISMIC CONTROLS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Seismic control requirements.
- B. Seismic restraint systems

1.02 RELATED REQUIREMENTS

- A. Section 01 4533 - Code-Required Special Inspections and Procedures 014000 Quali
- B. Section 03 3000 - Cast-in-Place Concrete.

1.03 DEFINITIONS

- A. Fire Suppression Component: Where referenced in this section in regards to seismic controls, applies to any portion of the fire suppression system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., piping).
- B. Seismic Restraint: Structural members or assemblies of members or manufactured elements specifically designed and applied for transmitting seismic forces between components and the seismic force-resisting system of the structure.

1.04 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASCE 19 - Structural Applications of Steel Cables for Buildings; 2016.
- C. ASHRAE (HVAC) - ASHRAE Handbook - HVAC Applications; Most Recent Edition Cited by Referring Code or Reference Standard.
- D. FEMA 412 - Installing Seismic Restraints for Mechanical Equipment; 2014.
- E. FEMA 413 - Installing Seismic Restraints for Electrical Equipment; 2004.
- F. FEMA 414 - Installing Seismic Restraints for Duct and Pipe; 2004.
- G. FEMA E-74 - Reducing the Risks of Nonstructural Earthquake Damage; 2012.
- H. FM 1950 - Examination Standard for Seismic Sway Braces for Pipe, Tubing and Conduit; 2023.
- I. MFMA-4 - Metal Framing Standards Publication; 2004.
- J. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2008.
- L. UL 203A - Standard for Sway Brace Devices for Sprinkler System Piping; Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate selection and arrangement of seismic control components with the actual piping and equipment 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. Seismic Controls:
 - a. Coordinate the arrangement of seismic restraints with piping, conduit, equipment, and other potential conflicts installed under other sections or by others.

- b. Coordinate the work with other trades to accommodate relative positioning of essential and nonessential components in consideration of seismic interaction.
- 5. Notify Architect 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 3000.

1.06 SUBMITTALS

- A. See Section 013300, for submittal procedures.
- B. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
 - 1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.
 - 2. Seismic Controls: Include seismic load capacities.
- D. Shop Drawings - Seismic Controls:
 - 1. Include dimensioned plan views and sections indicating proposed fire suppression component locations and distributed system routing, with locations and details of gravity supports and seismic restraints and associated attachments.
 - 2. Identify mounting conditions required for equipment seismic qualification.
 - 3. Identify anchor manufacturer, type, minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
 - 4. Indicate proposed arrangement of distributed system trapeze support groupings.
 - 5. Indicate proposed locations for distributed system flexible fittings and/or connections.
 - 6. Indicate locations of seismic separations where applicable.
 - 7. Include point load drawings indicating design loads transmitted to structure at each attachment location.
- E. Seismic Design Data:
 - 1. Compile information on project-specific characteristics of actual installed fire suppression components necessary for determining seismic design forces required to design appropriate seismic controls.
 - 2. Include structural calculations, stamped or sealed by seismic controls designer, demonstrating suitability of seismic controls for seismic design forces.
- F. Certification for seismically qualified equipment; identify basis for certification.
- G. Evaluation Reports: For products specified as requiring evaluation and recognition by a qualified evaluation service, provide current evaluation reports.
- H. 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.
- I. Evidence of qualifications for seismic controls designer.
- J. Manufacturer's detailed field testing and inspection procedures.
- K. Field quality control test reports.

1.07 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Seismic Controls Designer Qualifications: Registered professional engineer licensed in the State in which the Project is located and with minimum five years experience designing seismic restraints for nonstructural components. Bracing systems using components and methods

outlined in NFPA 13 may be designed by a registered NICET level III water based systems designer with minimum five years experience.

1. Designer may be employed by the manufacturer of the seismic restraint products.
2. Contractor is responsible for ensuring the Structural Engineer of Record reviews the bracing layout, bracing loads and structural attachments to confirm the designed brace attachments to the structure are acceptable, and provide additional structural blocking / support if required.

PART 2 PRODUCTS

2.01 SEISMIC CONTROL REQUIREMENTS

- A. Design and provide fire suppression component restraints, supports, and attachments suitable for seismic loads determined in accordance with applicable codes, as well as gravity and operating loads and other structural design considerations of the installed location. Consider wind loads for outdoor fire suppression components.
- B. Seismic Design Criteria: Obtain from project Structural Engineer of Record.
- C. Component Importance Factor (Ip): Fire suppression components to be assigned a component importance factor (Ip) of 1.5 unless otherwise indicated.
- D. Seismic Restraints:
 1. Provide seismic restraints for fire suppression components except where exempt according to applicable codes and specified seismic design criteria, as approved by authorities having jurisdiction.
 2. Seismic Restraint Exemptions, All Seismic Design Categories:
 - a. Fire Suppression Piping Exemptions, All Seismic Design Categories:
 - 1) Lateral sway bracing for piping individually supported within 6 inches (150 mm) of the structure measured between the top of pipe and the point of attachment to the structure, where all conditions for exception specified in NFPA 13 are met.
 - 2) Lateral sway bracing for branch lines smaller than 2-1/2 inches (65 mm) in diameter, where branch line restraint is provided in accordance with NFPA 13.
 3. Comply with applicable general recommendations of the following, where not in conflict with applicable codes, seismic design criteria, or other specified requirements:
 - a. ASHRAE (HVACA).
 - b. FEMA 412.
 - c. FEMA 413.
 - d. FEMA 414.
 - e. FEMA E-74.
 - f. SMACNA (SRM).
 4. Seismic restraint capacities to be verified by a Nationally Recognized Testing Laboratory (NRTL) or certified by an independent third-party registered professional engineer acceptable to authorities having jurisdiction.
 5. Seismic Restraint Systems:
 - a. Arrange restraint elements to avoid obstruction of sprinklers in accordance with NFPA 13.
 - b. Except where otherwise restricted, use of either cable or rigid restraints is permitted.
 - c. Use only one restraint system type for a given fire suppression component or distributed system (e.g., piping) run; mixing of cable and rigid restraints on a given component/run is not permitted.
 - d. Size restraint elements, including anchorage, to resist seismic loads as necessary to restrain fire suppression component in all lateral directions; consider bracket geometry in anchor load calculations.
 - e. Use rod stiffener clips to attach bracing to hanger rods as required to prevent rod buckling from vertical (upward) compressive load introduced by cable or rigid restraints loaded in tension, in excess of downward tensile load due to supported fire suppression component weight.

- f. Select hanger rods and associated anchorage as required to accommodate vertical (downward) tensile load introduced by rigid restraints loaded in compression, in addition to downward tensile load due to supported fire suppression component weight.
 - g. Clevis hangers may only be used for attachment of transverse restraints; do not use for attachment of longitudinal restraints.
 - h. Where seismic restraints are attached to clevis hangers, provide clevis bolt reinforcement accessory to prevent clevis hanger deformation.
 - i. Do not introduce lateral loads on open bar joist chords or the weak axis of beams, or loads in any direction at other than panel points unless approved by project Structural Engineer of Record.
 - j. Manufacturer's certified seismic restraint design may be submitted as an alternative to project-specific design and documentation, subject to approval of authorities having jurisdiction.
- E. Seismic Attachments:
- 1. Comply with support and attachment requirements of NFPA 13.
 - 2. Attachments to be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.
 - 3. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) or qualified evaluation service acceptable to authorities having jurisdiction for compliance with applicable building code, and qualified for seismic applications; concrete anchors to be qualified for installation in both cracked and uncracked concrete.
 - 4. Do not use power-actuated fasteners.
 - 5. Do not use friction clips (devices that rely on mechanically applied friction to resist loads). Beam clamps may be used for supporting sustained loads where provided with restraining straps, but not for sway bracing attachments as prohibited by NFPA 13.
 - 6. Comply with anchor minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
 - 7. Concrete Housekeeping Pads:
 - a. Increase size of pad as required to comply with anchor requirements.
 - b. Provide pad reinforcement and doweling to ensure integrity of pad and connection and to provide adequate load path from pad to supporting structure.
- F. Seismic Interactions:
- 1. Include provisions to prevent seismic impact between fire suppression components and other structural or nonstructural components.
 - 2. Include provisions such that failure of a component, either essential or nonessential, does not cause the failure of an essential component.
 - 3. Comply with minimum clearance requirements between other equipment, distribution systems, and associated supports and fire protection sprinkler system drops and sprigs.
- G. Seismic Relative Displacement Provisions:
- 1. Use suitable fittings or flexible connections, in accordance with NFPA 13, to accommodate:
 - a. Relative displacements at connections between components, including distributed systems (e.g., piping); do not exceed load limits for equipment utility connections.
 - b. Relative displacements between component supports attached to dissimilar parts of structure that may move differently during an earthquake.
 - c. Design displacements at seismic separations.
 - d. Anticipated drifts between floors.
 - 2. Provide clearance around fire suppression system piping extending through walls, floors, platforms, and foundations in accordance with NFPA 13.

2.02 SEISMIC RESTRAINT SYSTEMS

- A. Manufacturers:
 - 1. Seismic Restraint Systems:
 - a. AFCON, a brand of Anvil International: www.anvilintl.com/#sle.
 - b. Eaton Corporation: www.eaton.com.
 - c. Loos & Co, Inc.
 - d. nVent Caddy
 - 2. Source Limitations: Furnish seismic restraint system components and accessories produced by a single manufacturer and obtained from a single supplier.
- B. Description: System components and accessories specifically designed for field assembly and attachment of seismic restraints.
- C. Where required by NFPA 13, provide products listed as complying with UL 203A or FM 1950.
- D. Cable Restraints:
 - 1. Comply with ASCE 19.
 - 2. Cables: Pre-stretched, galvanized steel wire rope with certified break strength.
 - 3. Cable Connections: Use only swaged end fittings. Cable clips and wedge type end fittings are not permitted in accordance with ASCE 19.
 - 4. Use protective thimbles for cable loops where potential for cable damage exists.
- E. Rigid Restraints: Use MFMA-4 steel channel (strut), steel angle, or steel pipe for structural element; suitable for both compressive and tensile design loads.

PART 3 EXECUTION

3.01 EXAMINATION

3.02 CODE-REQUIRED SPECIAL INSPECTIONS

- A. Arrange work to accommodate tests and/or inspections performed by Special Inspection Agency employed by Owner or Architect in accordance with Section 014000 and statement of special inspections as required by applicable building code.
 - 1. Continuous Special Inspections: Special Inspection Agency to be present in the area where the work is being performed and observe the work at all times the work is in progress.
 - 2. Periodic Special Inspections: Special Inspection Agency to be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.

3.03 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Secure fasteners according to manufacturer's recommended torque settings.
- C. Seismic Controls:
 - 1. Use only specified components, anchorage, and hardware evaluated by seismic design. Comply with conditions of seismic certification where applicable.
 - 2. Holes for through-bolts and similar listed attachments shall be 1/16" greater than the diameter of the bolt.
 - 3. Concrete Housekeeping Pads:
 - a. Size in accordance with seismic design to meet anchor requirements.
 - b. Install pad reinforcement and doweling in accordance with seismic design to ensure integrity of pad and associated connection to slab.
 - 4. Seismic Restraint Systems:
 - a. Do not attach seismic restraints and gravity supports to dissimilar parts of structure that may move differently during an earthquake.
 - b. Install restraints within permissible angles in accordance with seismic design.

- c. Install cable restraints straight between component/run and structural attachment; do not bend around other nonstructural components or structural elements.
- d. Install cable restraints for vibration-isolated components slightly slack to prevent short-circuiting of isolation.
- e. Install hanger rod stiffeners using only specified clamps; do not weld stiffeners to hanger rod.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION

SECTION 21 0553
IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe markers.

1.02 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2020.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

1.03 SUBMITTALS

- A. See Section 013300 for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation instructions.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Automatic Controls: Tags.
- B. Control Panels: Nameplates.
- C. Instrumentation: Tags.
- D. Major Control Components: Nameplates.
- E. Piping: Tags.
- F. Pumps: Nameplates.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 3. Seton Identification Products, a Tricor Direct Company: www.seton.com/#sle.
- B. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch (6 mm).
 - 3. Background Color: Black.
 - 4. Thickness: 1/8 inch (3 mm).
 - 5. Plastic: Comply with ASTM D709.

2.03 TAGS

- A. Manufacturers:
 - 1. Advanced Graphic Engraving, LLC: www.advancedgraphicengraving.com/#sle.
 - 2. Brady Corporation: www.bradycorp.com/#sle.
 - 3. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 4. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 5. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.

- 6. Seton Identification Products, a Tricor Direct Company: www.seton.com/#sle.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 PIPE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com/#sle.
 - 2. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 5. 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. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.
- E. Underground Plastic Pipe Markers: Bright-colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil, 0.004 inch (0.10 mm) thick, manufactured for direct burial service.

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. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.
- F. Use tags on piping 3/4 inch (20 mm) 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 (6 m) 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.

END OF SECTION

**SECTION 21 1100
FACILITY FIRE-SUPPRESSION WATER-SERVICE PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Water pipe.
- B. Valves.
- C. Bedding and cover materials.
- D. Polyethylene jacketing (encasement).
- E. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete.
- B. Section 21 0500 - Common Work Results for Fire Suppression.
- C. Section 31 2316 - Excavation.
- D. Section 31 2316.13 - Trenching.
- E. Section 31 2323 - Fill.

1.03 REFERENCE STANDARDS

- A. 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; 2021.
- B. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2025.
- C. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings; 2022.
- D. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.
- E. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2021.
- F. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2017.
- G. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2017, with Errata (2018).
- H. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances; 2023.
- I. FM (AG) - FM Approval Guide; current edition.
- J. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. NSF 61 - Drinking Water System Components - Health Effects; 2022, with Errata.
- L. NSF 372 - Drinking Water System Components - Lead Content; 2022.
- M. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturer's catalog information.
 - 3. Indicate valve data and ratings.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Field Quality Control Submittals: Testing activities.
- E. Project Record Documents:

1. Record actual locations of piping mains, valves, connections, fire hydrants, free-standing fire department connections, underground manholes and vaults, valve boxes, thrust restraints, and invert elevations.
 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
- F. Maintenance Data: Include installation instructions, spare parts lists, and exploded assembly views.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 6000 - Product Requirements for additional provisions.

1.05 QUALITY ASSURANCE

- A. Provide grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
- B. Welder Qualifications:
1. Certify in accordance with ASME BPVC-IX.
- C. Products:
1. Listed, classified, and labeled as suitable for the purpose specified and indicated.
 2. Refer to FM (AG) - FM Approval Guide and UL (DIR).
- D. Perform Work in accordance with local authorities having jurisdiction, municipality, and water utility requirements.

1.06 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.

1.07 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

1.08 WARRANTY

- A. See Section 01 7800 - 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: Listed, AWWA C104/A21.4:
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.
- B. Ductile Iron Pipe: Listed, AWWA C151/A21.51.
1. Fittings: AWWA C110/A21.10, ductile iron, standard thickness.
 2. Joints: AWWA C111/A21.11, styrene-butadiene rubber (SBR) or vulcanized SBR rubber gasket with 3/4 inch (19 mm) diameter rods.
- C. In-Building Riser: Ames series IBR, 304 stainless steel, UL/FM approved.

2.02 VALVES

- A. General:
1. Manufacturer's name and pressure rating marked on valve body.

2. Minimum Compliance: UL (DIR) listed and labeled.
3. Maximum Service Temperature: 180 degrees F (82.2 degrees C).
4. Valve Coatings:
 - a. Internally: 4 mils, 0.004 inch (0.10 mm) epoxy, minimum.
 - b. Externally: Epoxy base then fire red enamel paint or heat-fused red epoxy paint.

2.03 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in Section 31 2316.13.
- B. Cover: As specified in Section 31 2316.13.

2.04 ACCESSORIES

- A. Concrete for Thrust Restraints: Concrete type specified in Section 03 3000.
- B. Tracer Wire:
 1. Provide magnetic, detectable conductor with clear plastic covering and imprinted with "Water Service" in large letters.
 2. Conductor to be of sufficient length to be continuous over each separate run of nonmetallic pipe.

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. Earthwork: Perform earthwork operations in accordance with Sections 31 2316, 31 2316.13, and 31 2323.
- 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 thrust restraint bearing on subsoil.
- D. Backfill exterior trenches around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.
- E. Coordinate indoor covered trench requirements and valve accessibility with other trades. Indoor trench to meet requirements of NFPA 24 and NFPA 13.
- F. Select valves, fittings, routing, etc. to minimize required indoor trench size.
- G. Where steel pipe is used in indoor trench, provide corrosion protection, support and restraint per NFPA 13.
- H. Restrain underground piping within indoor trench with mechanical joint restraints at minimum.

3.04 PIPING SCHEDULE

- A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- B. Standard-pressure, wet-pipe sprinkler system, NPS 1-1/2 and smaller, shall be one the following:
 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints for exterior piping.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 to NPS 6, shall be one of the following:
 1. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 2. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints for exterior piping.

3.05 INSTALLATION

- A. General Requirements:
 1. Location of Water Lines:
 - a. Terminate the work covered by this Section at a point approximately 5 feet (1.5 m) from the building unless indicated otherwise.
 - b. Do not install water lines in the same trench with gas lines, fuel lines, or electric wiring.
 - c. Do not install copper tubing in the same trench with ferrous piping materials.
 - d. Do not install water piping through or to come into contact with any part of a sewer manhole.
 - e. Where nonferrous metallic pipe crosses any ferrous piping, provide a minimum vertical separation of 1 foot (300 mm) between pipes.
 2. Sleeving:
 - a. Sleeve water piping where piping is required to be installed within 3 feet (900 mm) of existing structures.
 - b. Provide ductile iron or Schedule 40 steel sleeves.
 - c. Fill annular space between pipe and sleeves with mastic.
 - d. Install water pipe and sleeve without damaging structures or causing settlement or movement of foundations or footings.
 3. Pipe Laying and Jointing:
 - a. Remove fins and burrs from pipe and fittings.
 - b. Prior to placing in position, clean pipe, fittings, valves, and accessories, and maintain in clean condition.
 - c. Provide proper facilities for lowering pipe sections into trenches.
 - d. Dropping or dumping of piping, fittings, valves, or any other water line material into trenches is not permitted.
 - e. Cut pipe in a neat, workmanlike manner accurately to length established at the site and work into place without forcing or springing.
 - f. Replace by one of the proper length any pipe or fitting that does not allow sufficient space for proper installation of jointing material.
 - g. Wedging or blocking between bells and spigots will not be permitted.
 - h. Install bell-and-spigot pipe with the bell end pointing in the direction of laying.
 - i. Grade the pipeline in straight lines avoiding the formation of dips and low points.
 - j. Support piping at proper elevation and grade.
 - k. Secure firm, uniform support.
 - l. Wood support blocking will not be permitted.
 - m. Install pipe so that the full length of each pipe section and each fitting will rest solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings.
 - n. Provide anchors and supports where indicated and necessary for fastening work into place.
 - o. Provide proper provisions for expansion and contraction of pipelines.
 - p. Keep trenches free of water until joints have been properly made.
 - q. Close open ends of piping temporarily with wood blocks or bulkheads at the end of each workday.
 - r. Do not install pipe during unacceptable trench conditions or inclement weather.

- s. Minimum Depth of Pipe Cover: Not less than 2-1/2 feet (760 mm).
- 4. Connections to Existing Water Lines:
 - a. Ensure minimal interruption of service on the existing line.
 - b. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped.
- 5. Penetrations:
 - a. Provide ductile-iron for pipes passing through walls of valve pits and structures.
 - b. Fill annular space between sleeves and walls with rich cement mortar.
 - c. Fill annular space between pipe and sleeves with mastic.
- B. Special Requirements:
 - 1. Ductile Iron Piping:
 - a. Unless otherwise specified, install pipe and fittings in accordance with paragraph "General Requirements".
 - b. Jointing:
 - 1) Make push-on joints with the gaskets and lubricant specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly.
 - 2) Make mechanical joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11.
 - 3) Make flanged joints with the gaskets, bolts, and nuts specified for this type joint.
 - (a) Make flanged joints up tight; avoid undue strain on flanges, fittings, valves, and other accessories and equipment.
 - (b) Align bolt holes for each flanged joint.
 - (c) Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted.
 - (d) Do not allow adjoining flange faces to be out of parallel to such a degree that the flanged joint cannot be made watertight without over-straining the flange.
 - (e) When flanged pipe or fitting has dimensions that do not allow the making of a proper flanged joint as specified, replace it by one of proper dimensions.
 - (f) Use set-screwed flanges to make flanged joints where conditions prevent the use of full length, flanged pipe and assemble in accordance with the recommendations of the set-screwed flange manufacturer.
 - 4) Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer.
 - 5) Make grooved and shouldered type joints with the couplings previously specified for this type joint connecting pipe with the grooved or shouldered ends specified for this type joint; assemble in accordance with the recommendations of the coupling manufacturer.
 - (a) Groove pipe in the field only with approved grooved cutting equipment designed especially for the purpose and produced by a manufacturer of grooved joint couplings; secure approval for field-cut grooves before assembling the joint.
 - 6) Make insulating joints with the gaskets, sleeves, washers, bolts, and nuts previously specified for this type joint.
 - (a) Assemble insulating joints as specified for flanged joints, except that bolts with insulating sleeves be full size for the bolt holes.
 - (b) Ensure that there is no metal-to-metal contact between dissimilar metals after the joint has been assembled.
 - c. Allowable Deflection:
 - 1) Maximum Allowable Deflection: As stated in AWWA C600.

- 2) If the alignment requires deflection in excess of the above limitations, furnish special blends or a sufficient number of shorter pipe lengths to provide angular deflections within the limit set forth.
 - d. Pipe Anchorage:
 - 1) Provide concrete thrust blocks (reaction backing), for pipe anchorage except where metal harness is indicated.
 - 2) Thrust blocks to comply with the requirements of AWWA C600 for thrust restraint, except that size and positioning of thrust blocks to be as indicated.
 - 3) Use concrete, ASTM C94/C94M, having a minimum compressive strength of 2,500 psi (15 MPa) at 28 days; or use concrete of a mix not leaner than one part cement, 2-1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.
 - 4) Provide metal harness in accordance with the requirements of AWWA C600 for thrust restraint, using tie rods and clamps as indicated in NFPA 13, except as otherwise indicated.
 - e. Exterior Protection: Completely encase buried ductile iron pipelines with polyethylene tube or sheet, using Class A polyethylene film, in accordance with AWWA C105/A21.5.
- C. Valves:
1. Set valves on solid bearing.
 2. Center and plumb valve box over valve.
 3. Set box cover flush with finished grade.

3.06 SERVICE CONNECTIONS

3.07 FIELD QUALITY CONTROL

- A. Field Tests and Inspections:
1. See Section 01 4000 - Quality Requirements for additional requirements.
 2. Provide all labor, equipment, and incidentals required for field testing, except that water and electric power needed for field tests will be furnished as set forth in Section 01 5100 - Temporary Utilities.
 3. Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently and at least 5 days after placing of concrete.
 4. Fill pipeline 24 hours before testing and apply test pressure to stabilize system, using only potable water.
 5. Pressure test piping to 200 psi (1400 kPa).
 6. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
 7. Prepare reports of testing activities.

3.08 CLEANING

- A. Upon completion of the installation of water lines and appurtenances, remove and haul away all surplus material, including debris resulting from the work.

3.09 CLOSEOUT ACTIVITIES

- A. Demonstrate proper operation of equipment to Owner's designated representative.

END OF SECTION

**SECTION 21 1300
FIRE-SUPPRESSION SPRINKLER SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wet-pipe sprinkler system.
- B. Dry-pipe sprinkler system.
- C. System design, installation, and certification.

1.02 RELATED REQUIREMENTS

- A. Section 078413 Penetration Firestopping.
- B. Section 210000 - General Requirements for Fire Protection
- C. Section 21 0500 - Common Work Results for Fire Suppression: Pipe and fittings.
- D. Section 21 0548 - Vibration and Seismic Controls for Fire Suppression Piping and Equipment.
- E. Section 21 0553 - Identification for Fire Suppression Piping and Equipment.
- F. FM (AG) - FM Approval Guide; current edition.
- G. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL (DIR) - Online Certifications Directory; Current Edition.

1.03 SUBMITTALS

- A. See Section 013300 for submittal procedures.
- B. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- C. Shop Drawings:
 - 1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
 - 2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components, and accessories. Indicate system controls.
 - 3. Submit shop drawings to Authorities Having Jurisdiction for approval. Submit proof of approval to Architect.
- D. Samples: Submit two of each style of sprinkler specified.
- E. Designer's qualification statement.
- F. Installer's qualification statement.
- G. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements for additional provisions.
 - 2. Extra Sprinklers: Type and size matching those installed in quantity required by referenced NFPA design and installation standard.
 - 3. Sprinkler Wrenches: For each sprinkler type.
- I. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

1.04 QUALITY ASSURANCE

- A. Maintain one copy of referenced design and installation standard on site.
- B. Comply with UL (DIR) requirements.

- C. Designer Qualifications: Design system under direct supervision of a Professional Engineer, or NICET Level III or IV certified designer experienced in design of this type of work and licensed in the State in which the Project is located.
- D. Equipment and Components: Provide products that bear FM (AG) label or marking.
- E. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sprinklers, Valves, and Equipment:
 1. Anvil International: www.anvilintl.com/#sle.
 2. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
 3. Viking Corporation: www.vikinggroupinc.com/#sle.
 4. Victaulic
 5. General Air Products
 6. Reliable Sprinkler Company
 7. Anvil / Gruvlock
 8. Nibco

2.02 SPRINKLER SYSTEM

- A. Sprinkler System: Provide coverage for entire building(s).
- B. Occupancy: varies - protect storage closets as Ordinary Hazard Group II. Protect classrooms, corridors, restrooms, administrative spaces and similar areas per Light Hazard. Protect Mechanical and Electrical Spaces at a minimum of Ordinary Hazard Group I. .
- C. Water Supply: Determine volume and pressure from water flow test data.
 1. Contractor shall use verified flow tests conducted within a year (or less if required by the AHJ) of permit submittal.
 2. Existing flow data provided by the Civil Engineer
 - a. CFK Hydrant #1139 with flow at CFK Hydrant #847 elev: unknown - Static: 59 psi, Residual: 51 psi at 2041GPM flow.
 - b. CFK Hydrant #1139 with flow at CFK Hydrant #1140 elev: unknown - Static: 53 psi, Residual: 31 psi at 1655 GPM flow.
 3. Revise design when current test data is obtained prior to submittals.
- D. Interface system with building control system.
- E. Provide fire department connections where indicated.
- F. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to system riser. Provide at least 2 of each type and temperature of sprinkler used on the project with associated wrenches. Provide cabinet sized to contain the greater of 2 of each sprinkler type or the minimum number of heads required by NFPA 13 based on system size..

2.03 SPRINKLERS

- A. Provide sprinklers with temperatures, response ratings, and k-factors as required by NFPA 13. Where specially-listed sprinklers are provided, clearly indicate installation criteria on installation drawings.
- B. Suspended Ceiling Type: concealed flat-plate pendant type with matching push on cover plate.
 1. Response Type: Quick.
 2. Coverage Type: Standard.
 3. Finish: Enamel, color as selected.

4. Fusible Link: Glass bulb type temperature rated for specific area hazard.
 5. Manufacturers:
 - a. Tyco Fire Protection Products; _____: www.tyco-fire.com/#sle.
 - b. Viking.
 - c. Reliable.
- C. Exposed Area Type: Upright type with guardwhere subject to mechanical damage or installed below 7-0.
1. Response Type: As required by NFPA 13 for the hazard.
 2. Coverage Type: Standard.
 3. Finish: Enamel, color as selected.
 4. Fusible Link: Glass bulb type temperature rated for specific area hazard.
 5. Manufacturers:
 - a. Tyco.
 - b. Viking.
 - c. Reliable.
 - d. Victaulic
- D. Sidewall Type: concealed flat-plate horizontal sidewall type with matching push on cover plate.
1. Response Type: Quick.
 2. Coverage Type: Standard.
 3. Fusible Link: Glass bulb type temperature rated for specific area hazard.
 4. Manufacturers:
 - a. Viking.
 - b. Tyco.
 - c. Reliable.
 - d. Victaulic
- E. Dry Sprinklers: Concealed pendant type with matching push on cover plate or standard sidewall with standard escutcheon
1. Response Type: Quick.
 2. Coverage Type: Standard or Extended as required..
 3. Fusible Link: Glass bulb type temperature rated for specific area hazard.
 4. Manufacturers:
 - a. Viking.
 - b. Tyco.
 - c. Reliable.
 - d. Victaulic
- F. Specific Application Interstitial Sprinklers
1. Follow listing requirements for spacing, obstructions, hydraulic design criteria and indicate requirements on shop drawings.
 2. Coordinate and provide required baffels / compartmentalization as required per listing requirements and calculations.
 3. Response Type: Quick
 4. Coverage Type: per listing
 5. Manufacturers:
 - a. Viking
 - b. Tyco
- G. Specific Application Attic Sprinklers
1. Response Type: Quick
 2. Follow listing requirements for spacing, obstructions, hydraulic design criteria, and indicate requirements on shop drawings.
 3. Response type: Quick
 4. Coverage: Per listing

5. Manufacturers:
 - a. Viking
 - b. Tyco
 - c. Reliable
- H. Guards: Finish to match sprinkler finish and be listed for use with the sprinkler / sprinkler type.
- I. Flexible Drop System: Stainless steel, multiple use, open gate type.
 1. Application: Use to properly locate sprinkler heads.
 2. Include all supports and bracing.
 3. Provide braided type tube as required for the application.
 4. Maximum UL equivalent length 52 feet of 1" sch 40 pipe.
 5. Clearly indicate maximum length and calculated equivalent length on shop drawings & details.
 6. Manufacturers:
 - a. FlexHead Industries, a brand of Anvil International: www.anvilintl.com/#sle.
 - b. Victaulic Company; Vic-Flex: www.victaulic.com/#sle.
 - c. Megaflex

2.04 PIPING SPECIALTIES

- A. Wet system riser check valve.
 1. Areas with reliable power: UL/FM listed Riser Check valve. Check type valve with tapped outlets for supply and discharge gauges and main drain connection.
 2. Areas with unreliable power: Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber-faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:
 - a. Activate electric alarm.
 - b. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, and fill-line attachment with strainer.
 3. Replaceable internal components without removing valve from installed position.
 4. Design: For horizontal or vertical installation.
 5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 6. Manufacturers:
 - a. Reliable Automatic Sprinkler Co., Inc. (The).
 - b. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - c. Victaulic Company.
 - d. Viking Corporation.
- B. Dry Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm, accelerator, and with the following additional capabilities and features:
 1. Activate electric alarm.
 2. Test and drain valve.
 3. Externally resettable.
 4. Replaceable internal components without removing valve from installed position.
 5. Manufacturers:
 - a. Victaulic Company; Series 768 - NXT: www.victaulic.com/#sle.
 - b. Viking.
 - c. Reliable.
 - d. Tyco
- C. Test Connections:
 1. Inspector's Test Connection:

- a. Provide test connections approximately 6 ft (2 m) above floor for each or portion of each sprinkler system equipped with an alarm device, located at the most remote part of each system.
 - b. Route test connection to an open-site drain location, excluding janitor sinks, accepting full flow without negative consequences.
 - c. Limit vertical height of exterior wall penetration to 2 ft (0.61 m) above finished grade.
- 2. Backflow Preventer Test Connection:
 - a. Where means to test backflow at sprinkler system rates are not provided under civil sections (e.g. through private fire hydrants), provide downstream of the backflow prevention assembly, listed hose valves with 2.5 inch (65 mm) National Standard male hose threads with cap and chain.
 - b. Furnish one valve for each 250 gpm (16 L/s) of system demand or fraction thereof.
 - c. Provide permanent sign reading "Test Valve" in accordance with Section 21 0553.
- D. Water Motor Alarm (areas with unreliable power): Hydraulically operated impeller type alarm with aluminum alloy chrome plated gong and motor housing, nylon bearings, and inlet strainer.
- E. Electric Alarm: Electrically operated red enameled gong with pressure alarm switch.
 - 1. Standard: UL 464.
 - 2. Type: Vibrating, metal alarm bell.
 - 3. Size: 10-inch minimum- diameter.
 - 4. Voltage: 120 V ac, 60 Hz, 1 phase.
 - 5. Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox.
 - 6. Manufacturers:
 - a. Potter Electric Signal Company, LLC..
- F. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.
 - 1. UL, FM approved, with (2) single pole adjustable switches
 - 2. Manufacturers:
 - a. Potter Electric Signal Company, LLC..
- G. Supervisory Switches:
 - 1. Potter Electric Signal Company, LLC.
 - 2. Standard: UL 346.
 - 3. Type: Electrically supervised.
 - 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.
 - 7. Manufacturers:
 - a. Potter Electric Signal Company, LLC; CoilKeeper Solenoid Supervisory Switch: www.pottersignal.com/#sle.

2.05 AIR COMPRESSOR

- A. Manufacturers:
 - 1. General Air Products.
- B. Compressor: Single-unit, electric motor driven, motor, motor starter, safety valves, check valves, air maintenance device incorporating electric pressure switch and unloader valve.
- C. UL 1450-VDUR listed for fire protection

2.06 NITROGEN GENERATOR

- A. Manufacturers:
 - 1. Potter Electric Signal Company, LLC; IntelliGen INS Series: www.pottersignal.com/#sle.
 - 2. General Air Products.

3. Engineered Corrosion Solutions.
 4. Tyco / Johnson Controls
- B. Nitrogen Generator:
1. Provide FM (AG) approved system and accessories.
- C. Minimum Nitrogen Purity: 98 percent.
- D. Provide piping and accessories to connect to dry and preaction fire suppression systems.
- E. Accessories:
1. Provide control panel or remote annunciator panel.
 2. Provide air maintenance device.
 3. Provide nitrogen storage tank sized to comply with NFPA 13.
 4. Provide purge valves to remove oxygen from the system.
 5. Provide nitrogen analyzer to determine the nitrogen purity.
 6. Provide system with replaceable filters.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with referenced NFPA design and installation standard.
- B. Install equipment in accordance with manufacturer's instructions.
- C. Locate outside alarm bell on building wall - coordinate location with Architect and AHJ.
- D. Place pipe runs to minimize obstruction to other work.
- E. Place piping in concealed spaces above finished ceilings.
- F. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
- G. Flush entire piping system of foreign matter.
- H. Install guards on sprinklers where installed located below 7-0 AFF or otherwise subject to mechanical damage.
- I. Hydrostatically test entire system.
- J. Require test be witnessed by Fire Marshal.

3.02 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. 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.
- C. Specialty Valves:
 1. Install valves in vertical position for proper direction of flow, in main supply to system.
- D. 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.

3.03 INTERFACE WITH OTHER PRODUCTS

- A. Ensure required devices are installed and connected as required to fire alarm system.

3.04 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid. If calculations do not permit flexible sprinkler drops. Install into hard drops and provide seismic expansion plates as required.
- D. Receive architect approval of sprinkler layout in finished ceilings prior to applying for permit. In gyp-board ceilings, install sprinklers aligned with lights, diffusers, and other ceiling features. Install sprinklers in quarter-points of 4x2 ceiling tiles or at the center of ceiling tiles. Do not install sprinklers closer than 6" from t-bar in suspended ceilings.

END OF SECTION

**SECTION 22 4000
PLUMBING FIXTURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flush valve water closets.
- B. Tank type water closets.
- C. Waterless urinals.
- D. Wall hung urinals.
- E. Lavatories.
- F. Sinks.
- G. Under-lavatory pipe supply covers.
- H. Showers.
- I. Electric water coolers.
- J. Bi-level, electric water coolers.
- K. Mop sinks.
- L. Service sinks.

1.02 RELATED REQUIREMENTS

- A. Section 07 9200 - Joint Sealants: Sealing joints between fixtures and walls and floors.
- B. Section 12 3600 - Countertops: Counters for sinks and lavatories.
- C. Section 22 1005 - Plumbing Piping.
- D. Section 22 1006 - Plumbing Piping Specialties.
- E. Section 22 3000 - Plumbing Equipment.
- F. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration; 2008 (Reaffirmed 2013).
- C. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997 (Reaffirmed 2017).
- D. ASME A112.18.1 - Plumbing Supply Fittings; 2018, with Errata.
- E. ASME A112.18.9 - Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures; 2011 (Reaffirmed 2022).
- F. ASME A112.19.1 - Enamelled Cast Iron and Enamelled Steel Plumbing Fixtures; 2018.
- G. ASME A112.19.2 - Ceramic Plumbing Fixtures; 2018, with Errata.
- H. ASME A112.19.3 - Stainless Steel Plumbing Fixtures; 2022.
- I. ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks; 2022.
- J. ASSE 1014 - Performance Requirements for Backflow Prevention Devices for Hand-Held Showers; 2020.
- K. ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices; 2020.
- L. ASTM C1822 - Standard Specification for Insulating Covers on Accessible Lavatory Piping; 2021.
- M. NSF 61 - Drinking Water System Components - Health Effects; 2022, with Errata.

- N. NSF 372 - Drinking Water System Components - Lead Content; 2022.
- O. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

- A. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- B. Manufacturer's Instructions: Indicate installation methods and procedures.
- C. Sustainable Design Documentation: Submit appropriate evidence that materials used in potable water systems comply with the specified requirements.
- D. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
- E. Waterless Urinals: Submit recommended frequency of maintenance and parts replacement, methods of cleaning, sources of replacement supplies and parts.
- F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner'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. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturer warranty for electric water cooler.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS (REFER TO DRAWINGS FOR FIXTURE SCHEDULES)

- 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, lavatory faucets, and showerheads.

2.02 REGULATORY REQUIREMENTS

- A. Comply with applicable codes for installation of plumbing systems.
- B. Comply with UL (DIR) requirements.
- C. Perform work in accordance with local health department regulations.

2.03 FLUSH VALVE WATER CLOSETS

- A. Water Closets:
 - 1. Vitreous china, ASME A112.19.2, floor mounted, or wall mounted, siphon jet flush action, china bolt caps.
 - 2. Bowl: ASME A112.19.2; with elongated rim.
 - 3. Flush Valve: Exposed (top spud).
 - 4. Flush Operation: Sensor operated
 - 5. Handle Height: 44 inches (1117 mm) or less.
 - 6. Inlet Size: 1-1/2 inches (38 mm).
 - 7. Trapway Outlet: 4 inch (100 mm, DN).
 - 8. Color: White.
 - 9. Manufacturers:

- a. American Standard, Inc; Baby Devoro, 2-Piece Gravity: www.americanstandard-us.com/#sle.
 - b. Kohler Company; _____: www.kohler.com/#sle.
 - c. Toto.
- B. Flush Valves:
 - 1. Valve Supply Size: 1 inch (25 mm, DN).
 - 2. Valve Outlet Size: 1-1/2 inches (40 mm, DN).
 - 3. Manufacturers:
 - a. Sloan Valve Company; _____: www.sloanvalve.com/#sle.
 - b. Zurn Industries, LLC; ZEMS Series: www.zurn.com/#sle.
 - c. Toto.
 - 4. Manual Operated:
 - a. Type: ASME A112.18.1 or ASME A112.19.5; diaphragm type complete with vacuum breaker stops, and accessories.
 - b. Supplied Volume Capacity: 1.28 gallons per flush.
 - 5. Sensor-Operated:
 - a. Type: ASME A112.19.5; chloramine-resistant clog-resistant dual-seat diaphragm valve complete with vacuum breaker, stops and accessories.
 - b. Mechanism: Solenoid-operated piston or electronic motor-actuated operator with low-voltage powered infrared sensor, and mechanical override or override push button.
 - c. Supplied Volume Capacity: 1.28 gallons per flush.
- C. Toilet Seats:
 - 1. Manufacturers:
 - a. American Standard, Inc; _____: www.americanstandard-us.com/#sle.
 - b. Bemis Manufacturing Company; _____: www.bemismfg.com/#sle.
 - c. Church Seat Company; _____: www.churchseats.com/#sle.
 - 2. Plastic: Solid, white finish, elongated shape, open front, slow-closing hinged seat cover, extended back complete with self-sustaining hinges, and brass bolts with covers.
 - 3. Plastic: Black finish, open front, extended back, self-sustaining hinge, brass bolts, with cover.
- D. Water Closet Carriers:
 - 1. Manufacturers:
 - a. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
 - b. JOSAM Company; _____: www.josam.com/#sle.
 - c. Zurn Industries, LLC; Z1201-N: www.zurn.com/#sle.
 - 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 TANK TYPE WATER CLOSETS

- A. Manufacturers:
 - 1. American Standard, Inc; Baby Devoro, Flo-Wise, 2-Piece Gravity: www.americanstandard-us.com/#sle.
 - 2. Kohler Company; _____: www.kohler.com/#sle.
 - 3. Toto.
- B. Floor-Mounted Bowl:
 - 1. ASME A112.19.2; siphon jet, vitreous china, close-coupled closet combination with elongated rim, insulated vitreous china closet tank with fittings and lever flushing valve, bolt caps, vandalproof cover locking device.
 - 2. Water Consumption: 1.28 gal (4.8 L) per flush, maximum.
- C. Pressure-Assisted Flush Systems:
 - 1. Provide pressurized wash down vessel and components.

2. Water Consumption: 1.28 gal (4.8 L) per flush.
- D. Toilet Seats:
1. Plastic: Solid, white, elongated, open front, hinged seat cover, extended back with self-sustaining hinges, and brass bolts with covers.
 2. Manufacturers:
 - a. American Standard, Inc; _____: www.americanstandard-us.com/#sle.
 - b. Bemis Manufacturing Company; _____: www.bemismfg.com/#sle.

2.05 WATERLESS URINALS

- A. Manufacturers:
1. American Standard, Inc; _____: www.americanstandard-us.com/#sle.
 2. Kohler Company; _____: www.kohler.com/#sle.
 3. Sloan Valve; _____: www.sloanvalve.com/#sle.
 4. Zurn Industries, LLC; _____: www.zurn.com/#sle.
- B. Wall-hung, vitreous china, complying with ASME A112.19.2; one piece bowl and shields, with integral trap, back outlet, carrier, and necessary fittings.
1. Trapway Outlet Assembly: Siphon trap type not requiring additional water for drainage of urine; liquid trap seal that is lower specific gravity than water or urine and is biodegradable; completely enclosed cartridge intended to be replaced periodically or refillable liquid trap seal; tamperproof but removable for cleaning and replacement.
 2. Projection From Wall: Approximately 14 inches (360 mm).
 3. Width: Approximately 19 inches (490 mm).
 4. Color: White.

2.06 WALL HUNG URINALS

- A. Manufacturers:
1. American Standard, Inc; _____: www.americanstandard-us.com/#sle.
 2. Kohler Company; _____: www.kohler.com/#sle.
- B. Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier.
1. Consumption Volume: 0.125 gal (0.47 L) per flush, maximum.
 2. Flush Style: Washout.
 3. Flush Valve: Exposed (top spud).
 4. Flush Operation: Sensor operated.
 5. Trapway Outlet: Integral.
 6. Removable stainless steel strainer.
- C. Flush Valves:
1. Manufacturers:
 - a. Delany Products; _____: www.delanyproducts.com/#sle.
 - b. Sloan Valve Company; _____: www.sloanvalve.com/#sle.
 - c. Zurn Industries, LLC; ZEMS Series: www.zurn.com/#sle.
 2. Sensor-Operated:
 - a. Type: ASME A112.19.5; chloramine-resistant, clog-resistant dual-seat diaphragm valve with vacuum breaker, stops and accessories.
 - b. Mechanism: Solenoid-operated piston or electronic motor-actuated operator with low-voltage powered infrared sensor, and mechanical override or override push button.
 - c. Supplied Volume Capacity: 1.2 gal (4.5 L) per flush.
 3. Exposed Type: Chrome-plated, escutcheon, integral screwdriver stop.
- D. Urinal Carriers:
1. Manufacturers:
 - a. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
 - b. JOSAM Company; _____: www.josam.com/#sle.

- c. Zurn Industries, LLC; Z1221: www.zurn.com/#sle.
- 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.

2.07 LAVATORIES

- A. Manufacturers:
 - 1. American Standard, Inc; _____: www.americanstandard-us.com/#sle.
 - 2. Kohler Company; _____: www.kohler.com/#sle.
- B. Wall-Hung Basin:
 - 1. Vitreous China: ASME A112.19.2; white, basin with splash lip, front overflow, soap depression, and hanger.
 - 2. Carrier:
 - a. 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.
- C. Drop-In Basin:
 - 1. Vitreous China: ASME A112.19.2; self-rimming, white, front overflow, soap depression, seal of putty, calking, or concealed vinyl gasket.
- D. Under-Mount Basin:
 - 1. Vitreous China: ASME A112.19.2; white, front overflow, seal of putty, calking, or concealed vinyl gasket.

2.08 UNDER-LAVATORY PIPE SUPPLY COVERS

- A. Manufacturers:
 - 1. Plumberex Specialty Products, Inc; _____: www.plumberex.com/#sle.
- B. General:
 - 1. Insulate exposed drainage piping including hot, cold and tempered water supplies under lavatories or sinks per ADA Standards.
 - 2. Construction: 1/8 inch (3.2 mm) PVC with antimicrobial, antifungal and UV resistant properties.
 - a. Comply with ASME A112.18.9 for covers on accessible lavatory piping.
 - b. Comply with ICC A117.1.
 - c. Microbial and Fungal Resistance for Interior and Exterior: Comply with ASTM G21.
 - 3. Color: High gloss white.
 - 4. Fasteners: Reusable, snap-locking fasteners with no sharp or abrasive external surfaces. No cable ties allowed.

2.09 ELECTRIC WATER COOLERS

- A. Manufacturers:
 - 1. Elkay Manufacturing Company; _____: www.elkay.com/#sle.
 - 2. Haws Corporation; _____: www.hawesco.com/#sle.
 - 3. Oasis International; _____: www.oasiscoolers.com/#sle.
- B. Water Cooler: 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 gph (30.3 Lph) of 50 degrees F (10 degrees C) water with inlet at 80 degrees F (27 degrees C) and room temperature of 90 degrees F (32 degrees C), when tested in accordance with ASHRAE Std 18.
 - 2. Electrical: 115 VAC, 60 Hertz compressor, 6 foot (2 m) cord and plug for connection to electric wiring system including grounding connector.

2.10 BI-LEVEL, ELECTRIC WATER COOLERS

- A. Manufacturers:
 - 1. Elkay Manufacturing Company; _____: www.elkay.com/#sle.

2. Haws Corporation; _____: www.hawesco.com/#sle.
 3. Oasis International; _____: www.oasiscoolers.com/#sle.
- 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 gph (30.3 Lph) of 50 degrees F (10 degrees C) water with inlet at 80 degrees F (27 degrees C) and room temperature of 90 degrees F (32 degrees C), when tested in accordance with ASHRAE Std 18.
 2. Electrical: 115 VAC, 60 Hertz compressor, 6 foot (2 m) cord and plug for connection to electric wiring system including grounding connector.

2.11 MOP SINKS

- A. Terrazzo Mop Sink Manufacturers:
1. Acorn Engineering Company; _____: www.acorneng.com/#sle.
 2. American Bath Group; _____: www.americanbathgroup.com/#sle.
 3. Just Manufacturing Company; _____: www.justmfg.com/#sle.
 4. Zurn Industries, LLC; _____: www.zurn.com/#sle.
- B. Material: Precast terrazzo composed of marble chips cast in Portland cement.
- C. Tiling Flange Construction: Galvanized steel.
- D. Grid strainer: Stainless steel; integral; removable.
- E. Accessories:
1. Wall mounted faucet with vacuum breaker, bucket hook and wall support. Provide 5 feet (1.5 m) of 1/2 inch (13 mm) diameter plain end reinforced plastic hose.
 2. Hose clamp hanger.
 3. Mop hanger.

2.12 SERVICE SINKS

- A. Manufacturers:
1. Acorn Engineering Company; _____: www.acorneng.com/#sle.
 2. American Bath Group; _____: www.americanbathgroup.com/#sle.
 3. American Standard, Inc; _____: www.americanstandard-us.com/#sle.
- B. Bowl: ASME A112.19.1; 22 by 18 by 12 inch (560 by 460 by 300 mm) deep, porcelain enamelled (inside only) cast iron roll-rim sink, with 12 inch (300 mm) high back, concealed hanger, chrome-plated strainer, stainless steel rim guard, cast iron P-trap with adjustable floor flange.
- C. Trim: ASME A112.18.1 exposed wall type supply with cross handles, spout wall brace, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral screwdriver stops with covering caps and adjustable threaded wall flanges.

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.

END OF SECTION

**SECTION 22 0529
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. Pipe rollers and roller supports.
- F. Pipe supports, guides, shields, and saddles.
- G. Seismic bracing hardware.
- H. Anchors and fasteners.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 05 5000 - Metal Fabrications.
- C. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping; 2022.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2018.
- G. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).
- H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2020.
- 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; 2023.
- J. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2019.
- K. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
- M. FM (AG) - FM Approval Guide; current edition.
- N. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

- O. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- P. UL (DIR) - Online Certifications Directory; Current Edition.
- Q. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 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 Architect 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 3000.

1.05 SUBMITTALS

- A. See Section 01 3000 - 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. 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. Comply with applicable building code.

1.07 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. 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. Fire Resistance: Provide hardware rated for 60 minutes resistance unless specifically indicated by the authority having jurisdiction.
- F. Vibration Isolation and Seismic Restraint Requirements: See Section 22 0548.
- G. Materials for Metal Fabricated Supports: Comply with Section 05 5000.
 - 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.
- H. Corrosion Resistance: Use corrosion-resistant metal-based materials fully compatible with exposed piping materials and suitable for the environment where installed.
 1. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 2. Outdoor, Damp, or Wet-Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.

2.02 STRUT SYSTEMS FOR PIPE OR EQUIPMENT SUPPORT

- A. Strut Channels:
 1. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.
 2. 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. Equipment Supports: 1/2 inch (13 mm, DN) diameter.
 - b. Piping up to 1 inch (25 mm, DN): 1/4 inch (6 mm, DN) diameter.
 - c. Piping larger than 1 inch (25 mm, DN): 3/8 inch (10 mm, DN) diameter.
 - d. Trapeze Support for Multiple Pipes: 3/8 inch (10 mm) in length.
- C. Channel Nuts:
 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. FNW; 7821: www.fnw.com/#sle.
 - c. Unistrut, a brand of Atkore International, Inc: www.unistrut.com/#sle.
 - d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 2. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring as indicated on drawings.

2.03 BEAM CLAMPS

- A. Manufacturers:
 1. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 2. FNW; 7201: www.fnw.com/#sle.
 3. Unistrut, a brand of Atkore International, Inc: www.unistrut.com/#sle.
 4. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
- B. MSS SP-58 types 19 through 23, 25 or 27 through 30 based on required load.
- C. C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain and zinc finish. include zinc coated steel retainer strap.
- D. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish. For inverted usage provide manufacturer listed size(s).
- E. Wide Mouth Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish.
- F. Centerload Beam Clamp with Extension Piece: MSS SP-58 type 30, malleable iron with plain finish.
- G. FM (AG) and UL (DIR) Approved Beam Clamp: MSS SP-58 type 19, plain finish.
- H. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
- I. 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.

2.04 PIPE HANGERS

- A. Band Hangers, Adjustable:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. Gripple, Inc; Universal Clamp (Threaded): www.gripple.com/#sle.
 - 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. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 - 2. MSS SP-58 type 5, zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
- C. Swivel Ring Hangers, Adjustable:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. FNW; 7010: www.fnw.com/#sle.
 - c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 - 2. MSS SP-58 type 10, epoxy-painted, zinc-colored.
 - 3. 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.
 - 4. FM (AG) and UL (DIR) listed for specific pipe size runs and loads.
- D. Clevis Hangers, Adjustable:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. FNW; 7005: www.fnw.com/#sle.
 - c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 - 2. Copper Tube: MSS SP-58 type 1, epoxy-plated copper.
 - 3. Felt-Lined: MSS SP-58 type 1, zinc-plated, silicone-free carbon steel.
 - 4. Light-Duty: MSS SP-58 type 1, zinc-colored, epoxy plated.
 - 5. Standard-Duty: MSS SP-58 type 1, zinc-colored, epoxy plated.

2.05 PIPE CLAMPS

- A. Riser Clamps:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. FNW; 7020: www.fnw.com/#sle.
 - c. nVent Caddy, a brand of nVent: www.erico.com/#sle.
 - 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. 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.
 - 5. Copper Tube Pipe Clamp: MSS SP-58 type 8, epoxy plated copper.

6. UL (DIR) listed: Pipe sizes 1/2 to 8 inch (15 to 200 mm, DN).
- B. Extension Split Pipe Clamp:
1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. FNW; 7001: www.fnw.com/#sle.
 - c. nVent Caddy, a brand of nVent: www.erico.com/#sle.
 - d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 2. MSS SP-58 type 12, hinged split ring and yoke roller hanger with epoxy copper or plain finish.
 3. Material: ASTM A47/A47M malleable iron or ASTM A36/A36M carbon steel.
 4. Provide hanger rod and nuts of the same type and material for a given pipe run.
 5. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- C. Insulation Coupling:
1. Manufacturers:
 - a. FNW; 7897: www.fnw.com/#sle.
 - b. nVent Caddy, a brand of nVent: www.erico.com/#sle.
 - c. Unistrut, a brand of Atkore International, Inc: www.unistrut.com/#sle.
 - d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 2. Two bolt-type clamps designed for installation under insulation.
 3. Material: Carbon steel with epoxy copper or zinc finish.

2.06 PIPE SUPPORTS, GUIDES, SHIELDS, AND SADDLES

- A. 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.
- B. Stanchions:
1. Manufacturers:
 - a. Anvil International: www.anvilintl.com/#sle.
 - b. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - c. nVent Caddy, a brand of nVent: www.erico.com/#sle.
 - d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 2. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 3. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
- C. U-Bolts:
1. MSS SP-58 type 24, carbon steel u-bolt for pipe support or anchoring.
- D. Pipe Shields for Insulated Piping:
1. Manufacturers:
 - a. Anvil International: www.anvilintl.com/#sle.
 - b. FNW; 7753: www.fnw.com/#sle.
 - c. Gregory Industries, Inc: www.gregorycorp.com/#sle.
 - d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 2. MSS SP-58 type 40, ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
 3. 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 (321 mm).

- d. Service Temperature: Minus 40 to 178 degrees F (Minus 40 to 81 degrees C).
 - e. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
- E. 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. Liquid Temperatures Up to 122 degrees F (50 degrees C):
 - a. Overhead Support: MSS SP-58 types 1, 3 through 12 clamps.
 - b. Support From Below: MSS SP-58 types 35 through 38.
 - 3. Operating Temperatures from 122 to 446 degrees F (50 to 230 degrees C):
 - a. Overhead Support: MSS SP-58 type 1 or 3 through 12 clamps with appropriate saddle of MSS SP-58 type 40 for insulated pipe.
 - b. Roller Chair: MSS SP-58 types 41 or 43 through 46 roller chair support with appropriate saddle of MSS SP-58 type 39 for insulated pipe.
 - c. Sliding Support: MSS SP-58 types 35 through 38.
- F. Pipe Supports, Thermal Insulated:
- 1. Manufacturers:
 - a. Buckaroos, Inc: www.buckaroos.com/#sle.
 - b. KB Enterprises: www.snappitz.com/#sle.
 - 2. General Requirements:
 - a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
 - b. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation.
 - c. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
 - d. Provide pipe supports for 1/2 to 30 inch (15 to 750 mm, DN) iron pipes.
 - e. Insulation inserts to consist of rigid phenolic foam insulation surrounded by 360 degree, PVC jacketing.
 - 3. PVC Jacket:
 - a. Pipe insulation protection shields to be provided with ball bearing hinge and locking seam.
 - b. Moisture Vapor Transmission: 0.0071 perm inch (0.0092 ng/Pa s m), when tested in accordance with ASTM E96/E96M.
 - c. Minimum Thickness: 60 mil, 0.06 inch (1.524 mm).
- G. Copper Pipe Supports:

2.07 NONPENETRATING ROOFTOP SUPPORTS FOR LOW-SLOPE ROOFS

- A. Manufacturers:
 - 1. Anvil International; H-Block: www.anvilintl.com/#sle.
 - 2. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - 3. nVent Erico, a brand of nVent: www.erico.com/#sle.
 - 4. PHP Systems/Design: www.phpsd.com/#sle.
- B. Provide steel pedestals with thermoplastic or rubber base that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
- C. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
- D. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
- E. Mounting Height: Provide minimum clearance of 6 inches (150 mm) under supported component to top of roofing.

2.08 ANCHORS AND FASTENERS

- A. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
- B. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
- C. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
- D. Hollow Masonry: Use toggle bolts.
- E. Hollow Stud Walls: Use toggle bolts.
- F. Steel: Use beam ceiling clamps, beam clamps, machine bolts, or welded threaded studs.
- G. Beam Ceiling Flanges: ASTM A47/A47M Grade 32510, malleable iron or stainless steel with copper, plain, stainless steel, or zinc finish.
- H. Sheet Metal: Use sheet metal screws.
- I. Wood: Use wood screws.
- J. Plastic and lead anchors are not permitted.
- K. Powder-actuated fasteners are not permitted.
- L. Hammer-driven anchors and fasteners are not permitted.
- M. 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.

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 Architect, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Architect, 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. See Section 01 4000 - 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 22 0533
HEAT TRACING FOR PLUMBING PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Self-regulating parallel resistance electric heating cable.
- B. Cable outer jacket markings.
- C. Connection kits.
- D. Accessories.
- E. Controls.

1.02 RELATED REQUIREMENTS

- A. Section 22 0553 - Identification for Plumbing Piping and Equipment
- B. Section 22 0719 - Plumbing Piping Insulation.
- C. Section 22 1005 - Plumbing Piping.
- D. Section 22 1006 - Plumbing Piping Specialties.
- E. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.
- F. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- G. Section 26 0533.13 - Conduit for Electrical Systems.
- H. Section 26 0533.16 - Boxes for Electrical Systems.
- I. Section 26 0583 - Wiring Connections.

1.03 REFERENCE STANDARDS

- A. IEEE 515.1 - IEEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications; 2022.
- B. ITS (DIR) - Directory of Listed Products; Current Edition.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.
- B. Coordinate the work with other trades to provide ground fault protection for electric heat tracing circuits as required by NFPA 70.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for electric heat tracing.
- C. Shop Drawings: Indicate electric heat tracing layout, electrical terminations, thermostats, controls, and branch circuit connections.
- D. Manufacturer's Installation Instructions: Indicate installation instructions and recommendations.
- E. Field Quality Control Submittals: Indicate test reports and inspection reports.
- F. Project Record Documents: Record actual locations of electric heat tracing lines and thermostats.
- G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions of equipment and controls, maintenance and repair data, and parts listings.

- H. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner'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.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide two year manufacturer warranty for cables, connection kits, accessories, and controls.

PART 2 PRODUCTS

2.01 SELF-REGULATING PARALLEL RESISTANCE ELECTRIC HEATING CABLE

- A. Manufacturers:
 - 1. Chromalox, Inc: www.chromalox.com/#sle.
 - 2. Pentair: www.pentairthermal.com/#sle.
 - 3. Thermon Manufacturing Company: www.thermon.com/#sle.
- B. Provide products listed, classified, and labeled by UL (DIR), ITS (DIR), or testing firm acceptable to authorities having jurisdiction (AHJ).
- C. Factory Rating and Testing: Comply with IEEE 515.1.
- D. Heating Element:
 - 1. Provide pair of parallel No.16 tinned or nickel coated stranded copper bus wires embedded in cross linked conductive polymer core with varying heat output in response to temperature along its length.
 - 2. Terminations: Waterproof, factory assembled, non-heating leads with connector at one end and water-tight seal at opposite end.
 - 3. Capable of crossing over itself without overheating.
- E. Insulated Jacket: Flame retardant polyolefin.
- F. Cable Cover: Provide tinned copper and polyolefin outer jacket with UV inhibitor.
- G. Maximum Power-On Operating Temperature: 150 degrees F (65 degrees C).
- H. Maximum Power-Off Exposure Temperature: 185 degrees F (85 degrees C).
- I. Electrical Characteristics:

2.02 CABLE OUTER JACKET MARKINGS

- A. Name of manufacturer, trademark, or other recognized symbol of identification.
- B. Catalog number, reference number, or model.
- C. Month and year of manufacture, date coding, applicable serial number, or equivalent.
- D. Agency listing or approval.
- E. Applicable environmental or area use requirements, such as NEMA 4, Type 4, IP ratings, and hazardous (classified) location markings including temperature rating.
- F. Any applicable warning/caution statements such as "WARNING: De-energize circuit before removing cover.

2.03 CONNECTION KITS

- A. Provide power connection, splice/tee, and end seal kits compatible with the heating cable and without requiring cutting of the cable core to expose bus wires.
- B. Provide with NEMA 4X rating for prevention of corrosion and water ingress.
- C. Provide UV stabilized components.

2.04 ACCESSORIES

- A. Provide Accessories As Indicated or As Required for Complete Installation, Including but Not Limited To:
 - 1. Heat-conductive putty.
 - 2. Cable ties.
 - 3. Silicone end seals and splice kits.
 - 4. Installation clips.
 - 5. Warning labels for attachment to exterior of piping insulation. Refer to Section 22 0553.

2.05 CONTROLS

- A. Pipe Mounted Thermostats:
 - 1. Remote bulb unit with adjustable temperature range from 30 to 50 degrees F (minus one to 10 degrees C).
 - 2. Snap-action, open-on-rise, single pole switch with minimum current rating adequate for the connected cable.
 - 3. Remote bulb on capillary, resistance temperature device (RTD) or thermistor for direct sensing of pipe wall temperature.
 - 4. Control Enclosure: Corrosion resistant and waterproof.
- B. Line sensing high-limit temperature control and high-limit alarm.
- C. Programmable Controller:
 - 1. Micro-processor based.
 - 2. Capable of four separate schedules.
 - 3. On/Off/Auto switch.
 - 4. 365 day calendar with 20 programmable holidays.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping and equipment are ready to receive work.
- B. Verify field measurements are as indicated on shop drawings.
- C. Verify required power is available, in proper location, and ready for use.

3.02 PREPARATION

- A. Clean exposed surfaces prior to installation.
- B. Prepare surfaces using approved methods as recommended by manufacturer.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's written installation instructions.
- B. Comply with installation requirements of IEEE 515.1 and NFPA 70, Article 427.
- C. Apply heating cable linearly on pipe with fiberglass tape only after piping has successfully completed any required pressure testing.
- D. Comply with applicable local building codes and requirements of authorities having jurisdiction.
- E. Grounding: Refer to Section 26 0526.
- F. Identification:
 - 1. After thermal insulation installation, apply external pipeline decals to indicate presence of the thermal insulation cladding at intervals not to exceed 20 ft (6 m) including cladding over each valve or other equipment that may require maintenance.
 - 2. Refer to Section 22 0553.
- G. Equipment Wiring: Refer to Section 26 0583.
- H. Electrical Connections: Refer to Section 26 0519.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Perform start-up by factory technician or factory representative as per Owner's requirements.
- C. Field Testing and Inspections:
 - 1. Commission system in accordance with installation and operation manual.
 - 2. Inspect for sources of water entry and proper sealing.
 - 3. Inspect weather barrier to confirm that no sharp edges are contacting the trace heating.
 - 4. Insulation Resistance: Greater than 20 megohms at a test voltage of 2500 VDC for polymer insulated trace heaters.
 - 5. Test heating cable integrity with megohmmeter at the following intervals:
 - a. Before installing the cable.
 - b. After cable has been installed onto the piping.
 - c. After installing the connection kits.
 - d. After the installation of thermal insulation onto the piping.
 - e. Prior to initial start-up (commissioning).
 - 6. Measure voltage and current at each unit.
 - 7. Controls:
 - a. Verify control parameters are set to the application requirements.
 - b. Verify factory provided digital temperature controller is correctly configured with the building automation system if included.
 - 8. Submit written test report showing values measured on each test for each cable.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals.
- B. Demonstrate operation of controls.

3.06 PROTECTION

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

END OF SECTION

SECTION 22 0548
VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Vibration isolation requirements.
- B. Seismic control requirements.
 - 1. Includes requirements for seismic qualification of equipment not specified in this section.
- C. Vibration-isolated equipment support bases.
- D. Vibration isolators.
- E. Seismic restraint systems.

1.02 RELATED REQUIREMENTS

- A. Section 01 4533 - Code-Required Special Inspections and Procedures.
- B. Section 03 3000 - Cast-in-Place Concrete.
- C. Section 22 0529 - Hangers and Supports for Plumbing Piping and Equipment.

1.03 DEFINITIONS

- A. Plumbing Component: Where referenced in this section in regards to seismic controls, applies to any portion of the plumbing system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., piping).
- B. Seismic Restraint: Structural members or assemblies of members or manufactured elements specifically designed and applied for transmitting seismic forces between components and the seismic force-resisting system of the structure.

1.04 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASCE 19 - Structural Applications of Steel Cables for Buildings; 2016.
- C. FEMA 412 - Installing Seismic Restraints for Mechanical Equipment; 2014.
- D. FEMA 413 - Installing Seismic Restraints for Electrical Equipment; 2004.
- E. FEMA 414 - Installing Seismic Restraints for Duct and Pipe; 2004.
- F. FEMA E-74 - Reducing the Risks of Nonstructural Earthquake Damage; 2012.
- G. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. ICC-ES AC156 - Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components; 2010, with Editorial Revision (2015).
- I. MFMA-4 - Metal Framing Standards Publication; 2004.
- J. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2008.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment 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. Seismic Controls:

- a. Coordinate the arrangement of seismic restraints with piping, conduit, equipment, and other potential conflicts installed under other sections or by others.
 - b. Coordinate the work with other trades to accommodate relative positioning of essential and nonessential components in consideration of seismic interaction.
- 5. Notify Architect 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 3000.

1.06 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations stamped by a professional engineer licensed in the State of the pro.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
 - 1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.
 - 2. Seismic Controls: Include seismic load capacities.
- D. Shop Drawings - Vibration Isolation Systems:
 - 1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators; indicate equipment weights and static deflections.
 - 2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable; indicate equipment mounting provisions.
- E. Shop Drawings - Seismic Controls:
 - 1. Include dimensioned plan views and sections indicating proposed plumbing component locations and distributed system routing, with locations and details of gravity supports and seismic restraints and associated attachments.
 - 2. Identify mounting conditions required for equipment seismic qualification.
 - 3. Identify anchor manufacturer, type, minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
 - 4. Indicate proposed arrangement of distributed system trapeze support groupings.
 - 5. Indicate proposed locations for distributed system flexible fittings and/or connections.
 - 6. Indicate locations of seismic separations where applicable.
 - 7. Include point load drawings indicating design loads transmitted to structure at each attachment location coordinated with the Project Structural Engineer.
- F. Seismic Design Data:
 - 1. Compile information on project-specific characteristics of actual installed plumbing components necessary for determining seismic design forces required to design appropriate seismic controls, including but not limited to the following.
 - a. Component operating weight and center of gravity.
 - b. Component elevation in the building in relation to the roof elevation (z/h).
 - c. Component importance factor (I_p).
 - d. For distributed systems, component materials and connection methods.
 - e. Component amplification factor (a_p) and component response modification factor (R_p), determined in accordance with ASCE 7 tables.
 - f. Applicability of overstrength factor (for certain anchorage in concrete and masonry).
 - 2. Include structural calculations, stamped or sealed by seismic controls professional engineer, demonstrating suitability of seismic controls for seismic design forces.
- G. Certification for seismically qualified equipment; identify basis for certification.

- H. Evaluation Reports: For products specified as requiring evaluation and recognition by a qualified evaluation service, provide current evaluation reports.
- I. 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.
- J. Manufacturer's detailed field testing and inspection procedures.
- K. Field quality control test reports.

1.07 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Seismic Controls Designer Qualifications: Registered professional engineer licensed in the State in which the Project is located and with minimum five years experience designing seismic restraints for nonstructural components.
 - 1. Designer may be employed by the manufacturer of the seismic restraint products.
- D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION REQUIREMENTS

- A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing plumbing equipment and/or plumbing connections to vibration-isolated equipment.
- B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:
- C. General Requirements:
 - 1. Select vibration isolators to provide required static deflection.
 - 2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
 - 3. Select seismic type vibration isolators to comply with seismic design requirements, including conditions of equipment seismic certification where applicable.
 - 4. Select vibration isolators for outdoor equipment to comply with wind design requirements.
 - 5. Select vibration-isolated equipment support bases and associated vibration isolators to provide minimum 2-inch (50 mm) operating clearance beneath base unless otherwise indicated.
- D. Piping Isolation:
 - 1. Provide vibration isolators for piping supports:
 - a. Located in equipment rooms.
 - b. Located within 50 feet (15.2 m) of connected vibration-isolated equipment and pressure-regulating valve (PRV) stations.
 - c. For piping over 2 inch (50 mm) located below or within 50 feet (15.2 m) of noise-sensitive areas indicated.
 - 2. Minimum Static Deflection:
 - a. First Three Supports Closest to Isolated Equipment: Same as static deflection of equipment; maximum of 2 inch (50 mm) deflection required.
 - b. Remainder of Supports: 0.75 inch (19 mm) deflection unless otherwise indicated.
 - 3. Suspended Piping, Nonseismic Applications: Use resilient material isolator hangers, spring isolator hangers, or combination resilient material/spring isolator hangers.

4. Suspended Piping, Seismic Applications: Use seismic type resilient material isolator hangers, seismic type spring isolator hangers, or seismic type combination resilient material/spring isolator hangers.
5. Floor-Mounted Piping, Nonseismic Applications: Use open (unhoused) spring isolators.
6. Floor-Mounted Piping, Seismic Applications: Use seismic type restrained spring isolators.
7. Use modular seal or approved resilient material where vibration-isolated piping penetrates building elements (e.g., walls, floors) arranged to prevent vibration transmission to structure.

2.02 SEISMIC CONTROL REQUIREMENTS

- A. Design and provide plumbing component restraints, supports, and attachments suitable for seismic loads determined in accordance with applicable codes, as well as gravity and operating loads and other structural design considerations of the installed location. Consider wind loads for outdoor plumbing components. Coordinate attachments with the Project Structural Engineer.
- B. Seismic Design Criteria: Obtain from project Structural Engineer of Record.
- C. Seismic Restraints:
 1. Provide seismic restraints for plumbing components except where exempt according to applicable codes and specified seismic design criteria, as approved by authorities having jurisdiction.
 2. Comply with applicable general recommendations of the following, where not in conflict with applicable codes, seismic design criteria, or other specified requirements:
 - a. FEMA 412.
 - b. FEMA 413.
 - c. FEMA 414.
 - d. FEMA E-74.
 - e. SMACNA (SRM).
 3. Seismic restraint capacities to be verified by a Nationally Recognized Testing Laboratory (NRTL) or certified by an independent third-party registered professional engineer acceptable to authorities having jurisdiction.
 4. Seismic Restraint Systems:
 - a. Except where otherwise restricted, use of either cable or rigid restraints is permitted.
 - b. Use only cable restraints to restrain vibration-isolated plumbing components, including distributed systems.
 - c. Use only one restraint system type for a given plumbing component or distributed system (e.g., piping) run; mixing of cable and rigid restraints on a given component/run is not permitted.
 - d. Size restraint elements, including anchorage, to resist seismic loads as necessary to restrain plumbing component in all lateral directions; consider bracket geometry in anchor load calculations.
 - e. Use rod stiffener clips to attach bracing to hanger rods as required to prevent rod buckling from vertical (upward) compressive load introduced by cable or rigid restraints loaded in tension, in excess of downward tensile load due to supported plumbing component weight.
 - f. Select hanger rods and associated anchorage as required to accommodate vertical (downward) tensile load introduced by rigid restraints loaded in compression, in addition to downward tensile load due to supported plumbing component weight.
 - g. Clevis hangers may only be used for attachment of transverse restraints; do not use for attachment of longitudinal restraints.
 - h. Where seismic restraints are attached to clevis hangers, provide clevis bolt reinforcement accessory to prevent clevis hanger deformation.
 - i. Do not introduce lateral loads on open bar joist chords or the weak axis of beams, or loads in any direction at other than panel points unless approved by project Structural Engineer of Record.

- D. Seismic Attachments - Coordinate and obtain approval from the Structural Engineer of Record for all attachments.:
 - 1. Attachments to be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity coordinated with the Structural Engineer of Record.
 - 2. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) or qualified evaluation service acceptable to authorities having jurisdiction for compliance with applicable building code, and qualified for seismic applications; concrete anchors to be qualified for installation in both cracked and uncracked concrete.
 - 3. Do not use power-actuated fasteners.
 - 4. Do not use friction clips (devices that rely on mechanically applied friction to resist loads). Beam clamps may be used for supporting sustained loads where provided with restraining straps.
 - 5. Comply with anchor minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
 - 6. Concrete Housekeeping Pads:
 - a. Increase size of pad as required to comply with anchor requirements.
 - b. Provide pad reinforcement and doweling to ensure integrity of pad and connection and to provide adequate load path from pad to supporting structure.
- E. Seismic Interactions:
 - 1. Include provisions to prevent seismic impact between plumbing components and other structural or nonstructural components.
 - 2. Include provisions such that failure of a component, either essential or nonessential, does not cause the failure of an essential component.
- F. Seismic Relative Displacement Provisions:
 - 1. Use suitable fittings or flexible connections to accommodate:
 - a. Relative displacements at connections between components, including distributed systems (e.g., piping); do not exceed load limits for equipment utility connections.
 - b. Relative displacements between component supports attached to dissimilar parts of structure that may move differently during an earthquake.
 - c. Design displacements at seismic separations.
 - d. Anticipated drifts between floors.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Provide and install seismic restraint for all required piping and equipment as required by State and Local Codes. Provide Calculations and seismic restraint systems designed by a Structural Engineer licensed within the State Verify that field measurements are as shown on the drawings.
- B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 CODE-REQUIRED SPECIAL INSPECTIONS

- A. Arrange work to accommodate tests and/or inspections performed by Special Inspection Agency employed by Owner or Architect in accordance with Section 01 4533 and statement of special inspections as required by applicable building code.
- B. Frequency of Special Inspections: Where special inspections are designated as continuous or periodic, arrange work accordingly.
 - 1. Continuous Special Inspections: Special Inspection Agency to be present in the area where the work is being performed and observe the work at all times the work is in progress.

2. Periodic Special Inspections: Special Inspection Agency to be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.
- C. Seismic special inspections include, but are not limited to:
 1. Seismically Qualified Equipment: Verification that label, anchorage, and mounting comply with the certificate of compliance.
- D. Prior to starting work, Contractor to submit written statement of responsibility to authorities having jurisdiction and to Owner acknowledging awareness of special requirements contained in the statement of special inspections.
- E. Special Inspection Agency services do not relieve Contractor from performing inspections and testing specified elsewhere.

3.03 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Secure fasteners according to manufacturer's recommended torque settings.
- D. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.
- E. Vibration Isolation Systems:
 1. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
 2. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
 3. Adjust isolators to be free of isolation short circuits during normal operation.
 4. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.
- F. Seismic Controls:
 1. Provide specified snubbing element air gap; remove any factory-installed spacers, debris, or other obstructions.
 2. Use only specified components, anchorage, and hardware evaluated by seismic design. Comply with conditions of seismic certification where applicable.
 3. Where mounting hole diameter exceeds bolt diameter by more than 0.125 inch (3 mm), use epoxy grout, elastomeric grommet, or welded washer to reduce clearance to 0.125 inch (3 mm) or less.
 4. Equipment with Sheet Metal Housings:
 - a. Use Belleville washers to distribute stress over a larger surface area of the sheet metal connection interface as approved by manufacturer.
 - b. Attach additional steel as approved by manufacturer where required to transfer loads to structure.
 - c. Where mounting surface is irregular, do not shim housing; reinforce housing with additional steel as approved by manufacturer.
 5. Concrete Housekeeping Pads:
 - a. Size in accordance with seismic design to meet anchor requirements.
 - b. Install pad reinforcement and doweling in accordance with seismic design to ensure integrity of pad and associated connection to slab.
 6. Seismic Restraint Systems:
 - a. Do not attach seismic restraints and gravity supports to dissimilar parts of structure that may move differently during an earthquake.
 - b. Install restraints within permissible angles in accordance with seismic design.
 - c. Install cable restraints straight between component/run and structural attachment; do not bend around other nonstructural components or structural elements.

- d. Install cable restraints for vibration-isolated components slightly slack to prevent short-circuiting of isolation.
- e. Install hanger rod stiffeners where indicated using only specified clamps; do not weld stiffeners to hanger rod.

3.04 FIELD QUALITY CONTROL

- A. Inspect vibration isolation and/or seismic control components for damage and defects.
- B. Vibration Isolation Systems:
 - 1. Verify isolator static deflections.
 - 2. Verify required clearance beneath vibration-isolated equipment support bases.
 - 3. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.
- C. Seismic Controls:
 - 1. Verify snubbing element air gaps.
- D. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.
- E. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.05 ATTACHMENTS

- A. Statement of special inspections.

END OF SECTION

SECTION 22 0553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe markers.
- D. Underground warning tape.
- E. Ceiling tacks.

1.02 RELATED REQUIREMENTS

- A. Section 09 9123 - Interior Painting: Identification painting.

1.03 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2020.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

1.04 SUBMITTALS

- A. See Section 01 3000 - 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. Heat exchangers, water heaters, and other heat transfer products.
 - 2. Control panels, transducers, and other related control equipment products.
 - 3. Pumps, tanks, filters, water treatment devices, and other plumbing equipment products.
- B. Tags:
 - 1. Piping: 3/4 inch (20 mm) diameter and smaller.
 - 2. Manual operated and automated control valves.
 - 3. Instrumentation, relays, gauges, and other related control equipment products.
 - 4. Ceiling tacks placed on lay-in ceiling surface to reference plumbing components.
- C. Pipe Markers: 3/4 inch (20 mm) diameter and higher.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 3. Seton Identification Products: www.seton.com/#sle.
- B. Description: Laminated piece with up to three lines of text.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch (6 mm).

3. Background Color: Black.
4. Nameplate Height: 3/4 inch (19 mm).
5. Nameplate Material:
 - a. Flexible: Vinyl with adhesive backing per ASTM D709.

2.03 TAGS

- A. Manufacturers:
 1. Advanced Graphic Engraving: www.advancedgraphicengraving.com/#sle.
 2. Brady Corporation: www.bradycorp.com/#sle.
 3. Brimar Industries, Inc: www.pipemarker.com/#sle.
 4. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 5. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 6. Seton Identification Products: www.seton.com/#sle.
- B. Metal: Brass, 19 gauge 1-1/2 inch (40 mm) 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 (20 mm) diameter and smaller. Include corrosion resistant chain. Identify service, flow direction, and pressure.

2.04 PIPE MARKERS

- A. Manufacturers:
 1. Brady Corporation: www.bradycorp.com/#sle.
 2. Brimar Industries, Inc: www.pipemarker.com/#sle.
 3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 5. Seton Identification Products: www.seton.com/#sle.
- B. 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.
- C. Underground Flexible Marker: Bright-colored continuously printed ribbon tape, minimum 6 inches (150 mm) wide by 4 mil, 0.004 inch (0.10 mm) thick, manufactured for direct burial service.
- D. Identification Scheme, ASME A13.1:

2.05 UNDERGROUND WARNING TAPE

- A. Manufacturers:
 1. Brady Corporation: www.bradyd.com/#sle.
 2. Brimar Industries, Inc: www.brimar.com/#sle.
 3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 4. Seton Identification Products: www.seton.com/#sle.
- B. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
 1. Exception: Use foil-backed detectable type tape where required by serving utility or where directed by Owner.
- C. Non-detectable Type Tape: 6 inches (152 mm) wide, with minimum thickness of 4 mil, 0.004 inch (0.10 mm).
- D. Foil-backed Detectable Type Tape: 3 inches (76 mm) wide, with minimum thickness of 5 mil, 0.005 inch (0.12 mm), unless otherwise required for proper detection.
- E. Legend: Type of service, continuously repeated over full length of tape.
- F. Color:

2.06 CEILING TACKS

- A. Manufacturers:
 - 1. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
- B. Description: Steel with 3/4 inch (20 mm) diameter color coded head.
- C. Color code as follows:
 - 1. Plumbing Equipment: Yellow.
 - 2. Plumbing Valves: Green.
 - 3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive identification products.
- B. Prepare surfaces for stencil painting, see Section 09 9123.

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 underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.
- 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 (7.6 to 15.2 m) interval of straight run.
- F. 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 22 0719
PLUMBING PIPING INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Glass fiber insulation.
- B. Weather barrier coatings.
- C. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 09 9113 - Exterior Painting: Painting insulation jacket.
- C. Section 09 9123 - Interior Painting: Painting insulation jacket.
- D. Section 22 1005 - Plumbing Piping: Placement of hangers and hanger inserts.

1.03 REFERENCE STANDARDS

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
- B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019.
- D. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2019).
- E. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2019).
- F. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- G. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2017.
- H. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2019.
- I. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2022.
- J. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
- K. ASTM C1775 - Standard Specification for Laminate Protective Jacket and Tape for Use over Thermal Insulation for Outdoor Applications; 2014.
- L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - 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.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with a minimum of 5 years of e

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: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Knauf Insulation; Earthwool 1000 Degree Pipe Insulation: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.ocbuildingspec.com/#sle.
 - 5. Owens Corning Corporation; VaporWick Pipe Insulation: www.ocbuildingspec.com/#sle.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible with rigid pre-formed insulation for fittings. Wrapped diaper insulation for fittings is not permitted.
 - 1. K (Ksi) Value: ASTM C177, 0.24 at 75 degrees F (0.035 at 24 degrees C).
 - 2. Maximum Service Temperature: 850 degrees F (454 degrees C).
 - 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 (0.029 ng/(Pa s m)).
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.
- E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- F. Indoor Vapor Barrier Finish:

2.03 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. Manufacturers:
 - a. H.B. Fuller Construction Products, Inc; Childers - CP Series Weather Barrier Coating: www.fosterproducts.com/#sle.
 - 2. 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.
 - 3. Water Vapor Permeance: Greater than 1.0 perm (57 ng/(Pa s m)) in accordance with ASTM E96/E96M.
 - 4. Resistance to Fungal Growth: No growth when tested in accordance with ASTM D5590.
 - 5. Color: As selected by Architect.

2.04 JACKETING AND ACCESSORIES

- A. PVC Plastic Jacket:
 - 1. Manufacturers:
 - a. Johns Manville Corporation; _____: www.jm.com/#sle.
 - 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F (Minus 18 degrees C).

- b. Maximum Service Temperature: 150 degrees F (66 degrees C).
 - c. Moisture Vapor Permeability: 0.002 perm inch (0.0029 ng/(Pa s m)), maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil, 0.010 inch (0.25 mm).
 - e. Connections: Brush on welding adhesive.
- 3. Covering Adhesive Mastic: Compatible with insulation.
- B. Aluminum Jacket:
 - 1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch (0.41 mm) with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
 - 2. Thickness: 0.016 inch (0.40 mm) sheet.
 - 3. Finish: Smooth.
 - 4. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
 - 5. Fittings: 0.016 inch (0.40 mm) thick die-shaped fitting covers with factory-attached protective liner.
 - 6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (0.38 mm) thick aluminum.
 - 7. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.

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. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- D. 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.
- E. For hot piping conveying fluids over 140 degrees F (60 degrees C), insulate flanges and unions at equipment.
- F. Glass fiber insulated pipes conveying fluids above ambient temperature:
 - 1. Provide standard jackets, with vapor barrier, factory-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. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches (40 mm) 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 (150 mm) 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 8400.
- I. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet (3 meters) above finished floor): Finish with PVC jacket and fitting covers.
- 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.
- K. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil, 0.001 inch (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.
- L. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.03 SCHEDULES (REFER TO DRAWING SCHEDULE)

END OF SECTION

**SECTION 22 1005
PLUMBING PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sanitary waste piping, buried within 5 feet (1500 mm) of building.
- B. Sanitary waste piping, above grade.
- C. Domestic water piping, buried within 5 feet (1500 mm) of building.
- D. Domestic water piping, above grade.
- E. Propane gas piping, buried beyond 5 feet (1500 mm) of building.
- F. Propane gas piping, buried within 5 feet (1500 mm) of building.
- G. Propane gas piping, above grade.
- H. Natural gas piping, buried beyond 5 feet (1500 mm) of building.
- I. Natural gas piping, buried within 5 feet (1500 mm) of building.
- J. Natural gas piping, above grade.
- K. Pipe flanges, unions, and couplings.
- L. Pipe hangers and supports.
- M. Pipe sleeve-seal systems.
- N. Ball valves.
- O. Balancing valves.
- P. Pressure relief valves.
- Q. Pressure-temperature valves.
- R. Strainers.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 08 3100 - Access Doors and Panels.
- C. Section 09 9123 - Interior Painting.
- D. Section 22 0516 - Expansion Fittings and Loops for Plumbing Piping.
- E. Section 22 0529 - Hangers and Supports for Plumbing Piping and Equipment.
- F. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- G. Section 22 0553 - Identification for Plumbing Piping and Equipment.
- H. Section 22 0719 - Plumbing Piping Insulation.
- I. Section 31 2316 - Excavation.
- J. Section 31 2316.13 - Trenching.
- K. Section 31 2323 - Fill.
- L. Section 33 0110.58 - Disinfection of Water Utility Piping Systems.

1.03 REFERENCE STANDARDS

- A. ANSI Z21.22 - American National Standard for Relief Valves for Hot Water Supply Systems; 2015 (Reaffirmed 2020).
- B. ANSI Z223.1 - National Fuel Gas Code; 2024.
- C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- D. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

- E. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2021.
- F. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- G. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- H. ASME B31.9 - Building Services Piping; 2020.
- I. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; 2021.
- J. 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; 2021.
- K. ASSE 1003 - Performance Requirements for Water Pressure Reducing Valves for Potable Water Distribution Systems; 2020.
- L. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- M. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2021.
- N. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- O. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2020.
- P. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2020.
- Q. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.
- R. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2020a.
- S. ASTM C1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.
- T. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.
- U. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- V. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings; 2022.
- W. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2020.
- X. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2021.
- Y. ASTM D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings; 2020.
- Z. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020.
- AA. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings; 2021.
- BB. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2020.
- CC. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping; 2020.

- DD. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020.
- EE. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
- FF. ASTM F437 - Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80; 2021.
- GG. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40; 2017.
- HH. ASTM F439 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80; 2019.
- II. ASTM F441/F441M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80; 2020.
- JJ. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2020.
- KK. ASTM F628 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core; 2022.
- LL. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing; 2022a, with Editorial Revision.
- MM. ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems; 2022.
- NN. ASTM F1281 - Standard Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe; 2017, with Editorial Revision (2021).
- OO. ASTM F1282 - Standard Specification for Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe; 2017.
- PP. 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; 2021.
- QQ. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2017.
- RR. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2017, with Errata (2018).
- SS. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.
- TT. 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; 2020.
- UU. FM 1680 - Approval Standard for Couplings Used in Hubless Cast Iron Systems for Drain, Waste or Vent, Sewer, Rainwater or Storm Drain Systems Above and Below Ground, Industrial/ Commercial and Residential; 1989.
- VV. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- WW. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends; 2011.
- XX. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.
- YY. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends; 2011.
- ZZ. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
- AAA. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends; 2011.
- BBB. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

- CCC. NFPA 58 - Liquefied Petroleum Gas Code; 2020, with Amendment.
- DDD. NSF 61 - Drinking Water System Components - Health Effects; 2021.
- EEE. NSF 372 - Drinking Water System Components - Lead Content; 2022.
- FFF. UL (DIR) - Online Certifications Directory; Current Edition.
- GGG. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

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. Welders' Certificates: Submit certification of welders' compliance with ASME BPVC-IX.
- C. Sustainable Design Documentation: For products meeting regulatory lead-content restrictions.
- D. Project Record Documents: Record actual locations of valves.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements for additional provisions.

1.05 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- C. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
- D. 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 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.

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.
- B. Plenum-Installed Acid Waste Piping: Flame-spread index equal or below 25 and smoke-spread index equal or below 50 according to ASTM E84 or UL 723 tests.

2.02 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING (REFER TO DRAWING SCHEDULE)

- A. Cast Iron Pipe: CISPI 301, hubless.
 - 1. Fittings: Cast iron.
 - 2. Joints: CISPI 310, Heavy Duty Huskey 4-band clamps with neoprene gasket and stainless steel clamp and shield assemblies.

2.03 SANITARY WASTE PIPING, ABOVE GRADE (REFER TO DRAWING SCHEDULE)

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.

1. Fittings: Cast iron.
2. Joints: CISPI 310, Heavy Duty Husky 4-band clamps with neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.04 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING (REFER TO DRAWING SCHEDULE)

- A. Copper Pipe up to 2 inch: ASTM B42, Type K, annealed. No joints below ground.
 1. Fittings: ASME B16.26, cast bronze.
 2. Joints: Flared.
- B. Ductile Iron Pipe above 2 inch: 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 (19 mm) diameter rods.

2.05 DOMESTIC WATER PIPING, ABOVE GRADE (REFER TO DRAWING SCHEDULE)

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 2. Joints: ASTM B32, alloy Sn95 solder.

2.06 PROPANE GAS PIPING, ABOVE GRADE (REFER TO DRAWING SCHEDULE)

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 2. Joints: NFPA 58, threaded or welded to comply with ASME B31.1.

2.07 NATURAL GAS AND PROPANE PIPING, BURIED BEYOND 5 FEET (1500 MM) OF BUILDING (REFER TO DRAWING SCHEDULE)

- A. Polyethylene Pipe: ASTM D2513, SDR 11. Listed for natural gas and propane
 1. Fittings: ASTM D2683 or ASTM D2513 socket type.
 2. Joints: Fusion welded.

2.08 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 2. Joints: Threaded or welded to ASME B31.1.

2.09 BALANCING VALVES

- A. Manufacturers:
 1. Anvil International; _____: www.anvilintl.com/#sle.
 2. ITT Bell & Gossett; _____: www.bellgossett.com/#sle.
 3. Jomar Valves, a division of Jomar Group; _____: www.jomarvalve.com/#sle.
 4. Griswold Controls; _____: www.griswoldcontrols.com/#sle.
 5. Taco, Inc; _____: www.taco-hvac.com/#sle.
- B. Construction: Class 125, brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Manual Operated Y-Pattern Globe, Size 1/2 to 2 inch (15 to 50 mm, DN):
 1. Class 125, brass or bronze body, multi-turn handwheel, memory stop, variable orifice, soldered connections, dual PT (hot and cold pressure-temperature) test ports for 300 psi (2,068 kPa), minus 4 to 250 deg F (minus 20 to 121.1 deg C) WOG service.
- D. Calibration: Control flow within five percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi (24 kPa).

2.10 FLOW-BALANCING VALVES

- A. Manufacturers:
 1. Anvil International; _____: www.anvilintl.com/#sle.
 2. Griswold Controls; _____: www.griswoldcontrols.com/#sle.

3. ITT Bell & Gossett; _____: www.bellgossett.com/#sle.
- B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi (24 kPa).

2.11 PRESSURE REDUCING VALVES (REFER TO DRAWING SCHEDULE)

- A. Manufacturers:
 1. Cla-Val Company; _____: www.cla-val.com/#sle.
 2. Watts Regulator Company; _____: www.wattsregulator.com/#sle.
- B. 2 inch (50 mm, DN) and Smaller:
 1. ASSE 1003, bronze body, stainless steel, and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends.
 2. Pressure Reducing Pilot-Operator:
 - a. Operating Range: 5 to 50 psi (0.35 to 35 Bar).
 - b. Connected into brass or bronze pilot piping and fittings.
 - c. Fixed flow restrictor, pressure gauges, and isolation valves.
- C. 2 inch (50 mm, DN) and Larger:
 1. ASSE 1003, cast iron body with interior lining complying with AWWA C550, bronze fitted, elastomeric diaphragm and seat disc, flanged.
 2. Pressure Reducing Pilot-Operator:
 - a. Operating Range: 5 to 50 psi (0.35 to 35 Bar).
 - b. Connected into brass or bronze pilot piping and fittings.
 - c. Fixed flow restrictor, strainer, pressure gauges, and isolation valves.

2.12 PRESSURE-TEMPERATURE VALVES

- A. Manufacturers:
 1. Cla-Val Co; _____: www.cla-val.com/#sle.
 2. Watts Regulator Company; _____: www.wattsregulator.com/#sle.
- B. ANSI Z21.22, AGA certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F (98.9 degrees C), capacity ASME BPVC-IV certified and labelled.

2.13 STRAINERS

- A. Manufacturers:
 1. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 2. Green Country Filter Manufacturing; _____: www.greencountryfilter.com/#sle.
 3. Jomar Valves, a division of Jomar Group; _____: www.jomarvalve.com/#sle.
- B. Size 1/2 inch (15 mm, DN) to 3 inch (80 mm, DN):
 1. Class 150, threaded forged bronze Y-pattern body, stainless steel perforated mesh screen with cap, and rated for 150 psi (1,034 kPa), 250 deg F (121.1 deg C) WOG service.
- C. Size 2 inch (50 mm, DN) and Smaller:
 1. Threaded brass body for 175 psi (1200 kPa) CWP, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
 2. Class 150, threaded bronze body 300 psi (2070 kPa) CWP, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
- D. Size 1-1/2 inch (40 mm, DN) to 4 inch (100 mm, DN):
 1. Class 125, flanged iron body, Y pattern with 1/16 inch (1.6 mm) stainless steel perforated screen.
- E. Size 5 inch (125 mm, DN) and Larger:
 1. Class 125, flanged iron body, basket pattern with 1/8 inch (3.2 mm) 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. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 22 0516.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed.
 - 1. Coordinate size and location of access doors with Section 08 3100.
- I. Install vent piping penetrating roofed areas to maintain integrity of roof assembly; see Section ____.
- J. Where pipe support members are welded to structural building framing, coordinate with the structural engineer, scrape, brush clean, and apply one coat of zinc-rich primer to welding.
- K. Provide support for utility meters in accordance with requirements of utility companies.
- L. Prepare exposed, unfinished pipe, fittings, supports, and accessories for finish painting.
 - 1. See Section 09 9123 for painting of interior plumbing systems and components.
 - 2. See Section 09 9113 for painting of exterior plumbing systems and components.
- M. Excavate in accordance with Section 31 2316.
- N. Backfill in accordance with Section 31 2323.
- O. Install valves with stems upright or horizontal, not inverted. See Section 22 0523.
- 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.
- R. Sleeve pipes passing through partitions, walls, and floors.
- S. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
- T. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Install hangers to provide minimum 1/2 inch (15 mm) space between finished covering and adjacent work.
 - 3. Place hangers within 12 inches (300 mm) of each horizontal elbow.
 - 4. Use hangers with 1-1/2 inch (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 7. Provide copper plated hangers and supports for copper piping.
 8. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 9. Provide hangers adjacent to motor-driven equipment with vibration isolation; see Section 22 0548.
 10. Support cast iron drainage piping at every joint.
- U. Pipe 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 watertight seal.
 6. Install in accordance with manufacturer's recommendations.

3.04 APPLICATION

- A. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- B. Install valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Install globe valves for throttling, bypass, or manual flow control services.
- D. Provide spring-loaded check valves on discharge of water pumps.

3.05 TOLERANCES

- A. Drainage Piping: Establish invert elevations within 1/2 inch (10 mm) vertically of location indicated and slope to drain at minimum of 1/4 inch per foot (1:50) slope.
- B. Water Piping: Slope at minimum of 1/32 inch per foot (1:400) and arrange to drain at low points.

3.06 FIELD TESTS AND INSPECTIONS

- A. Verify and inspect systems according to requirements by the Authority Having Jurisdiction. In the absence of specific test and inspection procedures proceed as indicated below.
- B. Domestic Water Systems:
 1. Perform hydrostatic testing for leakage prior to system disinfection.
 2. Test Preparation: Close each fixture valve or disconnect and cap each connected fixture.
 3. General:
 - a. Fill the system with water and raise static head to 10 psi (345 kPa) above service pressure or code required pressure.
- C. Gas Distribution Systems:(Refer to and comply with NFPA 54, 58 and Local Code requirements for gas and propane system testing)
 1. Test Preparation: Close each appliance valve or disconnect and cap each connected appliance.
 2. General Systems:
 - a. Inject a minimum of 10 psi (68.9 kPa) of compressed air into the piping system for a duration of 15 minutes and verify with a gauge that no perceptible pressure drop is measured.
 - b. Ensure test pressure gauge has a range of twice the specific pressure rate selected with an accuracy of 1/10 of 1 pound (0.45 kg).

- D. Test Results: Document and certify successful results, otherwise repair, document, and retest.

3.07 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Disinfect water distribution system in accordance with Local and State Code requirements.
- B. Prior to starting work, verify system is complete, flushed, and clean.
- C. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 .
- D. Inject disinfectant, free chlorine throughout system to obtain residual chlorine in concentrations as required by local and State codes..
- E. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- F. Maintain disinfectant in system for 24 hours.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.08 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, and sand strainer.
 - 1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Calk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.

3.09 SCHEDULES

- A. Pipe Hanger Spacing as indicated in the State and Local Code.:

END OF SECTION

**SECTION 22 1006
PLUMBING PIPING SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Drains.
- B. Cleanouts.
- C. Hose bibbs.
- D. Hydrants.
- E. Washing machine boxes and valves.
- F. Refrigerator valve and recessed box.
- G. Backflow preventers.
- H. Water hammer arrestors.
- I. Mixing valves.
- J. Relief valves.
- K. Air vents.
- L. Floor drain trap seals.
- M. Electronic trap-seal primers.
- N. Domestic water distribution manifolds.
- O. Exterior penetration accessories.

1.02 RELATED REQUIREMENTS

- A. Section 22 1005 - Plumbing Piping.
- B. Section 22 3000 - Plumbing Equipment.
- C. Section 22 4000 - Plumbing Fixtures.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2025).
- C. ASME A112.6.3 - Floor and Trench Drains; 2019.
- D. ASME A112.6.4 - Roof, Deck, and Balcony Drains; 2003 (Reaffirmed 2012).
- E. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers; 2017.
- F. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent; 2021.
- G. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies; 2021.
- H. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance; 2011 (Reaffirmed 2016).
- I. ASSE 1047 - Performance Requirements for Reduced Pressure Detector Backflow Prevention Assemblies; 2021.
- J. ASTM B75/B75M - Standard Specification for Seamless Copper Tube; 2020.
- K. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2020.
- L. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- M. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2020.

- N. NSF 2 - Food Equipment; 2021.
- O. NSF 61 - Drinking Water System Components - Health Effects; 2021.
- P. NSF 372 - Drinking Water System Components - Lead Content; 2022.
- Q. PDI-WH 201 - Water Hammer Arresters; 2017.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
- D. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
- E. Sustainable Design Documentation: Submit appropriate evidence that materials used in potable water systems comply with the specified requirements.
- 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.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements for additional provisions.
 - 2. Extra Loose Keys for Outside Hose Bibbs: One.
 - 3. Extra Hose End Vacuum Breakers for Hose Bibbs: One.

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.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept specialties on site in original factory packaging. Inspect for damage.

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 (REFER TO DRAWING SCHEDULE)

- A. Manufacturers:
 - 1. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
 - 2. Josam Company; _____: www.josam.com/#sle.
 - 3. MIFAB, Inc; _____: www.mifab.com/#sle.
 - 4. Zurn Industries, LLC; _____: www.zurn.com/#sle.
- B. Floor Drains (Refer to drawing schedule):
- C. Floor Sink (FS-1):
 - 1. Lacquered cast iron body with dome strainer and seepage flange and nickel bronze frame and grate.

2.03 CLEANOUTS

- A. Manufacturers:
 - 1. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
 - 2. Josam Company; _____: www.josam.com/#sle.
 - 3. MIFAB, Inc; C1100-R: www.mifab.com/#sle.
 - 4. Zurn Industries, LLC; _____: www.zurn.com/#sle.

- B. Cleanouts at Exterior Surfaced Areas:
 - 1. Round cast nickel bronze access frame and non-skid cover.
- C. Cleanouts at Exterior Unsurfaced Areas:
 - 1. Line type with lacquered cast iron body and round epoxy coated gasketed cover.
- D. Cleanouts at Interior Finished Floor Areas (CO-3):
 - 1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round nickel bronze gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.
- E. Cleanouts at Interior Finished Wall Areas (CO-4):
 - 1. Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.

2.04 HOSE BIBBS

- A. Manufacturers:
 - 1. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
 - 2. Murdock Manufacturing, Inc; _____: www.murdockmfg.com/#sle.
 - 3. Watts Regulator Company; _____: www.wattsregulator.com/#sle.
 - 4. Zurn Industries, LLC; _____: www.zurn.com/#sle.
- B. Interior Hose Bibbs:
 - 1. Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome-plated where exposed with handwheel, integral vacuum breaker in compliance with ASSE 1011.

2.05 HYDRANTS

- A. Manufacturers:
 - 1. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
 - 2. Murdock Manufacturing, Inc; _____: www.murdockmfg.com/#sle.
 - 3. Zurn Industries, LLC; _____: www.zurn.com/#sle.
- B. Wall Hydrants:
 - 1. ASSE 1019; freeze resistant, self-draining type with chrome-plated wall plate hose thread spout, handwheel, and integral vacuum breaker.

2.06 WASHING MACHINE BOXES AND VALVES

- A. Box Manufacturers:
 - 1. IPS Corporation/Water-Tite; _____: www.ipscorp.com/#sle.
- B. Valve Manufacturers:
 - 1. Cash Acme, a brand of Reliance Worldwide Corporation; _____: www.cashacme.com/#sle.
 - 2. IPS Corporation/Water-Tite; _____: www.ipscorp.com/#sle.
 - 3. Zurn Industries, LLC; _____: www.zurn.com/#sle.
- C. Description: Plastic preformed rough-in box with brass long shank valves with wheel handles, socket for 2 inch (50 mm) waste, slip in finishing cover.

2.07 REFRIGERATOR VALVE AND RECESSED BOX

- A. Box Manufacturers:
 - 1. IPS Corporation/Water-Tite; _____: www.ipscorp.com/#sle.
 - 2. Oatey Supply Chain Services, Inc; _____: www.oatey.com/#sle.
- B. Valve Manufacturers:
 - 1. IPS Corporation/Water-Tite; _____: www.ipscorp.com/#sle.
 - 2. Zurn Industries, LLC; _____: www.zurn.com/#sle.
- C. Description: Plastic preformed rough-in box with brass valves with wheel handle, slip in finishing cover.

2.08 BACKFLOW PREVENTERS

- A. Manufacturers:
 - 1. Cash Acme, a brand of Reliance Worldwide Corporation; _____: www.cashacme.com/#sle.
 - 2. Watts Regulator Company, a part of Watts Water Technologies; _____: www.wattsregulator.com/#sle.
 - 3. Zurn Industries, LLC; 375XL: www.zurn.com/#sle.
- B. Reduced Pressure Backflow Preventer Assembly:
 - 1. ASSE 1013; cast bronze body 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, and non-threaded vent outlet.
 - 2. Size: _____ inch (_____ mm) assembly with threaded gate valves.

2.09 WATER HAMMER ARRESTORS

- A. Manufacturers:
 - 1. Cash Acme, a brand of Reliance Worldwide Corporation; _____: www.cashacme.com/#sle.
 - 2. Jay R. Smith Manufacturing Company; _____: www.jrsmith.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. 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 (minus 73 to 149 degrees C) and maximum 250 psi (1700 kPa) working pressure.

2.10 MIXING VALVES

- A. Thermostatic Mixing Valves:
 - 1. Manufacturers:
 - a. Symmons
 - b. Leonard Valve Company; _____: www.leonardvalve.com/#sle.
 - 2. Valve: Chrome-plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment.
 - 3. Accessories:
 - a. Check valve on inlets.
 - b. Stem thermometer on outlet.
 - c. Strainer stop checks on inlets.
 - 4. Cabinet: 16 gauge, 0.0598 inch (1.52 mm) stainless steel, for surface mounting with keyed lock.

2.11 RELIEF VALVES

- A. Manufacturers:
 - 1. Cash Acme, a brand of Reliance Worldwide Corporation; _____: www.cashacme.com/#sle.
 - 2. ITT Bell & Gossett; _____: www.bellgossett.com/#sle.
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.12 AIR VENTS

- A. Manufacturers:
 - 1. Cash Acme, a brand of Reliance Worldwide Corporation; _____: www.cashacme.com/#sle.
 - 2. ITT Bell & Gossett; _____: www.bellgossett.com/#sle.

3. Taco, Inc; _____: www.taco-hvac.com/#sle.
- B. Manual Type: Short vertical sections of 2 inch (50 mm) diameter pipe to form air chamber, with 1/8 inch (3 mm) brass needle valve at top of chamber.

2.13 FLOOR DRAIN TRAP SEALS

- A. Description: Push-fit EPDM or silicone fitting with a one-way membrane.

2.14 ELECTRONIC TRAP-SEAL PRIMERS

- A. Manufacturers:
 1. MIFAB, Inc; MI-100: www.mifab.com/#sle.
- B. Description: Enclosed electronic trap seal primer system with timer.
- C. Electrical Characteristics:
 1. 24 VDC.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- C. Encase exterior cleanouts in concrete flush with grade.
- D. Install floor cleanouts at elevation to accommodate finished floor.
- E. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.
- F. Pipe relief from backflow preventer to drain.
- G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatory sinks, washing machine outlets, or _____.
- H. Install air chambers on hot and cold water supply piping to each fixture or group of fixtures (each washroom). Fabricate same size as supply pipe or 3/4 inch (20 mm) minimum, and minimum 18 inches (450 mm) long.

END OF SECTION

**SECTION 22 1123
DOMESTIC WATER PUMPS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Circulators.

1.02 RELATED REQUIREMENTS

- A. Section 22 0513 - Common Motor Requirements for Plumbing Equipment.
- B. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- C. Section 26 0583 - Wiring Connections.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2025).
- B. ASME A13.1 - Scheme for the Identification of Piping Systems; 2020.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NSF 61 - Drinking Water System Components - Health Effects; 2022, with Errata.
- E. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide certified pump curve with duty point marked over pump and system operating conditions and NPSH curve and power requirement by pump tag.
 - 2. Manufacturer's catalog sheets for fixtures, fittings, accessories, and supplies.
- C. Shop Drawings: Include dimensions and performance data.
- D. Test Reports: Plumbing fixture operational tests.
- E. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- F. Executed warranty.
- G. Project Record Documents: Record actual locations of components.
- H. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing type of products specified in this section, with minimum three years of documented experience.
- B. Certifications: Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc, as suitable for purpose specified and indicated.
- C. Identification: Provide pumps with manufacturer's name, model number, and rated 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, and 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 7800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 1-year manufacturer warranty for pumps except circulator type. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 CIRCULATORS (REFER TO DRAWING SCHEDULE)

- A. Manufacturers:
 - 1. Armstrong Fluid Technology; _____: www.armstrongfluidtechnology.com/#sle.
 - 2. Bell & Gossett, a Brand of Xylem, Inc; _____: www.xylem.com/#sle.
 - 3. Grundfos Pumps Corporation; MAGNA 3: www.grundfos.com/#sle.
- B. Casing: Bronze with bronze cast impeller, and stainless steel rotor assembly.
- C. Shaft: Alloy steel with integral thrust collar and two oil-lubricated bronze sleeve bearings.
- D. Mechanical Seal: Carbon rotating against a stationary ceramic seat.
- E. Pipe-End Connection: Union connection.
- F. Service Temperature Range: Minus 30 to 250 degrees F (Minus 34.4 to 121.1 degrees C).
- G. Controls: Provide aquastat set for high-temp cutoff, electric plug, and illuminated hand switch.
- H. BMS or Other Integrated Automation Link: Provide auxiliary contacts for fault and run status.
- I. Accessories: Include inlet-outlet temperature and pressure gauges with 2-way isolation valves.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products with related fittings, and accessories according to manufacturer instructions.
- B. Potable and Drinking Water Service: Provide NSF 61 certified; comply with ICC (IPC).
- C. Electrical-Driven Pump Work:
 - 1. Provide electric-motor-driven equipment specified complete with local disconnect switch and control panel with starter, controls, safety devices, and related wiring.
 - 2. Provide automatic control and protective devices field-wired to interface-related devices required for specified operation.
- D. Ensure that small pressure gauges are installed on both upstream and downstream ends.
- E. Hot Water Service: Ensure that small pressure-temperature gauges are installed on both upstream and downstream ends.
- F. Factory-Provided Pump Controls: Factory provided, tested for use.
- G. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are nonoverloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- H. Coordinate BAS, BMS, or Integrated Automation linking between unit controller and remote software app or terminal; see Section 25 3500.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Operational Tests: Upon completion and sterilization of plumbing systems, conduct operating tests to demonstrate satisfactory, functional, and operating efficiency.

3.03 CLEANING

- A. Thoroughly clean plumbing fixtures and equipment.
- B. See Section 01 7419 - Construction Waste Management and Disposal for additional requirements.

3.04 PROTECTION

- A. Protect installed products from damage due from subsequent construction operations.
- B. Repair or replace products damaged before Date of Substantial Completion.

END OF SECTION

**SECTION 22 3000
PLUMBING EQUIPMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Commercial gas-fired water heaters.
- B. Diaphragm-type compression tanks.
- C. In-line circulator pumps.

1.02 RELATED REQUIREMENTS

- A. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- B. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); Current Edition.
- B. ANSI Z21.10.1 - Gas Water Heaters, Volume I, Storage Water Heaters with Input Ratings of 75,000 Btu Per Hour or Less; 2019, with Errata (2020).
- C. ANSI Z21.10.3 - Gas-Fired Water Heaters, Volume III, Storage Water Heaters with Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous; 2019.
- D. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2021.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 174 - Standard for Household Electric Storage Tank Water Heaters; Current Edition, Including All Revisions.
- G. UL 1453 - Standard for Electric Booster and Commercial Storage Tank Water Heaters; Current Edition, Including All Revisions.
- H. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

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 3000 - 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. Shop Drawings:
- D. Manufacturer's Instructions:
- E. Project Record Documents: Record actual locations of components.
- F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 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. Water Heaters: NSF approved.
 - 2. Gas Water Heaters: AHRI Directory of Certified Product Performance.
 - 3. Electric Water Heaters: UL listed and labeled to UL 174.
 - 4. Water Tanks: ASME labeled to ASME BPVC-VIII-1.
 - 5. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.08 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS

2.01 WATER HEATERS (REFER TO DRAWING SCHEDULE)

2.02 DIAPHRAGM-TYPE COMPRESSION TANKS

- A. Manufacturers:
 - 1. Amtrol Inc; _____: www.amtrol.com/#sle.
 - 2. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 - 3. Taco, Inc; _____: www.taco-hvac.com/#sle.
- 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 (860 kPa), 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 (80 kPa).

2.03 IN-LINE CIRCULATOR PUMPS

- A. Manufacturers:
 - 1. Armstrong Fluid Technology; _____: www.armstrongfluidtechnology.com/#sle.
 - 2. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
- B. Casing: Bronze, rated for 125 psig (860 kPa) 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. Drive: Flexible coupling.

2.04 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. Furnish motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified.

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 and related fuel piping and/or electrical work to achieve operating system.
- C. Pumps:
 - 1. 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.
 - 2. Align and verify alignment of base mounted pumps prior to start-up

END OF SECTION

**SECTION 22 0000
GENERAL REQUIREMENTS FOR PLUMBING**

PART 1 – GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with Division 01 – General Requirements when available. If not available, the Contractor shall meet the requirements of these specifications.
- B. Where the Owner-Contractor Agreement contradicts this division, the more stringent shall apply.

1.02 RELATED REQUIREMENTS

- A. Codes to include latest adopted editions, including current amendments, supplements, and local jurisdiction requirements in effect as of the date of the Contract Documents, including state/local building code, mechanical code, plumbing code, electrical code, fire code, and energy code.

1.03 GENERAL SCOPE

- A. Work included in 22 00 00 applies to Division 22 work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of mechanical systems for proposed project.
- B. Contract Documents include, but are not limited to, Specifications, Drawings, Addenda, Owner/Engineer Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.
- C. In the event there is a discrepancy between the drawings, specifications and current code, the more stringent shall apply.
- D. Examine the Drawings, specifications and other Contract Documents relating to the Work and the work of all trades and become fully informed as to the extent and character of work required. Coordinate all work with that of others to ensure proper and complete installation of all materials, equipment and supports.
- E. Intent:
 - 1. The intent of the Contract Documents is for the Contractor to include all work necessary for the complete systems, tested and ready for operation (hereinafter "Design Intent").
 - 2. Provide all items not specifically shown on the drawings, called for in the specifications or related Contract Documents, but required to conform to the labor, material and equipment to achieve the Design Intent.
 - 3. Provide all scaffolding, access provisions, tools, appliances, consumables, debris removal/disposal, supervision and labor, including required start-up, check-out and training to provide complete and fully operable systems in full compliance with the Contract Documents.
 - 4. Before submitting a bid and prior to the start of work, Contractor shall examine all conditions relating to the Work, including that associated with the work of other trades upon which Contractor's work may rely or otherwise depend, to achieve the Design Intent, in accordance with the best trade practices, workmanship and highest quality product installation, taking into account the sequence of the work, delivery, storage and hoisting requirements, requirements for access, testing and temporary services and all other site limitations and project complexities. Report to the Architect/Engineer any conditions which might prevent installation of materials and/or equipment in the manner intended by the Contract Documents or contrary to applicable codes, standards or regulations.
 - 5. By submitting a bid, the Contractor represents that it has made a thorough examination of the site, of the work, including that associated with the work of other trades, all existing conditions and limitations, and that it has examined the Contract Documents in complete detail and has determined beyond doubt that the drawings, specifications, and existing

conditions are sufficient, adequate and satisfactory for the construction of the work under the Contract.

6. No consideration or allowance will be granted for any alleged misunderstanding of materials, equipment or components to be furnished or work to be done; it being agreed that tender of proposal carries with it agreement to items, terms and conditions required by the Contract Documents.
7. Where minor adjustments of the work are necessary for purposes of fabrication or installation of items, or resolution of conflicts between items within the intent of the Contract Documents, the Contractor shall make such adjustments with no added compensation. Where such adjustments affect functional or aesthetic design of the work, they shall first be submitted to the Architect for review and approval.

F. Site Visit:

1. Contractor shall visit the site and verify the exact conditions relating to the work and obtain such information as may be necessary to present a complete and comprehensive bid. No allowance will be made for any extra expense due to Contractor's failure to make such a visit and reasonably verify all actual/existing conditions. In the event of a conflict between existing conditions and the requirements of the Contract Documents, perform the necessary work to conform to Design Intent. The Owner or his representative will be the sole individual to interpret the intent of the Drawings in the event of a conflict between (1) existing conditions and those shown on the drawings, or (2) quality of existing material and quality of material indicated on the drawings or in the specifications. Wherever a conflict such as this occurs, the higher standard shall prevail.

G. Conditions:

1. Conform to all Bidding Requirements and General Conditions
2. The Contractor is obligated to comply with the above in addition to the requirements of this Section.
3. Modifications by this Section do not nullify any other portions of the above-referenced conditions.

H. Make complete system installation, connecting to all equipment shown on the plans, or called for in the specifications. Contractor to provide any additional components not shown on plans to obtain design criteria as required for a complete system and by the balancing contractor.

I. Drawings:

1. Drawings do not attempt to show all aspects of building construction, which will affect the installation of the systems. The drawings are diagrammatic and do not intend to show all offsets and fittings that may be required for a complete installation. Locations of equipment, pipes, valves, traps, ductwork, etc. shown on the drawings, shall be followed as closely as conditions will permit. Review all project drawings, including, but not limited to, architectural, structural, plumbing and electrical drawings; and coordinate with all trades involved so there is no conflict with work of other trades and so Owner secures best arrangement of work consistent with use of space.
2. Verify exact distances between points shown on drawings by actual measurement at site, as no extra cost will be allowed for differences between actual measurements and scaled measurements on drawings.
3. Changes in design, configuration, or location of equipment, piping, or ductwork, advisable in the opinion of Contractor, shall be submitted to Architect/Engineer for approval before proceeding with work, with written assurance from other trades that such changes will not interfere with their installation, nor cause any extra cost on their part. Such changes shall be made at no additional cost to Owner.
4. Check location of all work of all trades and avoid interferences. Conflicts shall be reported to Architect/Engineer for decision and direction. Special attention is called to the following items:
 - a. Exact location of outlets shown on architectural details.
 - b. Location of suspended ceilings.

1.04 SPECIAL REQUIREMENTS

- A. When applicable, Contractor acknowledges the ongoing operations of the Owner at or in close proximity to the Project and agrees to coordinate the timing of the Work with the Owner's ongoing operations; perform the Work in a manner that minimizes or eliminates and adverse impact upon the Owner's ongoing operations; confine operations at the site to areas approved by Owner, permitted by law, permits and the Contract Documents; comply with the Owner's standard security, health and safety policies and procedures; not unreasonably encumber the site with any materials or equipment; and not place signs or advertising on or about the site without prior approval of Owner.
- B. Where applicable, all seismic construction, restraints, bracing, mounts and hanging systems shall be in full compliance with the requirements of all Authorities Having Jurisdiction (AHJ's), pre-approval, certification and engineering (including certified engineering calculations and stamps). Contractor shall be solely responsible for obtaining and complying with all requirements of the AHJ.

1.05 DEFINITIONS AND ABBREVIATIONS

- A. Finished Spaces: Spaces other than mechanical, plumbing and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical, electrical and plumbing equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include spaces above hard or lay-in type ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The word "provide," means "furnish and install."
- G. The word "approved," means acceptance by the Architect or Engineer
- H. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the drawings, or other paragraphs or schedules in the specifications, and similar requirements in the Contract Documents. Terms such as "shown," "noted," "scheduled," and "specified" are used to help the reader locate the reference. Location is not limited.
- I. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted," mean directed by the Architect/Engineer, requested by the Architect/Engineer, and similar phrases.

1.06 REFERENCE STANDARDS AND GUIDELINES

- A. Include but are not limited to the latest adopted editions from:
 - 1. AABC: Associated Air Balance Council
 - 2. ADA: Americans with Disabilities Act
 - 3. AHRI: Air-Conditioning Heating & Refrigeration Institute
 - 4. AMCA: Air Moving and Conditioning Association
 - 5. ANSI: American National Standards Institute
 - 6. ARI: Air Conditioning and Refrigeration Institute
 - 7. ASHRAE: American Society of Heating, Refrigerating, and Air Conditioning Engineers
 - 8. ASME: American Society of Mechanical Engineers
 - 9. ASPE: American Society of Plumbing Engineers
 - 10. ASSE: American Society of Sanitary Engineering
 - 11. ASTM: American Society of Testing Materials

- 12. AWWA: American Water Works Association
- 13. AWS: American Welding Society
- 14. CFR: Code of Federal Regulations
- 15. CISPI: Cast Iron Soil Pipe Institute
- 16. EPA: Environmental Protection Agency
- 17. FM: Factory Mutual Engineering Corporation
- 18. Fed. Spec.: Federal Specifications
- 19. GAMA: Gas Appliance Manufacturers Association
- 20. IAPMO: International Association of Plumbing & Mechanical Officials
- 21. ISO: International Organization for Standardization
- 22. MSS: Manufacturers Standardization Society
- 23. NEBB: National Environmental Balancing Bureau
- 24. NEC: National Electric Code
- 25. NEMA: National Electrical Manufacturers Association
- 26. NFPA: National Fire Protection Association
- 27. OSHA: Occupational Safety and Health Administration
- 28. SMACNA: Sheet Metal and Air Conditioning Contractors National Association, Inc.
- 29. UL: Underwriters Laboratories
- 30. WOG: Non-shock Water-Oil-Gas maximum working pressure rating

1.07 SUBMITTALS

- A. Reference Division 1 for submittal requirements when available. If not available, the contractor shall meet the requirements of these specifications.
- B. Submittal Schedule – Provide a detailed submittal schedule including all requirements of this Division and its subdivisions to the Architect and Engineer within thirty (30) days of contract award.
 - 1. Contractor shall submit for the Engineer's approval a Submittal Schedule for the performance of the work that is consistent with the requirements of the project schedule. The Submittal Schedule shall allow reasonable time for the Architect and other consultants review. If the time for Architects/Engineers review is not otherwise specified, the review period (from date of receipt) shall be a minimum of ten (10) business days. Once approved by the Architect/Engineer, submittal dates and time limits established by the Submittal Schedule shall not, except for reasonable cause, be changed or exceeded by the Contractor.
 - 2. For each submittal required by the Contract Documents, the schedule shall include: specification section number, subsection/paragraph identification number, item description (as stated in the applicable specification section, subsection or other Contract Document) and the scheduled delivery date to the Architect/Engineer.
 - 3. Contractor shall be responsible to the Architect/Engineer and/or Owner for all costs, expenses and impact to the project schedule resulting from any deviation to the approved Submittal Schedule, including but not limited to: material or payment for required overtime, out-of-house resources/consultants or other higher cost resources of the Architect/Engineer as may be required to perform out of sequence, stacked, critical, delayed, unscheduled or multiple reviews of required submittals necessitated by rejection of a prior submittal, (cumulatively and hereinafter, "Additional Review Costs")
- C. General
 - 1. Review is for general conformance with the Contract Documents and is not intended to otherwise approve or verify dimensions, quantities, or to coordinate the Work shown on shop drawings on or between Contractor and the work of other trades or Sections. Contractor is solely responsible for quantities, dimensions, means and methods. Dimensions shall be confirmed and correlated by Contractor at the jobsite prior to the start of the Work (procurement, fabrication, construction or other commencement activities). Contractor's failure to fully verify conditions at the jobsite prior to commencement of the work shall not relieve Contractor of its obligations under the

- Contract Documents and Contractor shall be responsible for all damages caused by or related to its failure to comply with the requirements of this provision.
2. Submittal review shall be performed to show compliance with the design intent.
Contractor shall specifically note any deviations from the Contract Documents and explain the reason and nature of the deviation. Such deviations will be reviewed or rejected on the submittal. Deviations not so identified shall not relieve the Contractor from the requirements of the Contract Documents.
 3. Resubmittals will be reviewed for compliance with comment(s) made on the original submittal only. Architect/Engineer shall not be responsible for changes made upon resubmittal that are not clearly identified (highlighted), and responsive directly to the initial rejection. Resubmittals should not be packaged with non-related first-time submittals, all resubmittals must be marked with the resubmittal number and date and must otherwise comply with all submittal requirements.
 4. Submit product data, shop drawings, commissioning plan(s) and checklists, penetration locations, supplemental data, etc. as may be required by the Contract Documents for all materials, equipment and other components of the work included in all Sections of this Division and other provisions of the Contract Documents in accordance with the requirements of this Division and referenced sections.
 5. All submittals must be reviewed by Contractor, and bear Contractor's review stamp and signoff for Conformity to the Contract Documents, prior to the submission of any required submittal to Architect/Engineer. Submittals that fail to meet this requirement will be considered incomplete, will not be reviewed by Architect/Engineer and will be returned to Contractor, without review and/or rejected and resubmittal will be required. Contractor shall be solely responsible for any and all Additional Review Costs and/or other project costs or schedule impact.
 6. Forward all submittals to Architect/Engineer in a coherent, organized fashion, complete and packaged as required herein, Architect/Engineer may reject submittals that fail to comply with this or any other provision of the Contract Documents and Contractor shall be solely responsible for any and all Additional Review Costs and/or other project costs or schedule impact.
 7. Subject to other provisions of the Contract Documents and in the absence of a more stringent requirement, Architect/Engineer will review a submittal not more than two (2) times. If a submittal is required to be reviewed more than twice due to incomplete, or incorrect information the contractor shall be solely responsible for any and all Additional Review Costs and/or other project costs or schedule impact.
 8. Identify each submittal item by reference to Specification Section paragraph in which item is specified, or drawing/detail number, as applicable. In addition, for equipment submittals, include identification numbers appearing on the equipment schedule.
 9. Identify each item by manufacturer, brand, trade name, number, size, rating, or whatever other data is necessary to properly identify and check materials and equipment. Words "as specified" are not sufficient identification.
 10. Organize submittals in same sequence as they appear in specification sections, articles or paragraphs.
 11. All materials and equipment submittals shall have a summary sheet at the front complete with catalog numbers. Where materials or equipment pertain to more than one building, submittals shall clearly indicate at which locations the materials or equipment is to be installed.
 12. Submittals shall show physical arrangement, construction details, finishes, materials used in fabrications, provisions for piping and/or conduit entrance, access requirements for installation and maintenance, physical size and dimension, electrical characteristics and requirements, foundation/curbs and all permanent and temporary support details as well as all information relating to weight, including but not limited to live and dead weights and other information necessary for component verification and coordination with other trades.

D. Catalog Cuts & Submittal Literature

1. Catalog cuts, submittal literature and published material may be included to supplement scale drawings provided that the actual make and model of equipment being submitted on is identified.
 2. Submittal literature, drawings and diagrams shall be specifically applicable to this project and shall not contain extraneous material or optional choices. Clearly mark literature to indicate the proposed item.
- E. Shop Drawings:
1. Shop drawings shall include all systems, equipment, and components, including but not limited to all equipment, devices, connections and elevations. Include all related specialty rooms (i.e. mechanical, electrical, data/technology). Drawings shall be at a minimum scale of 1/4" per 1'-0" and shall be fully coordinated with the work of other trades and/or sections.
 2. Detail major elements, components, systems, equipment and materials in relationship with other systems, installations, and building components. Identify congested areas and clearly indicate solutions to space problems, developed in conjunction with the work of other trades and/or Sections. Identification of space problems without proposed solutions is not acceptable and is grounds for rejection. For such areas indicate, superimposed, the work of all trades and/or Sections involved and:
 - a. Clearly identify each area of congestion and deviations from the Contract Documents, and:
 - b. Proposed solution(s), clearly documented and signed-off by all other trades and/or Sections involved.
 3. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
 - a. Planned system distribution layout, including specialty device locations and access for operation
 - b. Clearances for installing and maintaining insulation.
 - c. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 - d. Equipment and accessory service connections and support details.
 - e. Other systems installed in same space.
 - f. Exterior wall and foundation penetrations.
 - g. Fire-rated wall and floor penetrations.
 - h. Ceiling and wall-mounted access doors and panels required to provide access to operating devices or items needing access for proper maintenance
 - i. Sizes and location of required concrete pads and bases.
 - j. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 - k. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
- F. Anchorage and Supports: Submit details and calculations for support and anchors that are not specifically detailed on the drawings but required. All calculations must meet current seismic and structural code. Submit to the project structural engineer for review.
1. Provide seismic restraints in accordance with ASCE Standard 7 requirements for piping, ductwork, and mechanical equipment.
 2. Provide engineering for seismic restraint system, assemblies, and components.
 3. Provide shop drawings, calculations stamped by a professional engineer licensed in the State of the project and installation instructions for seismic restraint system.
 4. Provide final inspection and report for installed restraint system acceptance by a professional engineer.
 5. Where pre-approved bracing systems will be employed, submit:
 - a. System component brochure describing components used and detailed installation instructions.

- b. Loads to be transmitted to the structure at anchor points.
- 6. Where anchorage, support, and bracing are not detailed on the drawings, and pre-approved systems are not used, submit details and calculations of proposed systems. Include:
 - a. Anchorage and Supports
 - 1) Where equipment substitutions change the weight, size, configuration, or other aspects of systems and equipment that will affect the performance of anchorages and/or supports, submit calculations for proposed anchors and supports, and install them as shown in these calculations.
 - 2) Where substitutions will have no effect on anchors and supports detailed on Contract Documents, submit information on sizes, weights, center of gravity and other relevant information to demonstrate this fact.
- 7. Seismic Engineer: Professional engineer currently licensed in state where project is located as a structural, civil, or mechanical engineer. Responsible for designing, applying, and inspecting custom seismic restraint components in accordance with applicable codes.
- G. Shop Fabrication Drawings: Drawings are for the Contractor's use and shall be its responsibility. Do not submit shop fabrication documents unless specifically requested.
- H. Testing: Coordinate Shop Drawings to include any additional components for proper system testing.
- I. Certificates: Submit final inspection certificates signed by governing authorities.
- J. Operating and Maintenance Instructions and Manuals.
 - 1. Three (3) complete sets of instructions containing the manufacturer's operating and maintenance instructions for each piece of equipment shall be furnished to the Owner within ninety (90) days of issuance of final occupancy permit. Each set shall be electronic or permanently bound with a hard cover. The following identification shall be inscribed on the covers, "OPERATING AND MAINTENANCE INSTRUCTIONS", the name and location of the building, the name of the Contractor, and the Contract number. Flysheets shall be placed before instructions covering each subject. The instruction sheets shall be approximately 8 1/2" x 11" with large sheets of Drawings folded in.
 - 2. PDF electronic file: 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.
 - 3. Instructions on major items, including but not limited to: pumps, air compressors, boilers, specialty units, fans, heat pumps, and temperature controls, shall be by representative of manufacturer of respective equipment.
 - 4. Submit as identified below and as noted in other specification references.
 - a. Names, addresses and phone numbers of contractors and subcontractors. List of all system components, with the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year of operation.
 - b. Complete operating and maintenance instructions and parts lists of all equipment and component parts. Data sheets to show all connections, ratings, characteristics, wiring connections, catalog data on component parts whether furnished by equipment manufacturer or others, names, addresses and telephone numbers of source of supply for parts subject to wear or failure, and description of operating, test, adjustment, and maintenance procedures.
 - 1) Where data sheets included in manual cover equipment, options, or other features not part of equipment actually furnished, line out these references or otherwise clearly mark so remaining text, diagrams, drawings, schedules, and similar information shall apply specifically to equipment furnished.
 - c. Operating Instructions should include, but not be limited to:
 - 1) Normal starting, operational and shutdown procedures, including emergency procedures for each type of equipment/system.
 - 2) Equipment wiring and control diagrams.

- 3) All other items as may be specified/required by this Section and the Contract Documents.
- d. Maintenance Instructions
 - 1) All items as may be specified/required by this Section and the Contract Documents.
- e. Manufacturers Data (each piece of equipment)
 - 1) Installation instructions
 - 2) Drawings & specifications
 - 3) Parts List, including recommended stock and long lead parts/components.
 - 4) Wiring and riser diagrams.
 - 5) Warranties and guarantees for all equipment, materials and components, including repair, replacement and labor from both Contractor and manufacturer as required by the Contract Documents.
 - 6) Certificates of Installation – manufacturer's certification of supervision during equipment installation and start-up procedures.
 - 7) All other items as may be specified/required by this Section and the Contract Documents.
- K. Record AS-Built Documents.
 1. The Contractor shall prepare and provide a complete set of as-built drawings.
 2. Maintain one (1) complete set of prints and specifications at the job site exclusively for recording deviations from the drawings which are necessary because of job conditions, request for information and/or approved change orders. Record locations and depths of buried and concealed system components from fixed, easily identifiable objects, such as building walls or other fixed physical objects. Where systems are concealed in walls or other fixed physical objects, indicate distances from building corners or other building features not likely to be disturbed by future alterations.
 3. Submit Record As-Built Drawings in AutoCAD or Revit per the Owner's preference within 90 days of system acceptance by owner.
- L. Drawings, specifications (as-builts) and approved submittals.
 1. Where the project uses a BIM model the contractor shall keep the model updated in a similar fashion, maintaining the current project record as described above and submit, an addition to all other requirements of this Section and other provisions of the Contract Documents a complete and accurate BIM model for the project.
 2. Prior to Substantial Completion, obtain from the Architect a complete set of printed drawings at the Contractor's cost. Record all revisions to these drawings to indicate as-built conditions. Indicate all changes, including RFI's, on this set of documents. Submit one set of blueprints of these revised drawings for review. Make necessary changes and deliver to Architect one set of electronic documents, including any BIM model, upon Final Completion and Acceptance.
 3. All test reports, certifications, and inspection reports.
 4. AHJ/Specialty AHJ Approvals (i.e. Fire Marshal and/or Fire Department system approvals).
 5. Substantial and Final inspection certificate signed by governing authorities.
 6. All other items as may be specified/required by this Section and/or other provisions of the Contract Documents.
- M. Definitions of comments used in submittal review:
 1. "No Exception Taken" The meaning and intent of this statement is that the Engineer finds no objection (except those noted thereon or in correspondence) to inclusion of items or Work indicated in construction provided that it:
 - a. Complies with Contract Drawings and Specifications as to quantities, space requirements, and dimensions.
 - b. Does not interfere with other trades.
 - c. Is not the cause of union tradesmen disputes.

- d. Does not infringe on patent rights.
- e. Is not the cause of injury or damage to persons or property.
- f. Complies with OSHA regulations.
- 2. "Rejected" The meaning and intent of this statement is that the submitted material does not conform to plans and specifications. Resubmittal of a different product or shop drawing is required.
- 3. "Revise and Resubmit" This statement is used when the general product line is acceptable, but the submitted material varies in dimension, accessories, etc. from what is required. Resubmittal is required.
- 4. "Make Corrections Noted" This statement is used as an alternative to "Revise and Resubmit" when resubmittal is not required.
- 5. Said review does not relieve Contractor of any Contractual responsibilities.

1.08 EQUIPMENT DEVIATIONS AND SUBSTITUTIONS

- A. Substitutions will only be considered after project award. No substitutions will be considered during bid and/or negotiation periods.
- B. See Division 1 for requirements and procedures related to Deviations and Substitutions. Unless specified elsewhere in the Contract Documents, a minimum of ten (10) business days shall be allowed for evaluation. The burden of all systems re-engineering/design, testing, suitability, and constructability is solely placed upon the Contractor for all deviations from the basis of design as reflected in the Contract Documents.
- C. No substitutions will be allowed and/or considered unless the description of a product includes the phrase "approved equal" and then only upon a determination as to equivalency and impact upon the project budget, schedule, and the work of others, including any redesign of the project or its system components by the Architect, Engineer, or other trades. The final determination as to sufficiency or acceptance of any such substitution and/or deviation properly requested and submitted by Contractor will lie solely with the Architect/Engineer. Contractor may not implement substitutions that have not been approved by Architect/Engineer.
- D. Where the contractor proposes to use an item or equipment other than that specified or detailed on the drawings which requires any redesign of any portion of the project, including but not limited to the mechanical, electrical, plumbing, structure, or architectural design or any of their respective subcomponents. Contractor shall be responsible to the Architect/Engineer and/or Owner for all costs, expenses and impact to the project budget and/or schedule resulting from any required investigation, analysis or redesign, including but not limited to; payment for required overtime, out-of-house resources/consultants or other higher cost resources of the Architect/Engineer, Owner or AHJ as may be required to perform the investigation, analysis or redesign (cumulatively and hereinafter, "Deviation Review Costs")
- E. If approved by Architect/Engineer, all costs associated with the review and/or redesign, including but not limited to new drawings and detailing required, will be prepared by the Architect/Engineer and their sub-consultants for Change Order documentation for approval by Owner and the Authority Having Jurisdiction will be paid by the Contractor to the Architect and/or Professional Engineer as part of the Deviation Review Costs.

1.09 COORDINATION

- A. Prior to construction, coordinate installation and location of systems, devices and equipment with architectural and structural requirements, and other trades (including ceiling suspension, and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.
- B. Drawings and corresponding electronic media are diagrammatic and indicate the general arrangement of systems and work included in the Work. Consult the drawings, details and other electronic media for locations of fixtures and equipment; where same are not definitely located, obtain this information from the Architect/Engineer.

- C. Check drawings and related electronic media of other trades to verify spaces and conditions in which work will be performed prior to commencement of the work.
- D. If directed by the Architect/Engineer or required for proper installation, execution and coordination of the work, the Contractor shall, without extra charge, make reasonable modifications in the layout as needed.
- E. Take all dimensions from Architectural and Structural Drawings, certified equipment drawings and from the actual field measurements before fabricating work. All conflicts shall immediately be reported to the Architect/Engineer. Contractor is solely responsible for conflicts known or which reasonably should have been know but not reported or resolved before commencement of the work
- F. Equipment furnished shall fit in allocated space with due provision for manufacturer's recommended access and proper maintenance requirements. Verify and coordinate space requirements with all trades and equipment which comprise the Work.
- G. Prior to construction, coordinate the Work with that of other trades and building components. Prepare coordination drawings (or other specified electronic media) for all major trades, utilities and other primary systems routing in conjunction with the contract documents to maximize the pre-installation planning and coordination of trades, utilities and systems and minimize the requirement to manage field coordination through the RFI's, ASI's or other similar processes.
- H. Coordinate connection of systems with interior/exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- I. Before submitting a bid for the work the Contractor shall visit the site and become familiar with all the work on other related Drawings and Specifications, and plan the work to provide the best possible assembly of the combined work of all trades. No additional costs will be considered for work which has to be relocated due to conflicts with other trades.
- J. If, after examination of the bidding documents relating to the work, the Contractor has queries concerning the nature and scope of the work or intent of the Specifications, he/she shall promptly request clarification from the Architect/Engineer. After contract award, claims of ignorance of the intent and scope of the contract shall not be allowed.
- K. Contractor is responsible for coordinating the schedule of inspections by Engineer at appropriate stages of construction such as rough-in, pre-final, and final, and at other times required by the Specifications or by the construction. Notify Architect and Engineer ten (10) business days in advance of proposed site visit. Notification constitutes certification that construction is, or will be, complete and ready for observation. In the event that construction is not ready for observation, contractor shall bear the cost of additional site visits.

1.10 SPECIAL WORKMANSHIP FOR ARCHITECTURALLY EXPOSED SYSTEMS

- A. General: In addition to basic project workmanship requirements, a higher degree of care in systems layout and routing shall be exerted in selected areas, as follows.
- B. Architectural Exposed Areas: Note that this project may include locations where systems will be partially or fully exposed to view in finished architectural spaces due either to the intentional omission of ceilings, and/or to the intentional holding back of ceiling edges from walls, for architectural effects. These areas shall receive extra effort and care above and beyond basic project workmanship principles.
- C. Special Workmanship Requirements: In these special areas, comply with the following requirements:
 - 1. Run systems tight to overhead structure whenever possible.
 - 2. In spaces with gaps between ceiling edges and walls, do not run systems down near ceilings. Locate them as high above as feasible.
 - 3. Do not cross under framing members within view of such gaps. Seek alternative routes around or through obstacles.

4. Fasten systems sufficiently often to prevent visual sagging or drooping between support points.
 5. Route systems parallel to walls, framing members, and other elements defining spatial geometries.
 6. Change directions orthogonally.
 7. Do not run diagonally when traversing horizontal or vertical surfaces.
- D. Rejection of Work: Workmanship and/or materials not complying with the above additional requirements in these special areas to the satisfaction of the Architect shall be rejected and shall be immediately replaced in an acceptable manner without additional cost.

1.11 ACCESSIBILITY

- A. Contractor is responsible for verifying that equipment and devices will fit within the space shown on the drawings. Contractor shall locate all equipment which must be serviced, operated or maintained, in fully accessible locations.
- B. Minor deviations from the drawings may be made to allow for better accessibility, but changes of magnitude or which involve extra cost shall not be made without approval from the Architect/Engineer.

1.12 QUALITY ASSURANCE

- A. Regulatory Requirements: Work and materials installed shall conform with all local, State, Federal and other applicable laws and regulations.
- B. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.
- C. Conform to all applicable standards, codes and regulation and industry best practice requirements.
- D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- E. All materials and equipment shall be new, shall bear manufacturer's name, and shall conform to the grade, quality and standards specified herein. Type, capacity and application shall be suitable and capable of satisfactory operation for the purpose intended. All equipment and components shall include UL label and/or marking on equipment body/device including manufacturer's name, pressure rating(s), electrical classification(s), limits and ratings as applicable to individual components for the purpose specified and intended.
- F. Equipment Selection: Equipment allowed by the specifications but with different electrical characteristics, physical dimensions, capacities, and/or ratings than what is shown on the Drawings may be furnished, provided such proposed equipment is approved in writing and connecting mechanical and electrical services, such as pipe and/or duct connection sizes, circuit breakers, conduit, motors, bases, and equipment spaces are revised to accommodate such equipment. Maintain a minimum duct length of three straight diameters at all fan inlets and outlets. All expenses shall be borne by the Contractor. Specified minimum energy ratings and/or equipment efficiencies must meet design and commissioning requirements.
- G. ASME Compliance: ASME listed water heaters and boilers with an input of 200,000 BTUH and higher, hot water storage tanks which exceed 120 gallons, and hot water expansion tanks which are connected to ASME rated equipment or required by code or local jurisdiction.
- H. Provide safety controls required by National Boiler Code (ASME CSD 1) for boilers and water heaters with an input of 400,000 BTUH and higher.
- I. Listing and labeling: Provide motors that are listed and labeled. Terms "listed and labeled": as defined by UL, NEC, Article 100 or other applicable recognized agency as specified in the Contract Documents.
- J. Cutting & Patching: Unless otherwise required by the Contract Documents, Contractor shall be responsible for all cutting, fitting and patching required to complete the Work, or to make

portions of the Work and existing conditions fit together properly, and all such areas shall be restored to the conditions existing prior to the cutting, fitting and patching unless otherwise provided in the Contract Documents

- K. Lead Free Requirements: Contractor shall use lead free products and where required by law, ordinance, regulation or standard, all materials products and practices shall comply with limitations and requirements as to the allowable limits and/or percentages of lead. Lead free products must be certified by and independent 3rd party.
 - 1. This provision shall apply to any and all similarly regulated materials, products and practices that may be considered hazardous or are otherwise regulated by applicable law, ordinance regulation or standard in the project local.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. All materials and equipment shall be adequately covered and protected against dirt, water, chemical or mechanical damage, and theft. At completion, all work, equipment and materials shall be cleaned, and damage repaired by Contractor. Damaged equipment will be replaced by the contractor if Owner does not accept repairs done to the equipment. Such replacement shall be scheduled to minimize building system interruption of occupied or scheduled for occupancy.
- B. Material delivered at the site shall not be left exposed to the weather or left unattended. Deliver pipes, tubes and conduit with factory-applied end-caps. Contractor shall be responsible to maintain end-caps or provide temporary end caps on all open-ended piping, tubes and conduit through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
- C. Protect bright finished shafts, bearing housings and similar items until in service.
- D. Protect plastic pipes and materials from sunlight and support to prevent sagging and bending.
- E. Elevate stored materials above grade. When stored inside, do not exceed structural capacity of the floor.
- F. Provide protective coatings to materials to prevent damage and/or infiltration of moisture and dirt on all materials and equipment including but not limited to cast iron and steel valves.
- G. Contractor shall check the openings in the building and the size of the doors, passages, and openings through which equipment is to be admitted. Wherever necessary, he shall provide the equipment in sections or knocked down in order to admit the equipment through these openings.
- H. Contractor shall provide all rigging, erection and hoisting equipment as required to handle or place equipment and piping in position. This rigging and hoisting equipment shall only be attached and placed on the structure in locations as approved by Architect/Engineer at the site. Section 016000 "Product Requirements."

1.14 PERMITS AND FEES

- A. Contractor shall arrange and pay for all permits, fees, and inspections required to perform the Work. The Contractor shall present the Owner with properly signed certificates of final inspection before the Work will be accepted.
- B. Contractor shall call for all inspections by local building official(s) when they become due, and shall not cover any work until approved by these governing authorities.
- C. Contractor shall make all arrangements with utility companies for water, steam, gas and drainage services, etc., associated with the work and include required payments for meters, piping, services, connection charges and materials furnished and installed by utility companies. Work and materials shall be in strict accordance with rules of respective authorities.

1.15 DOCUMENT OWNERSHIP

- A. The Drawings and Specifications, combined with the calculations, field data, notes, and reports, are the intellectual and real property of the Architect and/or Engineer. This covers all forms of written and recorded or electronic media. The reuse of these documents without specific permission of the Architect and Engineer is prohibited. The Drawings may be employed by the

Owner and Contractor for the express use of constructing, commissioning and operating the facility only upon proper execution of an Agreement for Use of Electronic Files & Data.

1.16 GUARANTEE AND WARRANTY

- A. Refer Division 01 – General Requirements when available. If not available, the Contractor shall meet the following requirements.
- B. Contractor warrants to Owner that the materials and equipment provided under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise. Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects. Work, materials and equipment not conforming to these requirements, including substitutions not properly approved by Change Order, shall be considered defective. This warranty excludes remedy for damage caused by improper or insufficient maintenance, improper operation or normal wear, tear and usage. Contractor shall assign to Owner, or otherwise assure the Owner has the full benefit of, all warranties and guarantees of manufacturer, subcontractors, sub-subcontractors and suppliers, and Contractor shall perform the Work in a manner that does not adversely affect or invalidate any available warranties or guarantees.
- C. Contractor shall warrant and guarantee all work against faulty material or workmanship for a period of one (1) year from the date of final completion and written acceptance by the Owner, unless specified more stringently elsewhere in the Contract Documents.
- D. If the project is occupied or the systems placed in operation in several phases at the request of the Owner, the guarantee of each system or piece of equipment used shall begin on the date each system or piece of equipment was placed in satisfactory operation, tested, commissioned and accepted, in writing, by the Owner. The use of building equipment for temporary service and testing or phases of work completed prior to the projects final completion and acceptance by the Owner does not constitute the commencement of the warranty period.
- E. If a defect or deficiency in the Work is discovered within the one (1) year Warranty & Guarantee period or within such longer period as may be prescribed by the Laws or by any specific guarantee, and Owner elects to have Contractor correct such defect or deficiency, Owner shall notify Contractor of such defect or deficiency in writing. This period of correction relates only to the specific obligation to correct defects and deficiencies and in no way otherwise limits the Contractor's responsibility for Work that is not in accordance with the Contract Documents, If Contractor fails to timely correct defects or deficiencies in the Work, Owner may, at its sole option, correct them and charge contractor for all cost therefore.
- F. Specific exclusions, if any, from this one (1) year warranty and guarantee period are listed in the individual specification sections.

1.17 LIMITATIONS OF LIABILITY

- A. To the extent any of the following provisions are not more stringently included in the Contract Document the following Limitations of Liability shall apply:
- B. Architect/Engineer is not responsible for Contractor's means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, and is not responsible for Contractor's failure to perform or furnish the work in accordance with the Contract Documents.
- C. In the event that Architect/Engineer's employees or sub-consultants make comments or issue warnings about safety issues, such comments and warnings shall be considered to have been offered by a Good Samaritan and shall not impose any obligation or responsibility.
- D. Engineer will not be responsible for the acts or omissions of Owner, Contractor, any subcontractor, any supplier, or of any other person or organization performing or furnishing any of the portions of the work
- E. Contractor understands and acknowledges that Engineer is not authorized to order extra work or issue Change Orders to the work, however in the event and to the degree that Engineer may offer advice, suggestions, and opinions Contractor shall not rely on such advice, suggestions,

and opinions unless directed in writing by Owner or its designated representative, and shall, in no event, make any claim against the Engineer for any such advice, suggestions, and opinions.

- F. To the fullest extent permitted by law, Contractor shall indemnify and hold harmless Architect, Engineer, and their joint ventures, officers, directors, partners, employees and agents from and against any and all claims, costs, losses and damages (including but not limited to all fees and charge of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs) caused in whole or in part by the negligent acts or omissions of Contractor, Contractor's officers, directors, partners, employees, agents; or contractor's subcontractors or material men in the performance of Work. Contractor shall direct its insurer to list Architect, Engineer, and their joint ventures, as Additional Insureds on general liability insurance policies covering this project. Prior to commencing work, Contractor shall submit copies of its certificate of insurance to both Architect and Engineer.

1.18 SAFETY

- A. Contractor shall comply with all OSHA regulations. Contractor is required to obtain and pay for insurance required to cover all activities within Contractor's Scope of Work.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. See Drawings for equipment data, capabilities, and requirements. Manufacturers are identified for the purpose of establishing quality; alternative manufacturers of equal quality are acceptable. If alternative manufacturers are proposed it is the contractor's responsibility to verify and demonstrate the proposed alternative is equivalent.
- B. Provide like items from one manufacturer, including but not limited to pumps, pipes, fittings, valves, control devices, water heaters, etc.

2.02 MATERIALS

- A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL approved or have adequate approval or be acceptable by State, County, and City authorities. Provide all materials omitted herein but necessary to complete the work.
- B. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
- C. All electrical materials shall bear the label of, or be listed by, the Underwriters' Laboratories (UL), unless the material is of a type for which label or listing service is not provided.
- D. Hazardous Materials: Comply with local, State and Federal regulations relating to hazardous materials. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.03 ACCESS PANELS

- A. Confirm Access Panel requirements in individual Division 23 sections. Comply with the following:
 - 1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly. Ceiling access panels to be minimum of 24 x 24 or as required and approved size. Wall access panels to be minimum of 12 x 12 or as required and approved size.
 - 2. Coordinate final door location with the devices which require access and architectural finishes.

2.04 DRAIN PANS

- A. Provide drip pans under all hot water heaters, above-ceiling inline pumps, cooling coils, heat recovery coils and other equipment and piping within areas where a leak will cause a hazardous condition. Locate pan immediately below piping and equipment, and extend a minimum of 6"

on each side and lengthwise 18" beyond equipment being protected. Pans shall be 2" deep and fabricated from reinforced sheet metal (20 gauge copper or 20 gauge steel with two ounces zinc finish hot dipped after fabrication) with rolled edges and soldered or welded seams.

Provide ¾" copper drainage piping, properly discharged to floor drain, hub drain, or as shown on Drawings. Provide condensate pumps as necessary. Comply with Oregon Mechanical Specialty Code for overflow protection and pipe sizing.

2.05 GUARDS

- A. Provide guards in accordance with State Safety Code and OSHA requirements over all rotating equipment including belts, shafts and couplings. Drive guards over belts and sheaves shall include 2-1/2" diameter access opening at shaft ends for speed counter.

2.06 PENETRATION FIRE STOPPING

- A. Through-penetration fire stopping system tested and listed by Underwriters Laboratories and ASTM E 814-88: Standard Test Method for Fire Tests of Through-Penetration Firestops.
- B. Select system for proper application based on wall construction, type of penetrating item, wall rating, etc. Each product shall be listed for use in its intended application.
- C. Fire Stop assembly shall be able to withstand standard fire and hose stream test (F Rating) and limit temperature rise (T Rating) of penetrations on protected side as required by Authorities Having Jurisdiction. Conform to ASTM E 814.

2.07 MISCELLANEOUS STEEL

- A. Provide all steel as required for adequate support of all mechanical equipment. Use standard angle or channel, I or H sections as required by application. Adequately cross-braced and welded pipe stands may be used for tank supports. Provide suitable base plates for all stands and anchors for all hanging equipment. Drill or burn support holes only in flanges of structural shapes and only in one leg of any one angle, and as far from center of length as possible. coordinate structural loads with a Professional Structural Engineer.
- B. Paint: Apply one coat of black Rustoleum primer to shop fabricated items before delivery to the job; other painting as specified herein.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of the systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate systems, equipment, and materials installation with other building components.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for system installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - 5. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - 7. Coordinate connection of systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 - 8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

9. Install systems, materials, and equipment level and plumb, and parallel or perpendicular to other building systems and components, where installed exposed in finished spaces.
 10. Install equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
 11. Install access panel or doors where units are concealed behind finished surfaces. Coordinate with other divisions.
 12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
 13. Replace all filters with new filters upon Owner taking occupancy of the building or at a time mutually agreed upon between the Owner and Contractor.
 14. Do not install ductwork or piping in elevator machine rooms, electrical and/or communication rooms unless it directly services that room.
- B. Locate wall, floor and ceiling fire ratings from architectural drawings for appropriate hourly rating of combination fire/smoke dampers or fire dampers shown on mechanical drawings.

3.02 PLUMBING SYSTEMS - COMMON REQUIREMENTS

- A. General: Install Plumbing systems as described below, unless piping Sections specify otherwise. Individual Division 22 Sections specify unique installation requirements.
- B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of systems. Indicated locations and arrangements were used to size pipe and duct and calculate friction loss, expansion, pump sizing, fan sizing, and other design considerations. Install piping and ductwork as indicated, unless deviations to layout are approved on Coordination Drawings.
- C. Install piping at indicated slope.
- D. Install components with pressure rating equal to or greater than system operating pressure.
- E. Install piping and ductwork in concealed interior and exterior locations, except in equipment rooms and service areas.
- F. Install piping and ductwork free of sags and bends.
- G. Install exposed interior and exterior piping and ductwork at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- H. Install piping and ductwork tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- I. Install piping and ductwork to allow application of insulation plus 1-inch clearance around insulation.
- J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- K. Install flexible connectors according to manufacturer's written instructions, and where indicated and specified in other Division 22 sections.
- L. Install flexible expansion loops according to manufacturer's written instructions, and where indicated and specified in other Division 22 sections.
- M. Install fittings for changes in direction and branch connections.
- N. Install couplings according to manufacturer's written instructions.
- O. Install Portable Instrument Connections in all piping systems where DDC temperature and/or pressure sensors and thermometers and/or pressure gauges are located.
- P. Do not route piping through elevator equipment rooms, unless specifically allowed by local authority.

- Q. Do not route piping over electrical panels, transformers, switchgear or other electrical equipment.
- R. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
 - 1. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
 - 2. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.
 - 3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
 - 4. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
 - 5. Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.
- S. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
- T. Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 1. Build sleeves into new walls and slabs as work progresses.
 - 2. Install sleeves large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS.
 - b. Steel, Sheet-Metal Sleeves: For pipes 6-inch NPS and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. If available, refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with non-shrink, nonmetallic grout.
 - d. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.
- U. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches in diameter and larger.
 - 3. Assemble and install sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- V. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using sleeve seals. Size sleeve for manufacturer's recommended clear space between pipe and sleeve.
 - 1. Assemble and install sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
 - 2. Caulk exterior side of annular space once the sleeve seal is in place using an elastomeric joint sealant.
- W. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe and duct penetrations. Seal pipe and duct penetrations with firestopping materials. If available, refer to Division 7 Section "Firestopping" for materials.
- X. Verify final equipment locations for roughing-in.
- Y. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

- Z. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 3. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
 4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 5. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 6. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 7. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
 8. Align threads at point of assembly.
 9. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
 10. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
 - a. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators.
 - b. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench to recommended torque values.
- AA. Piping Connections: Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
 2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.
- BB. Identification
1. Valves:
 - a. Attach 1 1/2" square brass tags stamped with designating number 1/2" high, filled in with red enamel, to each valve.
 - b. Securely fasten valve tag to valve spindle or handle with a brass chain.
 2. Schedules and Charts:
 - a. Furnish to Owner's representative three (3) complete framed plastic laminated valve tag schedules. Schedule shall indicate tag number, valve location by floor and nearest column number, valve size and fire area controlled.
 - b. Furnish three (3) framed plastic laminated diagrammatic charts showing schematically the complete sprinkler system, with major control valves and valve numbers.
 - c. Furnish one (1) framed plastic laminated placard at each sprinkler riser, indicating the basic hydraulic data as required by NFPA 13 or local Fire Marshal.
 3. Piping Identification:

- a. Apply color coded polyvinyl chloride pipe bands identifying service and direction of flow.
- b. On exposed piping, apply bands at 20'-0" on centers at straight runs, at valve locations, and at points where piping enters and leaves a partition, wall, floor, or ceiling.
- c. On concealed piping installed above removable ceiling construction, apply bands in manner described for exposed piping.
- d. On concealed piping installed above non-removable ceiling construction, or in pipe shafts, apply bands at valves or other devices that are made accessible by means of access doors or panels.
- e. Apply bands at exit and entrance points at each piece of equipment.
- f. Band widths shall be 8" for pipes up to 10" diameter, and 16" for larger diameter piping. Letter heights stating service shall be pre-printed on band, 3/4" high for 8" bands and 1 1/4" high for 16" bands.
- g. Colors shall conform to ANSI Standard A13.1.
- h. Letter size shall conform to ANSI A13.1.
- i. Tags and bands shall be approved for this service.

3.03 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to approved submittal data.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated. Supports shall be neatly placed and properly fastened. All equipment shall be fastened in place with bolts.
- D. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

3.04 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor materials and equipment.
- B. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.05 DRAWINGS

- A. The Drawings show the general arrangement and location of the ductwork, piping and equipment. Work shall be installed in accordance with the Drawings, except for changes required by conflicts with the work of other trades. The Contractor shall provide for the support, expansion, and pitch of any rearranged piping in conformance with the intent of the Drawings, Specifications, and codes.
- B. Note that certain plumbing work is shown, wholly or in part, on Architectural Drawings.
- C. Plumbing Drawings are diagrammatic and are intended to show the approximate location of equipment and piping. Dimensions shown on Drawings shall take precedence over scaled dimensions on Drawings. All dimensions shall be verified in the field by the Contractor.
- D. The exact location of apparatus, equipment, and piping shall be ascertained from the Owner or the representative in the field, and work shall be laid out accordingly. Should the Contractor fail to ascertain such locations the work shall be changed at Contractor's own expense when so ordered by the Owner. The Engineer and owner reserve the right to make minor changes in the location of ductwork, piping and equipment up to the time of installation without additional cost.
- E. It is the intention of the Drawings and Specifications that, where certain mechanical items such as unions, expansion joints, and other mechanical components are not shown, but where such items are required by the nature of the work, shall be furnished and installed.

- F. The Plumbing Drawings and Specifications are intended to supplement each other. Any material or labor called for in one shall be furnished even though not specifically mentioned in the other.
- G. Pipe and duct sizes shown are the minimum allowable and shall be increased in size if required by code or wherever necessary to meet unusual conditions.

3.06 DAMAGE

- A. Repair any damage to the building, premises, and equipment occasioned by the work under this Section and all other Sections.
- B. Repair all damage to any part of the building or premises caused by the Work installed under this Section until the warranty period expiration date.

3.07 EARTHWORK

- A. General: Perform earthwork required for installation of new work below grade in accordance with referenced specifications.
- B. Excavate trenches to uniform widths to provide a working clearance on each side of the pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated. Grade trench bottoms to provide uniform bearing and support for each section of pipe. Form holes and depressions for joints after trench bottom has been graded. Provide temporary pumping equipment to keep excavation free from water. Install pipe bedding in rock excavation consisting of not less than 6 inch of sand or equivalent material.
- C. Provide bracing and shoring as necessary.
- D. Backfill trenches only after completion of pressure tests and inspection. Carefully compact material under pipe and bring backfill evenly up on both sides and along the full length of piping or conduit. Cover to 12-inch thickness over top of pipe. Fill and tamp remainder of backfill material in 6-inch layers. Provide backfill materials generally consisting of clean earth or sand relatively free of clods or stones. For sewer and water piping, use pea gravel. For gas piping, use sand. Backfill under, around, and to 6 inches above top of piping.
- E. Compact soil to 6-inch layer (maximum) loose thickness of backfill. Where roadway or parking area surfaces will be placed over backfill, provide moisture conditions, which will produce compacted density of 95 percent of maximum density. Elsewhere, 90 percent. Test in accordance with Divisions 1 and 2 (if applicable) and local code requirements (most stringent to prevail).
- F. Take special care in compacting under services where they enter building to prevent settling. Contractor fully responsible for damage to piping and property as a result of settling around service piping.
- G. Dispose surplus materials off-site in a suitable location.
- H. Place and maintain barricades, construction signs, torches, lanterns, and guards as required during periods of open excavation to protect persons from injury and to avoid property damage.
- I. Leave premises thoroughly clean at completion of earthwork.
- J. Wherever piping is to be installed in areas, which have been excavated below pipe inverts, for any purpose, install piping to prevent subsequent settlement. Do not install piping until backfill is to full compaction, completed to minimum 18 inch above installed pipe. Install piping in re-excavated trenches and backfill as previously specified.

3.08 CONCRETE WALLS AND CONCRETE FOOTINGS

- A. Where pipes must pass through concrete walls and footings, they shall pass through pipe sleeves with 1/2" annular space set in place at time of construction.
- B. Ducts shall pass through 10 gauge galvanized sheetmetal sleeves. Provide sheetmetal closure collars at duct penetration.

- C. Sheetmetal sleeves set into concrete walls: Provide steel frame around opening where required by Structural Engineer.
- D. Coordinate core drilled openings with General Contractor. Coordination shall include location, size, and spacing of openings. No slot openings will be allowed. Coordinate openings to avoid critical structural items such as reinforcing bars, tensioning tendons, etc.

3.09 ELECTRICAL REQUIREMENTS - CONTROLS AND COORDINATION WITH ELECTRICAL CONTRACTOR

- A. Contractor shall coordinate with the Electrical Contractor on furnishing and installing of controls, motors, starters, etc. Coordinate means informing Electrical Contractor of items requiring electrical connection, providing copies of submittal data, installation data, scheduling work to ensure efficient progress, and promptly supplying those items to be installed by Electrical Contractor.
- B. The specific requirements for electrical power and/or devices for each and every piece of equipment requiring electrical service, supplied and/or installed under this Contract, shall be coordinated and verified with the Plumbing drawings and specifications, and with the manufacturers of the equipment supplied. This shall include the voltage, phase, and ampacity; conduit requirements; and exact location and type of disconnect, control, and/or connection required. Any changes from the Drawings and Specifications required as a result of this coordination shall be part of this Contract.
- C. Electrical Contractor shall furnish and install the following for all mechanical equipment:
 - 1. Conduit and wiring for line voltage power to the equipment.
 - 2. Disconnect switches.
 - 3. Manual motor starters.
 - 4. Magnetic motor starters when part of a motor control center. See Division 26 and Drawings for further information.
- D. The work under this Section shall include furnishing and installing all controls on low and manual line voltage, including thermostats, auxiliary switches, relay wiring, interlock wiring; equipment control panels and transformers; and controls conduit unless specifically indicated as part of other work. Materials and methods of the control installation shall be in accordance with the Electrical Specifications.
- E. The Plumbing Contractor shall review all wiring connections which have any influence on this equipment or work and verify that these connections are correct before permitting any equipment to be operated which is furnished, installed, or modified under this Contract.

3.10 ELECTRICAL EQUIPMENT ROOM PRECAUTIONS

- A. Ductwork or piping for mechanical systems shall not be installed in any switchgear room, transformer vault, telephone room or electric closet except as indicated. In any case, no ductwork or piping for mechanical systems shall be installed in the space equal to the width and depth of any electrical service equipment, switchboards, panel boards, or motor control centers and extending from the floor to a height of six feet above the equipment or to the structural ceiling, whichever is lower.

3.11 CUTTING AND REPAIRING

- A. No cutting shall be done except with approval. Cutting of structural members or footings is prohibited without the prior written consent of the structural engineer.
- B. Where cutting of paving, walls, ceilings, etc. is necessary for the installation of the plumbing work, it shall be done under the direction of this Section. Damage caused by this cutting shall be repaired to match original and adjacent surfaces without additional expense to the Owner. Cutting of new construction shall be by the installing Contractor of that construction as directed by this Contractor.

3.12 ACCESSIBILITY

- A. General: Valves, damper operators, filters, thermometers, pressure gauges, clean-out fittings, and indicating equipment or specialties requiring reading, adjusting, inspection, repairing, removal, or replacement shall be conveniently and accessibly located with reference to finished building. Thermometers and gauges installed to be easily read from floor.
- B. Panels: No unions, flanges, valves, dampers, controls, or equipment shall be placed in a location that will be inaccessible after the system is complete. Access panels or doors shall be provided where required whether or not shown on Drawings.
- C. Access Panels in Walls or Ceilings:
 - 1. Provide access panels in walls or ceilings. Milcor or approved equal, where indicated and where required to provide access to valves, dampers, and other appurtenances. Panels shall be style as selected by and as directed by wall or ceiling construction. Panel size shall be 24" x 24" unless indicated otherwise. Panels in acoustical barriers shall have same transmission loss as barrier. Panels in rated construction shall have same rating as construction in which installed.
 - 2. Door panels shall be no lighter than 14 gauge steel. Doors shall be equipped with concealed spring hinges and flush, screwdriver operated locks, except that key operated locks shall be used for all access doors in walls where door is within 6'-0" of floor. Locks for all key operated doors shall be keyed alike.
 - 3. Doors in ceramic tile surfaces shall be stainless steel or chrome plated. Doors in other finished surfaces shall be prime coated.
 - 4. Doors in fire rated grease exhaust duct shafts shall be fire rated and openable without the use of tools.
- D. Equipment Spaces: Provide aisles between equipment and ducts, electrical gear, etc. for complete service and inspection of equipment. Maintain minimum 6'-6" headroom in all access aisles. Maintain minimum 36" clearance at all service panels. Provide minimum clearances at electrical equipment per NEC. Provide 36" wide, 3/4" thick plywood covered catwalks in attics from access door to equipment.

3.13 TESTING

- A. Test all piping, equipment, and systems as called for in the Specifications and as required by State and Local Codes. Notify and inspection authorities prior to testing so that they may be witnessed. Protect all personnel and equipment during testing. Where Specifications do not cover specific points or methods, conform to manufacturer's specifications.

3.14 OPENINGS

- A. Locating and sizing of all openings for pipe, conduit and ductwork through walls, roof, etc. shall be done under this Division. Framing of openings shall be done by the respective trades in whose work the opening is made.

3.15 EQUIPMENT

- A. Keep all openings closed with plugs or caps to prevent entrance of foreign matter. Protect all piping, ductwork, fixtures, and equipment against dirt, water, chemical, or mechanical damage both before and after installation. Any equipment or apparatus damaged prior to final acceptance shall be restored to original condition or replaced at the discretion and at no additional cost to the Owner.
- B. Start-Up: Equipment shall be adjusted, lubricated, aligned, etc. prior to start-up. Inspect each piece of equipment prior to start-up. Start each piece of equipment in accordance with manufacturer's directions and warranty requirements.
- C. Finish: Protect all equipment and materials until in use. Any visible rust or corrosion shall be removed as directed prior to installation. All damaged factory painted finishes shall be cleaned and painted with manufacturer provided paint.

3.16 MANUFACTURER'S DIRECTIONS

- A. Materials and equipment shall be installed in accordance with manufacturer's application and recommendations, requirements, and instructions, and in accordance with Contract Documents. Where manufacturer's instructions differ from those indicated or specified, they shall be brought to attention for resolution prior to equipment ordering and installation.
- B. Where requirements indicated in Contract Documents exceed manufacturer's requirements, Contract Documents shall govern.

3.17 FURRING AND PIPE SPACES

- A. Spaces provided in the design of the building shall be utilized and the work shall be kept within the furring lines established on the Drawings.
- B. Layout: Maintain maximum head room under piping and equipment. Contractor to coordinate line locations with beams, windows, etc. to provide maximum clearance. From Drawings, ascertain heights of suspended ceilings and size of pipe shafts in which piping is concealed, and location and size of structural members in and adjacent to pipe shafts. Coordinate piping installation with ductwork, lighting, and other equipment. Ensure necessary clearances on trim plates at exposed penetrations of walls and floors. If sufficient room is not available above suspended ceiling or vertical shafts obtain clarification from before work is started.

3.18 CLEAN-UP

- A. During the course of work under this Section, all rubbish, debris, surplus materials, tools, etc. resulting from this work shall be removed from work area and shall be disposed of off-site at the end of each working day. The Owner's premises shall be left clean and in a condition acceptable to the owner.
- B. Clean all work installed under this Contract to satisfaction of Owner and submit documentation that each system has been cleaned and results witnessed by the representative.
- C. All water distribution and piping systems, including those for cold water and hot water systems, shall be flushed thoroughly until piping is cleaned to satisfaction of the owner. See other Specification Sections for additional requirements.

3.19 STERILIZATION

- A. Before being placed in service, all domestic water distribution systems, including those for cold water, drinking water, and the hot water system, shall be sterilized in accordance with State and Local Codes. The system shall be flushed with potable water until the sterilization residue is within the tolerable limits for domestic water.

3.20 ENGRAVED NAMEPLATES

- A. Furnish and install plastic laminated engraved nameplates with 1/4" minimum lettering at panel mounted control devices, manual control stations, power disconnects, motor starters and pieces of equipment. Nameplates exposed to weather shall be engraved brass.

3.21 FINAL INSPECTION

- A. The Contractor shall furnish the certificates of final inspection and approval from the inspection authorities having jurisdiction.

3.22 SITE VISITS BY ENGINEER

- A. Engineer's responsibility is limited to normal construction support services only, consisting of office consultation, site visits, and reports at appropriate stages of construction such as rough-in, pre-final, and final.
- B. If the Engineer is requested for a site visit and the work performed to that point is not able to be reviewed, requiring an additional site visit, all costs incurred by the Engineer for additional site visits or office shall be paid for by that Contractor.

END OF SECTION

**SECTION 22 0513
COMMON MOTOR REQUIREMENTS FOR PLUMBING 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 RELATED REQUIREMENTS

- A. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.
- B. Section 26 2913 - Enclosed Controllers.

1.03 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015 (Reaffirmed 2020).
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2017.
- C. NEMA MG 00001 - Motors and Generators; 2024.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- E. Operation Data: Include instructions for safe operating procedures.
- F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture of electric motors for Plumbing system use, and their accessories, with minimum three 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.

1.06 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.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 PRODUCTS

2.01 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service: Refer to Section 26 0583 for required electrical characteristics.
- B. Electrical Service:
 - 1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
 - 2. Motors Larger than 1/2 Horsepower, refer to the electrical drawings.
- C. Nominal Efficiency:
 - 1. Open Motor with Two Poles: 82.5.
 - 2. Open Motor with Four Poles: 82.5.
 - 3. Open Motor with Six poles: 50.0.
 - 4. Enclosed Motor with Two Poles: 75.5.
 - 5. Enclosed Motor with Four Poles: 82.5.
 - 6. Enclosed Motor with Six Poles: 50.0.
- D. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 104 degrees F (40 degrees C) environment.
 - 3. Design for temperature rise in accordance with NEMA MG 00001 limits for insulation class, service factor, and motor enclosure type.
 - 4. Motors with frame sizes 254T and larger: Energy efficient type.
- E. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.
- F. 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.
- G. 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.

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 22 0517
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 8400 - Firestopping.
- B. Section 22 0523 - General-Duty Valves for Plumbing Piping.
- C. Section 22 0553 - Identification for Plumbing Piping and Equipment: Piping identification.
- D. Section 22 0716 - Plumbing Equipment Insulation.
- E. Section 22 0719 - 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); 2022a.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).
- C. FM (AG) - FM Approval Guide; current edition.
- D. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

- A. See Section 01 3000 - 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.

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.
- 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.

1.06 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. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

- A. Vertical Piping:
 - 1. Sleeve Length: 1 inch (25 mm) above finished floor.
 - 2. Provide sealant for watertight joint.
 - 3. Blocked Out Floor Openings: Provide 1-1/2 inch (40 mm) angle set in silicon adhesive around opening.

4. Drilled Penetrations: Provide 1-1/2 inch (40 mm) angle ring or square set in silicone adhesive around penetration.
- B. Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- C. 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.
- D. Pipe Passing Through Concrete Beam Flanges, except where Brass Pipe Sleeves are Specified:
 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 2. Connect sleeve with floor plate except in mechanical rooms.
- E. Pipe Passing Through Mechanical Room Floors above Basement:
 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 (25 mm) greater than external pipe diameter.
 3. All Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.02 PIPE-SLEEVE SEALS

- A. 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. Corrosion resistant.
 - b. Oil, fuel, gas, and solvent resistant.
 - c. Underground, buried, and wet conditions.
 5. Glass-reinforced plastic pressure end plates.
- B. Sealing Compounds:
 1. Provide packing and sealing compound to fill pipe to sleeve thickness.
 2. Combined packing and sealing compounding to match partition fire-resistance hourly rating.
- C. Pipe Sleeve Material:
 1. 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. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Structural Considerations: Do not penetrate building structural members.
- 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 mechanically expandable chloroprene inserts with bitumen sealed metal components.
 2. 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 (15 mm) where penetrations occur between conditioned and unconditioned spaces.
 3. All Rated Openings: Caulk tight with fire stopping material complying with ASTM E814 in accordance with Section 07 8400 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 22 0519
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pressure gauges.
- B. Thermometers.
- C. Pressure-temperature test plugs.

1.02 REFERENCE STANDARDS

- A. AGA/ANSI B109 Set - INCLUDES ANSI B109.1, ANSI B109.2, ANSI B109.3, ANSI B109.4; 2000.
- B. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2025).
- C. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
- D. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2020).
- E. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).
- F. NSF 61 - Drinking Water System Components - Health Effects; 2022, with Errata.
- G. NSF 372 - Drinking Water System Components - Lead Content; 2022.
- H. UL (DIR) - Online Certifications Directory; Current Edition.
- I. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.
- J. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. Product Data: Provide red-marked product data sheets for each furnished item with associated components and accessories.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

- A. Manufacturers:
 - 1. Ashcroft, Inc: www.ashcroft.com/#sle.
 - 2. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 3. Moeller Instrument Company, Inc: www.moellerinstrument.com/#sle.
 - 4. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
- B. Bourdon Tube for Liquids and Gases:
 - 1. Dial Size and Cover: 4-1/2 inch (115 mm) diameter scale with glass window.
 - 2. Dial Text and Markings: Black color on white background with scaled kPa and psi units.
 - 3. Accuracy: ASME B40.100, adjustable commercial grade (D) with 5 percent of span.
 - 4. Process Connection: Lower-back, 1/4 inch (8 mm, DN) NPT male except where noted.
- C. Accessories:
 - 1. Gauge Cock: Carbon steel with tee or lever handle for maximum 150 psi (1034 kPa).

2.02 THERMOMETERS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Moeller Instrument Company, Inc: www.moellerinstrument.com/#sle.

3. Watts Water Technologies, Inc: www.watts.com/#sle.
 4. Weiss Instruments, LLC: www.weissinstruments.com/#sle.
 5. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
- B. General:
1. Product Compliance: ASTM E1.
 2. Lens: Clear glass, except where stated.
 3. Accuracy: One percent, when tested in accordance with ASTM E77, except where stated.
 4. Scale: Black markings depicting single scale in degrees F where expected process value falls half-span of standard temperature range.
- C. Thermometers - Straight: 5 inch (127 mm) v-shape lead-free brass case with clear glass window scale, 2 inch (50.8 mm) NPT stem, 3-1/4 inch (82.5 mm) NPT thermowell, and red or blue non-toxic organic liquid filled glass tube.
- D. Thermometers - Adjustable Angle: 7 inch (177.8 mm) v-shape lead-free brass case with clear glass window scale, 6 inch (152.4 mm) NPT stem, red or blue organic non-toxic liquid filled glass tube, and adjustable joint with positive locking device allowing 360 degrees in horizontal plane or 180 degrees in vertical plane adjustments.
- E. Thermometers - Dial Type:
1. Fixed: 5 inch (125 mm) diameter dial with black pointer, lead-free brass case, silicone damping bimetal element, hermetically sealed lens, recalibrating screw, and 2-1/2 inch (63.5 mm) NPT stem.

2.03 PRESSURE-TEMPERATURE TEST PLUGS:

- A. Size: 500 psi (34.5 bar) capacity; 1/2 inch (13 mm) MPT brass fitting with gasket, cap, and retaining strap for 1/8 inch (3 mm) pressure gauge or temperature probe.
- B. Wetted Materials per Temperature Range:
1. Up to 200 degrees F (93 degrees C): Brass probe with neoprene core.
 2. 200 to 350 degrees F (93 to 176 degrees C): Brass probe with EPDM core.
- C. Accessories: Brass, lever-handle cock and snubber-filter.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Verify Utility Service Provider piping readiness to receive meter.
- B. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports, and test plugs.

3.02 INSTALLATION

- A. Install pressure gauges as follows:
1. At Pumps: Place single gauge before strainer, suction side and discharge side.
 2. Include gauge cock to isolate each gauge and extend nipples for insulation clearance.
 3. Adjust gauges to selected viewing angle, clean thoroughly, and calibrate to zero.
- B. Install thermometers as follows:
1. Hot Water Heaters: Place upstream and downstream of heater. Add one on the inlet end when using steam as the water heating medium.
 2. Piping: Install thermometers in branch butt weld connection fitting or socket-weld thermowell. Enlarge pipes smaller than 2-1/2 inch (60 mm) to accommodate sockets. Ensure sockets are above insulation clearance.
- C. Locate PT (pressure-temperature) test plugs adjacent to control device sockets.

END OF SECTION

**SECTION 22 0523
GENERAL-DUTY VALVES FOR PLUMBING PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Ball valves.
- B. Check valves.
- C. Flow limiting valves.
- D. Gate valves.
- E. Globe valves.
- F. Lubricated plug valves.
- G. Chainwheels.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 08 3100 - Access Doors and Panels.
- C. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- D. Section 22 0553 - Identification for Plumbing Piping and Equipment.
- E. Section 22 0716 - Plumbing Equipment Insulation.
- F. Section 22 0719 - Plumbing Piping Insulation.
- G. Section 22 1005 - 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. API STD 594 - Check Valves: Flanged, Lug, Wafer, and Butt-Welding; 2022.
- B. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- D. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- E. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves; 2022.
- F. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- G. ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2020.
- H. ASME B31.9 - Building Services Piping; 2020.
- I. 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; 2021.

- J. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.
- K. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010a.
- L. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
- M. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .
- N. NSF 61 - Drinking Water System Components - Health Effects; 2022, with Errata.
- O. NSF 372 - Drinking Water System Components - Lead Content; 2022.

1.05 SUBMITTALS

- A. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- B. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.
- D. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.

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. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
 - 5. Secure check valves in either the closed position or open position.
 - 6. Adjust butterfly valves to closed or partially closed 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 (REFER TO DRAWING SCHEDULE)

- 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, gate or plug.
 - 2. Throttling: Provide globe, angle, or ball.
 - 3. Swing Check (Pump Outlet):

- a. 2 inch (50 mm, DN) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. 2-1/2 inch (65 mm, DN) and Larger for Domestic Water: Iron swing check valves with closure control, metal or resilient seat check valves.
 - c. 2-1/2 inch (65 mm, DN) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- 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. Required Valve End Connections for Non-Wafer Types:
 - 1. Steel Pipe:
 - a. 2 inch (50 mm, DN) and Smaller: Threaded ends.
 - b. 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN): flanged ends.
 - c. 5 inch (125 mm, DN) and Larger: flanged ends.
 - 2. Copper Tube:
 - a. 2 inch (50 mm, DN) and Smaller: Threaded ends.
 - b. 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN): flanged ends.
 - c. 5 inch (125 mm, DN) and Larger: flanged ends.
- F. Domestic, Hot and Cold Water Valves:
 - 1. 2 inch (50 mm, DN) and Smaller:
 - a. Bronze: Provide with threaded ends.
 - b. Bronze Angle: Class 125, bronze disc.
 - c. Ball: Two piece, full port, brass with brass trim.
 - d. Bronze Swing Check: Class 125, bronze disc.
 - e. Bronze Gate: Class 125, NRS.
 - f. Bronze Globe: Class 125, bronze disc.
 - 2. 2-1/2 inch (65 mm, DN) and Larger:
 - a. Iron, 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN): Provide with flanged ends.
 - b. Iron Swing Check: Class 125, metal seats.
 - c. Iron Center-Guided Check: Class 125, compact-wafer, metal seat.
 - d. Iron Gate: Class 125, NRS.
 - e. Iron Globe: Class 125.
- G. Sanitary Waste Water Valves:
 - 1. 2 inch (50 mm, DN) and Smaller:
 - a. Bronze: Provide with threaded.
 - b. Bronze Angle: Class 125, bronze disc.
 - c. Ball: Two piece, full port, bronze with bronze trim.
 - d. Bronze Swing Check: Class 125, bronze disc.
 - e. Bronze Gate: Class 125, NRS.
 - f. Bronze Globe: Class 125, bronze disc.
 - 2. 2-1/2 inch (65 mm, DN) and Larger:
 - a. Iron Swing Check: Class 125, metal seats.
 - b. Iron Gate: Class 125, NRS.

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. Handwheel: Valves other than quarter-turn types.
 - 2. Hand Lever: Quarter-turn valves 6 inch (150 mm, DN) and smaller except plug valves.
 - 3. Wrench: Plug valves with square heads.

4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- D. Insulated Piping Valves: With 2 inch (50 mm, DN) stem extensions and the following features:
 1. Gate Valves: Rising stem.
 2. 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.
 3. Memory Stops: Fully adjustable after insulation is installed.
- E. Valve-End Connections:
 1. Threaded End Valves: ASME B1.20.1.
 2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
 3. Pipe Flanges and Flanged Fittings 1/2 inch (15 mm, DN) through 24 inch (600 mm, DN): ASME B16.5.
 4. Solder Joint Connections: ASME B16.18.
- F. General ASME Compliance:
 1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
 2. Solder-joint Connections: ASME B16.18.
 3. Building Services Piping Valves: ASME B31.9.
- 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 BRONZE, ANGLE VALVES

- A. Class 125; CWP Rating: 200 psi (1,380 kPa):
 1. Comply with MSS SP-80, Type 1.
 2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
 3. End Connections: Pipe thread.
 4. Stem: Bronze.
 5. Disc: Bronze.
 6. Packing: Asbestos free.
 7. Handwheel: Malleable iron or bronze.

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. Two Piece, Full Port with Bronze Trim:
 1. Comply with MSS SP-110.
 2. WSP Rating: 150 psi (1,035 kPa).
 3. WOG Rating: 600 psi (4,140 kPa).
 4. Body: Forged bronze or dezincified-brass alloy.
 5. Ends Connections: Pipe thread.
 6. Seats: PTFE.
 7. Stem: Bronze, blowout proof.
 8. Ball: Chrome plated brass.
 9. Operator: Provide lockable handle and stem extension.
 10. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.
 - b. FNW; X450: www.fnw.com/#sle.
 - c. Jomar Valves, a division of Jomar Group: www.jomarvalve.com/#sle.

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 (1,380 kPa).
 - 3. Design: Vertical flow.
 - 4. Body: Comply with ASTM B61 or ASTM B62, bronze.
 - 5. End Connections: Threaded.
 - 6. Disc (Type 1): Bronze.
 - 7. Disc (Type 2): NBR.

2.06 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. Body: Bronze, ASTM B62.
 - 4. End Connections: Threaded.
 - 5. Disc: Bronze.
 - 6. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.
 - b. Jomar Valves, a division of Jomar Group: www.jomarvalve.com/#sle.
- C. Class 150:
 - 1. Pressure and Temperature Rating: MSS SP-80, Type 3.
 - 2. Design: Y-pattern, horizontal or vertical flow.
 - 3. WSP Rating: 150 psi (1,034 kPa).
 - 4. WOG Rating: 300 psi (2,068 kPa).
 - 5. Body: Bronze, ASTM B62.
 - 6. End Connections: Threaded.
 - 7. Disc: Bronze.

2.07 BRONZE, GATE VALVES

- A. General:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Non-Rising Stem or NRS
 - 1. Pressure-Temperature Range: MSS SP-80, Type I.
 - 2. Class 125:
 - a. WSP Rating: 125 psi (861.8 kPa), saturated.
 - b. CWP Rating: 200 psi (1,380 kPa).
 - 3. Class 150: CWP Rating; 300 psi (2,070 kPa).
 - 4. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
 - 5. Ends Connections: Threaded.
 - 6. Stem: Bronze.
 - 7. Disc: Solid wedge; bronze.
 - 8. Packing: Asbestos free.
 - 9. Handwheel Operator: Malleable iron.

2.08 IRON, GATE VALVES

- A. Bolted Bonnet: OS&Y; Rising Stem:
 - 1. Pressure and Temperature Rating: MSS SP-70, Type I.
 - 2. Class 125: WOG Rating; 200 psi (1,380 kPa).
 - 3. Class 250: WOG Rating; 500 psi (3,450 kPa).
 - 4. Body: ASTM A126, gray iron with bolted bonnet.
 - 5. End Connections: Flanged.
 - 6. Trim: Bronze.
 - 7. Disc: Solid wedge.
 - 8. Packing and Gasket: Asbestos free.

2.09 BRONZE, GLOBE VALVES

- A. General:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Class 125 and Class 250:
 - 1. Class 125:
 - a. WOG Rating: 200 psi (1,380 kPa).
 - b. WSP Rating: 125 psi (861.8 kPa), saturated.
 - 2. Class 250: WOG Rating; 300 psi (2,070 kPa).
 - 3. Comply with MSS SP-80, Type 1.
 - 4. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
 - 5. End Connections: Threaded.
 - 6. Bonnet: NRS; Non-rising Stem.
 - 7. Non-Rising Stem: Bronze.
 - 8. Disc: PTFE.
 - 9. Packing: Asbestos free.
 - 10. Handwheel Operator: Malleable iron.

2.10 IRON, GLOBE VALVES

- A. Class 125 and Class 250:
 - 1. Class 125, WOG Rating: 200 psi (1,380 kPa).
 - 2. Class 250, WOG Rating: 500 psi (3,450 kPa).
 - 3. Comply with MSS SP-85, Type I.
 - 4. Body: Gray iron; ASTM A126, with bolted bonnet.
 - 5. Bonnet: NRS; Non-rising Stem.
 - 6. Connection Ends: Flanged.
 - 7. Trim: Bronze.
 - 8. Packing and Gasket: Asbestos free, adjustable.
 - 9. Operator: Handwheel or chainwheel.
 - 10. Temperature Range: Minus 20 to 150 degrees F (Minus 28.8 to 65.6 degrees C).
 - 11. Pressure and Temperature Rating: ASME B16.1.

2.11 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to ball valve stems.
 - 3. Sprocket Rim with Chain Guides: Ductile iron. Include zinc coating.
 - 4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

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.
- D. Provide chainwheels on operators for valves 4 inch (100 mm, DN) and larger where located 84 inch (2,100 mm, DN) or more above finished floor, terminating 60 inch (1,520 mm, DN) above finished floor.

END OF SECTION

**SECTION 23 0000
GENERAL REQUIREMENTS FOR HVAC**

PART 1 – GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with Division 01 – General Requirements when available. If not available, the Contractor shall meet the requirements of these specifications.
- B. Where the Owner-Contractor Agreement contradicts this division, the more stringent shall apply.

1.02 RELATED REQUIREMENTS

- A. Codes to include latest adopted editions, including current amendments, supplements, and local jurisdiction requirements in effect as of the date of the Contract Documents, including state/local building code, mechanical code, plumbing code, electrical code, fire code, and energy code.
- B. All work shall be in accordance with David Douglas School District Design and Construction Standards, Version 1 dated February 2024.

1.03 GENERAL SCOPE

- A. Work included in 23 00 00 applies to Division 23 work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of mechanical systems for proposed project.
- B. Contract Documents include, but are not limited to, Specifications, Drawings, Addenda, Owner/Engineer Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.
- C. In the event there is a discrepancy between the drawings, specifications and current code, the more stringent shall apply.
- D. Examine the Drawings, specifications and other Contract Documents relating to the Work and the work of all trades and become fully informed as to the extent and character of work required. Coordinate all work with that of others to ensure proper and complete installation of all materials, equipment and supports.
- E. Intent:
 - 1. The intent of the Contract Documents is for the Contractor to include all work necessary for the complete systems, tested and ready for operation (hereinafter "Design Intent").
 - 2. Provide all items not specifically shown on the drawings, called for in the specifications or related Contract Documents, but required to conform to the labor, material and equipment to achieve the Design Intent.
 - 3. Provide all scaffolding, access provisions, tools, appliances, consumables, debris removal/disposal, supervision and labor, including required start-up, check-out and training to provide complete and fully operable systems in full compliance with the Contract Documents.
 - 4. Before submitting a bid and prior to the start of work, Contractor shall examine all conditions relating to the Work, including that associated with the work of other trades upon which Contractor's work may rely or otherwise depend, to achieve the Design Intent, in accordance with the best trade practices, workmanship and highest quality product installation, taking into account the sequence of the work, delivery, storage and hoisting requirements, requirements for access, testing and temporary services and all other site limitations and project complexities. Report to the Architect/Engineer any conditions which might prevent installation of materials and/or equipment in the manner intended by the Contract Documents or contrary to applicable codes, standards or regulations.
 - 5. By submitting a bid, the Contractor represents that it has made a thorough examination of the site, of the work, including that associated with the work of other trades, all existing

conditions and limitations, and that it has examined the Contract Documents in complete detail and has determined beyond doubt that the drawings, specifications, and existing conditions are sufficient, adequate and satisfactory for the construction of the work under the Contract.

6. No consideration or allowance will be granted for any alleged misunderstanding of materials, equipment or components to be furnished or work to be done; it being agreed that tender of proposal carries with it agreement to items, terms and conditions required by the Contract Documents.
7. Where minor adjustments of the work are necessary for purposes of fabrication or installation of items, or resolution of conflicts between items within the intent of the Contract Documents, the Contractor shall make such adjustments with no added compensation. Where such adjustments affect functional or aesthetic design of the work, they shall first be submitted to the Architect for review and approval.

F. Site Visit:

1. Contractor shall visit the site and verify the exact conditions relating to the work and obtain such information as may be necessary to present a complete and comprehensive bid. No allowance will be made for any extra expense due to Contractor's failure to make such a visit and reasonably verify all actual/existing conditions. In the event of a conflict between existing conditions and the requirements of the Contract Documents, perform the necessary work to conform to Design Intent. The Owner or his representative will be the sole individual to interpret the intent of the Drawings in the event of a conflict between (1) existing conditions and those shown on the drawings, or (2) quality of existing material and quality of material indicated on the drawings or in the specifications. Wherever a conflict such as this occurs, the higher standard shall prevail.

G. Conditions:

1. Conform to all Bidding Requirements and General Conditions
2. The Contractor is obligated to comply with the above in addition to the requirements of this Section.
3. Modifications by this Section do not nullify any other portions of the above-referenced conditions.

H. Make complete system installation, connecting to all equipment shown on the plans, or called for in the specifications. Contractor to provide any additional components not shown on plans to obtain design criteria as required for a complete system and by the balancing contractor.

I. Drawings:

1. Drawings do not attempt to show all aspects of building construction, which will affect the installation of the systems. The drawings are diagrammatic and do not intend to show all offsets and fittings that may be required for a complete installation. Locations of equipment, pipes, valves, traps, ductwork, etc. shown on the drawings, shall be followed as closely as conditions will permit. Review all project drawings, including, but not limited to, architectural, structural, plumbing and electrical drawings; and coordinate with all trades involved so there is no conflict with work of other trades and so Owner secures best arrangement of work consistent with use of space.
2. Verify exact distances between points shown on drawings by actual measurement at site, as no extra cost will be allowed for differences between actual measurements and scaled measurements on drawings.
3. Changes in design, configuration, or location of equipment, piping, or ductwork, advisable in the opinion of Contractor, shall be submitted to Architect/Engineer for approval before proceeding with work, with written assurance from other trades that such changes will not interfere with their installation, nor cause any extra cost on their part. Such changes shall be made at no additional cost to Owner.
4. Check location of all work of all trades and avoid interferences. Conflicts shall be reported to Architect/Engineer for decision and direction. Special attention is called to the following items:
 - a. Exact location of outlets shown on architectural details.

- b. Location of suspended ceilings.

1.04 SPECIAL REQUIREMENTS

- A. When applicable, Contractor acknowledges the ongoing operations of the Owner at or in close proximity to the Project and agrees to coordinate the timing of the Work with the Owner's ongoing operations; perform the Work in a manner that minimizes or eliminates and adverse impact upon the Owner's ongoing operations; confine operations at the site to areas approved by Owner, permitted by law, permits and the Contract Documents; comply with the Owner's standard security, health and safety policies and procedures; not unreasonably encumber the site with any materials or equipment; and not place signs or advertising on or about the site without prior approval of Owner.
- B. Where applicable, all seismic construction, restraints, bracing, mounts and hanging systems shall be in full compliance with the requirements of all Authorities Having Jurisdiction (AHJ's), pre-approval, certification and engineering (including certified engineering calculations and stamps). Contractor shall be solely responsible for obtaining and complying with all requirements of the AHJ.

1.05 DEFINITIONS AND ABBREVIATIONS

- A. Finished Spaces: Spaces other than mechanical, plumbing and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical, electrical and plumbing equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include spaces above hard or lay-in type ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The word "provide," means "furnish and install."
- G. The word "approved," means acceptance by the Architect or Engineer
- H. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the drawings, or other paragraphs or schedules in the specifications, and similar requirements in the Contract Documents. Terms such as "shown," "noted," "scheduled," and "specified" are used to help the reader locate the reference. Location is not limited.
- I. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted," mean directed by the Architect/Engineer, requested by the Architect/Engineer, and similar phrases.

1.06 REFERENCE STANDARDS AND GUIDELINES

- A. Include but are not limited to the latest adopted editions from:
 - 1. AABC: Associated Air Balance Council
 - 2. ADA: Americans with Disabilities Act
 - 3. AHRI: Air-Conditioning Heating & Refrigeration Institute
 - 4. AMCA: Air Moving and Conditioning Association
 - 5. ANSI: American National Standards Institute
 - 6. ARI: Air Conditioning and Refrigeration Institute
 - 7. ASHRAE: American Society of Heating, Refrigerating, and Air Conditioning Engineers
 - 8. ASME: American Society of Mechanical Engineers
 - 9. ASPE: American Society of Plumbing Engineers
 - 10. ASSE: American Society of Sanitary Engineering

11. ASTM: American Society of Testing Materials
12. AWWA: American Water Works Association
13. AWS: American Welding Society
14. CFR: Code of Federal Regulations
15. CISPI: Cast Iron Soil Pipe Institute
16. EPA: Environmental Protection Agency
17. FM: Factory Mutual Engineering Corporation
18. Fed. Spec.: Federal Specifications
19. GAMA: Gas Appliance Manufacturers Association
20. IAPMO: International Association of Plumbing & Mechanical Officials
21. ISO: International Organization for Standardization
22. MSS: Manufacturers Standardization Society
23. NEBB: National Environmental Balancing Bureau
24. NEC: National Electric Code
25. NEMA: National Electrical Manufacturers Association
26. NFPA: National Fire Protection Association
27. OSHA: Occupational Safety and Health Administration
28. SMACNA: Sheet Metal and Air Conditioning Contractors National Association, Inc.
29. UL: Underwriters Laboratories
30. WOG: Non-shock Water-Oil-Gas maximum working pressure rating

1.07 SUBMITTALS

- A. Reference Division 1 for submittal requirements when available. If not available, the contractor shall meet the requirements of these specifications.
- B. Submittal Schedule – Provide a detailed submittal schedule including all requirements of this Division and its subdivisions to the Architect and Engineer within thirty (30) days of contract award.
 1. Contractor shall submit for the Engineer's approval a Submittal Schedule for the performance of the work that is consistent with the requirements of the project schedule. The Submittal Schedule shall allow reasonable time for the Architect and other consultants review. If the time for Architects/Engineers review is not otherwise specified, the review period (from date of receipt) shall be a minimum of ten (10) business days. Once approved by the Architect/Engineer, submittal dates and time limits established by the Submittal Schedule shall not, except for reasonable cause, be changed or exceeded by the Contractor.
 2. For each submittal required by the Contract Documents, the schedule shall include: specification section number, subsection/paragraph identification number, item description (as stated in the applicable specification section, subsection or other Contract Document) and the scheduled delivery date to the Architect/Engineer. Provide a Combining multiple specification sections into one submittal is not allowable.
 3. Contractor shall be responsible to the Architect/Engineer and/or Owner for all costs, expenses and impact to the project schedule resulting from any deviation to the approved Submittal Schedule, including but not limited to: payment for required overtime, out-of-house resources/consultants or other higher cost resources of the Architect/Engineer as may be required to perform out of sequence, stacked, critical, delayed, unscheduled or multiple reviews of required submittals necessitated by rejection of a prior submittal, (cumulatively and hereinafter, "Additional Review Costs")
- C. General
 1. Review is for general conformance with the Contract Documents and is not intended to otherwise approve or verify dimensions, quantities, or to coordinate the Work shown on shop drawings on or between Contractor and the work of other trades or Sections. Contractor is solely responsible for quantities, dimensions, means and methods. Dimensions shall be confirmed and correlated by Contractor at the jobsite prior to the start of the Work (procurement, fabrication, construction or other commencement

- activities). Contractor's failure to fully verify conditions at the jobsite prior to commencement of the work shall not relieve Contractor of its obligations under the Contract Documents and Contractor shall be responsible for all damages caused by or related to its failure to comply with the requirements of this provision.
2. Submittal review shall be performed to show compliance with the design intent. Contractor shall specifically note any deviations from the Contract Documents and explain the reason and nature of the deviation. Such deviations will be reviewed or rejected on the submittal. Deviations not so identified shall not relieve the Contractor from the requirements of the Contract Documents.
 3. Resubmittals will be reviewed for compliance with comment(s) made on the original submittal only. Architect/Engineer shall not be responsible for changes made upon resubmittal that are not clearly identified (highlighted), and responsive directly to the initial rejection. Resubmittals should not be packaged with non-related first-time submittals, all resubmittals must be marked with the resubmittal number and date and must otherwise comply with all submittal requirements.
 4. Submit product data, shop drawings, commissioning plan(s) and checklists, penetration locations, supplemental data, etc. as may be required by the Contract Documents for all materials, equipment and other components of the work included in all Sections of this Division and other provisions of the Contract Documents in accordance with the requirements of this Division and referenced sections.
 5. All submittals must be reviewed by Contractor, and bear Contractor's review stamp and signoff for Conformity to the Contract Documents, prior to the submission of any required submittal to Architect/Engineer. Submittals that fail to meet this requirement will be considered incomplete, will not be reviewed by Architect/Engineer and will be returned to Contractor, without review and/or rejected and resubmittal will be required. Contractor shall be solely responsible for any and all Additional Review Costs and/or other project costs or schedule impact.
 6. Forward all submittals to Architect/Engineer in a coherent, organized fashion, complete and packaged as required herein, Architect/Engineer may reject submittals that fail to comply with this or any other provision of the Contract Documents and Contractor shall be solely responsible for any and all Additional Review Costs and/or other project costs or schedule impact. Provide a separate submittal for each specification section number. Combining multiple specification sections into one submittal is not allowable.
 7. Subject to other provisions of the Contract Documents and in the absence of a more stringent requirement, Architect/Engineer will review a submittal not more than two (2) times. If a submittal is required to be reviewed more than twice due to incomplete, or incorrect information the contractor shall be solely responsible for any and all Additional Review Costs and/or other project costs or schedule impact.
 8. Identify each submittal item by reference to Specification Section paragraph in which item is specified, or drawing/detail number, as applicable. In addition, for equipment submittals, include identification numbers appearing on the equipment schedule.
 9. Identify each item by manufacturer, brand, trade name, number, size, rating, or whatever other data is necessary to properly identify and check materials and equipment. Words "as specified" are not sufficient identification.
 10. Organize submittals in same sequence as they appear in specification sections, articles or paragraphs.
 11. All materials and equipment submittals shall have a summary sheet at the front complete with catalog numbers. Where materials or equipment pertain to more than one building, submittals shall clearly indicate at which locations the materials or equipment is to be installed.
 12. Submittals shall show physical arrangement, construction details, finishes, materials used in fabrications, provisions for piping and/or conduit entrance, access requirements for installation and maintenance, physical size and dimension, electrical characteristics and requirements, foundation/curbs and all permanent and temporary support details as well

as all information relating to weight, including but not limited to live and dead weights and other information necessary for component verification and coordination with other trades.

D. Catalog Cuts & Submittal Literature

1. Catalog cuts, submittal literature and published material may be included to supplement scale drawings provided that the actual make and model of equipment being submitted on is identified.
2. Submittal literature, drawings and diagrams shall be specifically applicable to this project and shall not contain extraneous material or optional choices. Clearly mark literature to indicate the proposed item.

E. Shop Drawings:

1. Shop drawings shall include all systems, equipment, and components, including but not limited to all equipment, devices, connections and elevations. Include all related specialty rooms (i.e. mechanical, electrical, data/technology). Drawings shall be at a minimum scale of $\frac{1}{4}"$ per 1'-0" and shall be fully coordinated with the work of other trades and/or sections.
2. Detail major elements, components, systems, equipment and materials in relationship with other systems, installations, and building components. Identify congested areas and clearly indicate solutions to space problems, developed in conjunction with the work of other trades and/or Sections. Identification of space problems without proposed solutions is not acceptable and is grounds for rejection. For such areas indicate, superimposed, the work of all trades and/or Sections involved and:
 - a. Clearly identify each area of congestion and deviations from the Contract Documents, and:
 - b. Proposed solution(s), clearly documented and signed-off by all other trades and/or Sections involved.
3. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
 - a. Planned system distribution layout, including specialty device locations and access for operation
 - b. Clearances for installing and maintaining insulation.
 - c. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 - d. Equipment and accessory service connections and support details.
 - e. Other systems installed in same space.
 - f. Exterior wall and foundation penetrations.
 - g. Fire-rated wall and floor penetrations.
 - h. Ceiling and wall-mounted access doors and panels required to provide access to operating devices or items needing access for proper maintenance
 - i. Sizes and location of required concrete pads and bases.
 - j. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 - k. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

F. Anchorage and Supports: Submit details and calculations for support and anchors that are not specifically detailed on the drawings. All calculations must meet current seismic and structural code.

1. Provide seismic restraints in accordance with ASCE Standard 7 requirements for piping, ductwork, and mechanical equipment.
2. Provide engineering for seismic restraint system, assemblies, and components.
3. Provide shop drawings and installation instructions for seismic restraint system.
4. Provide final inspection and report for installed restraint system acceptance.
5. Where pre-approved bracing systems will be employed, submit:

- a. System component brochure describing components used and detailed installation instructions.
 - b. Loads to be transmitted to the structure at anchor points.
- 6. Where anchorage, support, and bracing are not detailed on the drawings, and pre-approved systems are not used, submit details and calculations of proposed systems. Include:
 - a. Anchorage and Supports
 - 1) Where equipment substitutions change the weight, size, configuration, or other aspects of systems and equipment that will affect the performance of anchorages and/or supports, submit calculations for proposed anchors and supports, and install them as shown in these calculations.
 - 2) Where substitutions will have no effect on anchors and supports detailed on Contract Documents, submit information on sizes, weights, center of gravity and other relevant information to demonstrate this fact.
- 7. Seismic Engineer: Professional engineer currently licensed in state where project is located as a structural, civil, or mechanical engineer. Responsible for designing, applying, and inspecting custom seismic restraint components in accordance with applicable codes.
- G. Shop Fabrication Drawings: Drawings are for the Contractor's use and shall be its responsibility. Do not submit shop fabrication documents unless specifically requested.
- H. Testing: Coordinate Shop Drawings to include any additional components for proper system testing.
- I. Certificates: Submit final inspection certificates signed by governing authorities.
- J. Operating and Maintenance Instructions and Manuals.
 - 1. Three (3) complete sets of instructions containing the manufacturer's operating and maintenance instructions for each piece of equipment shall be furnished to the Owner within ninety (90) days of issuance of final occupancy permit. Each set shall be electronic or permanently bound with a hard cover. The following identification shall be inscribed on the covers, "OPERATING AND MAINTENANCE INSTRUCTIONS", the name and location of the building, the name of the Contractor, and the Contract number. Flysheets shall be placed before instructions covering each subject. The instruction sheets shall be approximately 8 1/2" x 11" with large sheets of Drawings folded in.
 - 2. PDF electronic file: 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.
 - 3. Instructions on major items, including but not limited to: pumps, air compressors, boilers, specialty units, fans, air handlers, AC units and temperature controls, shall be by representative of manufacturer of respective equipment.
 - 4. Submit as identified below and as noted in other specification references.
 - a. Names, addresses and phone numbers of contractors and subcontractors. List of all system components, with the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year of operation.
 - b. Complete operating and maintenance instructions and parts lists of all equipment and component parts. Data sheets to show all connections, ratings, characteristics, wiring connections, catalog data on component parts whether furnished by equipment manufacturer or others, names, addresses and telephone numbers of source of supply for parts subject to wear or failure, and description of operating, test, adjustment, and maintenance procedures.
 - 1) Where data sheets included in manual cover equipment, options, or other features not part of equipment actually furnished, line out these references or otherwise clearly mark so remaining text, diagrams, drawings, schedules, and similar information shall apply specifically to equipment furnished.
 - c. Operating Instructions should include, but not be limited to:

- 1) Normal starting, operational and shutdown procedures, including emergency procedures for each type of equipment/system.
 - 2) Equipment wiring and control diagrams.
 - 3) All other items as may be specified/required by this Section and the Contract Documents.
- d. Maintenance Instructions
- 1) All items as may be specified/required by this Section and the Contract Documents.
- e. Manufacturers Data (each piece of equipment)
- 1) Installation instructions
 - 2) Drawings & specifications
 - 3) Parts List, including recommended stock and long lead parts/components.
 - 4) Wiring and riser diagrams.
 - 5) Warranties and guarantees for all equipment, materials and components, including repair, replacement and labor from both Contractor and manufacturer as required by the Contract Documents.
 - 6) Certificates of Installation – manufacturer's certification of supervision during equipment installation and start-up procedures.
 - 7) All other items as may be specified/required by this Section and the Contract Documents.
- K. Record Documents.
1. Maintain one (1) complete set of prints and specifications at the job site exclusively for recording deviations from the drawings which are necessary because of job conditions, request for information and/or approved change orders. Record locations and depths of buried and concealed system components from fixed, easily identifiable objects, such as building walls or other fixed physical objects. Where systems are concealed in walls or other fixed physical objects, indicate distances from building corners or other building features not likely to be disturbed by future alterations.
 2. Submit Record Drawings within 90 days of system acceptance by owner.
- L. Drawings, specifications (as-builts) and approved submittals.
1. Where the project uses a BIM model the contractor shall keep the model updated in a similar fashion, maintaining the current project record as described above and submit, in addition to all other requirements of this Section and other provisions of the Contract Documents a complete and accurate BIM model for the project.
 2. Prior to Substantial Completion, obtain from the Architect a complete set of printed drawings at the Contractor's cost. Record all revisions to these drawings to indicate as-built conditions. Indicate all changes, including RFI's, on this set of documents. Submit one set of blueprints of these revised drawings for review. Make necessary changes and deliver to Architect one set of electronic documents, including any BIM model, upon Final Completion and Acceptance.
 3. All test reports, certifications, and inspection reports.
 4. AHJ/Specialty AHJ Approvals (i.e. Fire Marshal and/or Fire Department system approvals).
 5. Substantial and Final inspection certificate signed by governing authorities.
 6. All other items as may be specified/required by this Section and/or other provisions of the Contract Documents.
- M. Definitions of comments used in submittal review:
1. "No Exception Taken" The meaning and intent of this statement is that the Engineer finds no objection (except those noted thereon or in correspondence) to inclusion of items or Work indicated in construction provided that it:
 - a. Complies with Contract Drawings and Specifications as to quantities, space requirements, and dimensions.
 - b. Does not interfere with other trades.

- c. Is not the cause of union tradesmen disputes.
- d. Does not infringe on patent rights.
- e. Is not the cause of injury or damage to persons or property.
- f. Complies with OSHA regulations.
- 2. "Rejected" The meaning and intent of this statement is that the submitted material does not conform to plans and specifications. Resubmittal of a different product or shop drawing is required.
- 3. "Revise and Resubmit" This statement is used when the general product line is acceptable, but the submitted material varies in dimension, accessories, etc. from what is required. Resubmittal is required.
- 4. "Make Corrections Noted" This statement is used as an alternative to "Revise and Resubmit" when resubmittal is not required.
- 5. Said review does not relieve Contractor of any Contractual responsibilities.

1.08 TEMPORARY FACILITIES AND CONTROLS

- A. Refer Division 01 – General Requirements when available. If not available, the Contractor shall meet the following requirements.
- B. Use of Project equipment for temporary service during construction is not allowed.

1.09 EQUIPMENT DEVIATIONS AND SUBSTITUTIONS

- A. Substitutions will only be considered after project award. No substitutions will be considered during bid and/or negotiation periods.
- B. See Division 1 for requirements and procedures related to Deviations and Substitutions. Unless specified elsewhere in the Contract Documents, a minimum of ten (10) business days shall be allowed for evaluation. The burden of all systems re-engineering/design, testing, suitability, and constructability is solely placed upon the Contractor for all deviations from the basis of design as reflected in the Contract Documents.
- C. No substitutions will be allowed and/or considered unless the description of a product includes the phrase "approved equal" and then only upon a determination as to equivalency and impact upon the project budget, schedule, and the work of others, including any redesign of the project or its system components by the Architect, Engineer, or other trades. The final determination as to sufficiency or acceptance of any such substitution and/or deviation properly requested and submitted by Contractor will lie solely with the Architect/Engineer. Contractor may not implement substitutions that have not been approved by Architect/Engineer.
- D. Where the contractor proposes to use an item or equipment other than that specified or detailed on the drawings which requires any redesign of any portion of the project, including but not limited to the mechanical, electrical, plumbing, structure, or architectural design or any of their respective subcomponents. Contractor shall be responsible to the Architect/Engineer and/or Owner for all costs, expenses and impact to the project budget and/or schedule resulting from any required investigation, analysis or redesign, including but not limited to; payment for required overtime, out-of-house resources/consultants or other higher cost resources of the Architect/Engineer, Owner or AHJ as may be required to perform the investigation, analysis or redesign (cumulatively and hereinafter, "Deviation Review Costs")
- E. If approved by Architect/Engineer, all such redesign, including all new drawings and detailing required, will be prepared by the Architect/Engineer and their sub-consultants for Change Order documentation for approval by Owner and the Authority Having Jurisdiction will be paid by the Contractor as part of the Deviation Review Costs.

1.10 COORDINATION

- A. Prior to construction, coordinate installation and location of systems, devices and equipment with architectural and structural requirements, and other trades (including ceiling suspension, and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted,

including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.

- B. Drawings and corresponding electronic media are diagrammatic and indicate the general arrangement of systems and work included in the Work. Consult the drawings, details and other electronic media for locations of fixtures and equipment; where same are not definitely located, obtain this information from the Architect/Engineer.
- C. Check drawings and related electronic media of other trades to verify spaces and conditions in which work will be performed prior to commencement of the work.
- D. If directed by the Architect/Engineer or required for proper installation, execution and coordination of the work, the Contractor shall, without extra charge, make reasonable modifications in the layout as needed.
- E. Take all dimensions from Architectural and Structural Drawings, certified equipment drawings and from the actual field measurements before fabricating work. All conflicts shall immediately be reported to the Architect/Engineer. Contractor is solely responsible for conflicts known or which reasonably should have been known but not reported or resolved before commencement of the work.
- F. Equipment furnished shall fit in allocated space with due provision for manufacturer's recommended access and proper maintenance requirements. Verify and coordinate space requirements with all trades and equipment which comprise the Work.
- G. Prior to construction, coordinate the Work with that of other trades and building components. Prepare coordination drawings (or other specified electronic media) for all major trades, utilities and other primary systems routing in conjunction with the contract documents to maximize the pre-installation planning and coordination of trades, utilities and systems and minimize the requirement to manage field coordination through the RFI's, ASI's or other similar processes.
- H. Coordinate connection of systems with interior/exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- I. Before submitting a bid for the work the Contractor shall visit the site and become familiar with all the work on other related Drawings and Specifications, and plan the work to provide the best possible assembly of the combined work of all trades. No additional costs will be considered for work which has to be relocated due to conflicts with other trades.
- J. If, after examination of the bidding documents relating to the work, the Contractor has queries concerning the nature and scope of the work or intent of the Specifications, he/she shall promptly request clarification from the Architect/Engineer. After contract award, claims of ignorance of the intent and scope of the contract shall not be allowed.
- K. Contractor is responsible for coordinating the schedule of inspections by Engineer at appropriate stages of construction such as rough-in, pre-final, and final, and at other times required by the Specifications or by the construction. Notify Architect and Engineer ten (10) business days in advance of proposed site visit. Notification constitutes certification that construction is, or will be, complete and ready for observation. In the event that construction is not ready for observation, contractor shall bear the cost of additional site visits.

1.11 ACCESSIBILITY

- A. Contractor is responsible for verifying that equipment and devices will fit within the space shown on the drawings. Contractor shall locate all equipment which must be serviced, operated or maintained, in fully accessible locations.
- B. Minor deviations from the drawings may be made to allow for better accessibility, but changes of magnitude or which involve extra cost shall not be made without approval from the Architect/Engineer.

1.12 QUALITY ASSURANCE

- A. Regulatory Requirements: Work and materials installed shall conform with all local, State, Federal and other applicable laws and regulations.
- B. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.
- C. Installer Qualifications: Company specializing in performing the work of this section with a minimum 5 years documented experience. Company personnel shall be approved by manufacturer for all product installations and required training.
- D. Conform to all applicable standards, codes and regulation and industry best practice requirements.
- E. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- F. All materials and equipment shall be new, shall bear manufacturer's name, and shall conform to the grade, quality and standards specified herein. Type, capacity and application shall be suitable and capable of satisfactory operation for the purpose intended. All equipment and components shall include UL label and/or marking on equipment body/device including manufacturer's name, pressure rating(s), electrical classification(s), limits and ratings as applicable to individual components for the purpose specified and intended.
- G. Equipment Selection: Equipment allowed by the specifications but with different electrical characteristics, physical dimensions, capacities, and/or ratings than what is shown on the Drawings may be furnished, provided such proposed equipment is approved in writing and connecting mechanical and electrical services, such as pipe and/or duct connection sizes, circuit breakers, conduit, motors, bases, and equipment spaces are revised to accommodate such equipment. Maintain a minimum duct length of three straight diameters at all fan inlets and outlets. All expenses shall be borne by the Contractor. Specified minimum energy ratings and/or equipment efficiencies must meet design and commissioning requirements.
- H. ASME Compliance: ASME listed water heaters and boilers with an input of 200,000 BTUH and higher, hot water storage tanks which exceed 120 gallons, and hot water expansion tanks which are connected to ASME rated equipment or required by code or local jurisdiction.
- I. Provide safety controls required by National Boiler Code (ASME CSD 1) for boilers and water heaters with an input of 400,000 BTUH and higher.
- J. Listing and labeling: Provide motors that are listed and labeled. Terms "listed and labeled": as defined by UL, NEC, Article 100 or other applicable recognized agency as specified in the Contract Documents.
- K. Cutting & Patching: Unless otherwise required by the Contract Documents, Contractor shall be responsible for all cutting, fitting and patching required to complete the Work, or to make portions of the Work and existing conditions fit together properly, and all such areas shall be restored to the conditions existing prior to the cutting, fitting and patching unless otherwise provided in the Contract Documents
- L. Lead Free Requirements: Contractor shall endeavor to use lead free products and where required by law, ordinance, regulation or standard, all materials products and practices shall comply with limitations and requirements as to the allowable limits and/or percentages of lead. Lead free products must be certified by and independent 3rd party.
 - 1. This provision shall apply to any and all similarly regulated materials, products and practices that may be considered hazardous or are otherwise regulated by applicable law, ordinance regulation or standard in the project local.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. All materials and equipment shall be adequately covered and protected against dirt, water, chemical or mechanical damage, and theft. At completion, all work, equipment and materials shall be cleaned, and damage repaired by Contractor. Damaged equipment will be replaced by

the contractor if Owner does not accept repairs done to the equipment. Such replacement shall be scheduled to minimize building system interruption of occupied or scheduled for occupancy.

- B. Material delivered at the site shall not be left exposed to the weather or left unattended. Deliver pipes, tubes and conduit with factory-applied end-caps. Contractor shall be responsible to maintain end-caps or provide temporary end caps on all open-ended piping, tubes and conduit through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
- C. Protect bright finished shafts, bearing housings and similar items until in service.
- D. Protect plastic pipes and materials from sunlight and support to prevent sagging and bending.
- E. Elevate stored materials above grade. When stored inside, do not exceed structural capacity of the floor.
- F. Provide protective coatings to materials to prevent damage and/or infiltration of moisture and dirt on all materials and equipment including but not limited to cast iron and steel valves.
- G. Contractor shall check the openings in the building and the size of the doors, passages, and openings through which equipment is to be admitted. Wherever necessary, he shall provide the equipment in sections or knocked down in order to admit the equipment through these openings.
- H. Contractor shall provide all rigging, erection and hoisting equipment as required to handle or place equipment and piping in position. This rigging and hoisting equipment shall only be attached and placed on the structure in locations as approved by Architect/Engineer at the site. Section 016000 "Product Requirements."

1.14 PERMITS AND FEES

- A. Contractor shall arrange and pay for all permits, fees, and inspections required to perform the Work. The Contractor shall present the Owner with properly signed certificates of final inspection before the Work will be accepted.
- B. Contractor shall call for all inspections by local building official(s) when they become due, and shall not cover any work until approved by these governing authorities.
- C. Contractor shall make all arrangements with utility companies for water, steam, gas and drainage services, etc., associated with the work and include required payments for meters, piping, services, connection charges and materials furnished and installed by utility companies. Work and materials shall be in strict accordance with rules of respective authorities.

1.15 DOCUMENT OWNERSHIP

- A. The Drawings and Specifications, combined with the calculations, field data, notes, and reports, are the intellectual and real property of the Architect and/or Engineer. This covers all forms of written and recorded or electronic media. The reuse of these documents without specific permission of the Architect and Engineer is prohibited. The Drawings may be employed by the Owner and Contractor for the express use of constructing, commissioning and operating the facility only upon proper execution of an Agreement for Use of Electronic Files & Data.

1.16 GUARANTEE AND WARRANTY

- A. Refer Division 01 – General Requirements when available. If not available, the Contractor shall meet the following requirements.
- B. Contractor warrants to Owner that the materials and equipment provided under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise. Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects. Work, materials and equipment not conforming to these requirements, including substitutions not properly approved by Change Order, shall be considered defective. This warranty excludes remedy for damage caused by improper or insufficient maintenance, improper operation or normal wear, tear and usage. Contractor shall assign to Owner, or otherwise assure the Owner has the full benefit of, all warranties and guarantees of manufacturer, subcontractors, sub-subcontractors and suppliers, and Contractor

shall perform the Work in a manner that does not adversely affect or invalidate any available warranties or guarantees.

- C. Contractor shall warrant and guarantee all work against faulty material or workmanship for a period of one (1) year from the date of final completion and written acceptance by the Owner, unless specified more stringently elsewhere in the Contract Documents.
- D. If the project is occupied or the systems placed in operation in several phases at the request of the Owner, the guarantee of each system or piece of equipment used shall begin on the date each system or piece of equipment was placed in satisfactory operation, tested, commissioned and accepted, in writing, by the Owner. The use of building equipment for temporary service and testing or phases of work completed prior to the projects final completion and acceptance by the Owner does not constitute the commencement of the warranty period.
- E. If a defect or deficiency in the Work is discovered within the one (1) year Warranty & Guarantee period or within such longer period as may be prescribed by the Laws or by any specific guarantee, and Owner elects to have Contractor correct such defect or deficiency, Owner shall notify Contractor of such defect or deficiency in writing. This period of correction relates only to the specific obligation to correct defects and deficiencies and in no way otherwise limits the Contractor's responsibility for Work that is not in accordance with the Contract Documents, If Contractor fails to timely correct defects or deficiencies in the Work, Owner may, at its sole option, correct them and charge contractor for all cost therefore.
- F. Specific exclusions, if any, from this one (1) year warranty and guarantee period are listed in the individual specification sections.

1.17 LIMITATIONS OF LIABILITY

- A. To the extent any of the following provisions are not more stringently included in the Contract Document the following Limitations of Liability shall apply:
- B. Architect/Engineer is not responsible for Contractor's means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, and is not responsible for Contractor's failure to perform or furnish the work in accordance with the Contract Documents.
- C. In the event that Architect/Engineer's employees or sub-consultants make comments or issue warnings about safety issues, such comments and warnings shall be considered to have been offered by a Good Samaritan and shall not impose any obligation or responsibility.
- D. Engineer will not be responsible for the acts or omissions of Owner, Contractor, any subcontractor, any supplier, or of any other person or organization performing or furnishing any of the portions of the work
- E. Contractor understands and acknowledges that Engineer is not authorized to order extra work or issue Change Orders to the work, however in the event and to the degree that Engineer may offer advice, suggestions, and opinions Contractor shall not rely on such advice, suggestions, and opinions unless directed in writing by Owner or its designated representative, and shall, in no event, make any claim against the Engineer for any such advice, suggestions, and opinions.
- F. To the fullest extent permitted by law, Contractor shall indemnify and hold harmless Architect, Engineer, and their joint ventures, officers, directors, partners, employees and agents from and against any and all claims, costs, losses and damages (including but not limited to all fees and charge of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs) caused in whole or in part by the negligent acts or omissions of Contractor, Contractor's officers, directors, partners, employees, agents; or contractor's subcontractors or material men in the performance of Work. Contractor shall direct its insurer to list Architect, Engineer, and their joint ventures, as Additional Insureds on general liability insurance policies covering this project. Prior to commencing work, Contractor shall submit copies of its certificate of insurance to both Architect and Engineer.

1.18 SAFETY

- A. Contractor shall comply with all OSHA regulations. Contractor is required to obtain and pay for insurance required to cover all activities within Contractor's Scope of Work.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. See Drawings for equipment data, capabilities, and requirements. Manufacturers are identified for the purpose of establishing quality; alternative manufacturers of equal quality are acceptable. If alternative manufacturers are proposed it is the contractor's responsibility to verify and demonstrate the proposed alternative is equivalent.
- B. Provide like items from one manufacturer, including but not limited to pumps, fans, valves, control devices, air handlers, vibration isolation devices, etc.

2.02 MATERIALS

- A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL approved or have adequate approval or be acceptable by State, County, and City authorities. Provide all materials omitted herein but necessary to complete the work.
- B. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
- C. All electrical materials shall bear the label of, or be listed by, the Underwriters' Laboratories (UL), unless the material is of a type for which label or listing service is not provided.
- D. Hazardous Materials: Comply with local, State and Federal regulations relating to hazardous materials. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.03 ACCESS PANELS

- A. Confirm Access Panel requirements in individual Division 23 sections. Comply with the following:
 - 1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly. Ceiling access panels to be minimum of 24 x 24 or as required and approved size. Wall access panels to be minimum of 12 x 12 or as required and approved size.
 - 2. Coordinate final door location with the devices which require access and architectural finishes.

2.04 DRAIN PANS

- A. Provide drip pans under all hot water heaters, above-ceiling inline pumps, cooling coils and heat recovery coils. Locate pan immediately below piping and equipment, and extend a minimum of 6" on each side and lengthwise 18" beyond equipment being protected. Pans shall be 2" deep and fabricated from reinforced sheet metal (20 gauge copper or 20 gauge steel with two ounces zinc finish hot dipped after fabrication) with rolled edges and soldered or welded seams. Provide 3/4" copper drainage piping, properly discharged to floor drain, hub drain, or as shown on Drawings. Provide condensate pumps as necessary. Comply with Oregon Mechanical Specialty Code for overflow protection and pipe sizing.

2.05 GUARDS

- A. Provide guards in accordance with State Safety Code and OSHA requirements over all rotating equipment including belts, shafts and couplings. Drive guards over belts and sheaves shall include 2-1/2" diameter access opening at shaft ends for speed counter.

2.06 PENETRATION FIRE STOPPING

- A. Through-penetration fire stopping system tested and listed by Underwriters Laboratories and ASTM E 814-88: Standard Test Method for Fire Tests of Through-Penetration Firestops.
- B. Select system for proper application based on wall construction, type of penetrating item, wall rating, etc. Each product shall be listed for use in its intended application.
- C. Fire Stop assembly shall be able to withstand standard fire and hose stream test (F Rating) and limit temperature rise (T Rating) of penetrations on protected side as required by Authorities Having Jurisdiction. Conform to ASTM E 814.

2.07 MISCELLANEOUS STEEL

- A. Provide all steel as required for adequate support of all mechanical equipment. Use standard angle or channel, I or H sections as required by application. Adequately cross-braced and welded pipe stands may be used for tank supports. Provide suitable base plates for all stands and anchors for all hanging equipment. Drill or burn support holes only in flanges of structural shapes and only in one leg of any one angle, and as far from center of length as possible.
- B. Paint: Apply one coat of black Rustoleum primer to shop fabricated items before delivery to the job; other painting as specified herein.

PART 3 – EXECUTION

3.01 GENERAL MECHANICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of the mechanical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate systems, equipment, and materials installation with other building components.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for system installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - 5. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - 7. Coordinate connection of systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 - 8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
 - 9. Install systems, materials, and equipment level and plumb, and parallel or perpendicular to other building systems and components, where installed exposed in finished spaces.
 - 10. Install equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
 - 11. Install access panel or doors where units are concealed behind finished surfaces. Coordinate with other divisions.
 - 12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
 - 13. Replace all air filters with new filters upon Owner taking occupancy of the building or at a time mutually agreed upon between the Owner and Contractor.

14. Do not install ductwork or piping in elevator machine rooms, electrical and/or communication rooms unless it directly services that room.
- B. Locate wall, floor and ceiling fire ratings from architectural drawings for appropriate hourly rating of combination fire/smoke dampers or fire dampers shown on mechanical drawings.

3.02 CONTINUITY OF SERVICE

- A. Contractor, in the performance of the Work shall plan for and incorporate into the work the continuity of services. Where the continuity of service(s) is required to be interrupted Contractor shall plan and schedule the work to minimize interruptions to the facility and its normal operations, prearrange and coordinate all outages/interruptions with Owner's representative, utilities and the work of others. Requests for system interruptions/outages must be submitted at least (5) days prior to intended shutdown time and then subject to Owner's adjustment and/or approval.
- B. For connections that require a significant interruption to facility operations (as determined by the Owner), Contractor shall provide for Owner's written approval a detailed plan, schedule and description of the work for each system interruption. The plan shall include a description and schedule of each work item to be completed, designation of site supervisor and contact information, designated work crew as well as facility access and egress points for materials, manpower and equipment, contingency plan for parts, materials and equipment as well as a program to restore systems in the event of unplanned disruption or inability to complete the work in the timeframe scheduled and approved by Owner. Contractor shall confirm scheduled dates with the Owner and provide a minimum of five (5) days advance notice for each operation.
- C. Where possible and subject to Owners sole discretion, connections to existing systems shall be performed during normal operating conditions. Unless required otherwise (specifications, code, practice, etc.) all tap connections shall be 'live', 'wet' or 'hot'", with the proper safety programs and procedures for isolating system components to ensure the safety of the workforce, occupants and the facility.
- D. Contractor shall include all costs for overtime labor, expedited materials, equipment and contingency planning as necessary to maintain continuity of services, schedule and complete necessary connections. Contractor shall also include provisions for maintaining any and all supplemental systems that may be required to remain in service for the safety, protection and critical operations of the facility and its occupants including but not limited to: Fire Alarm, Security, Phone/Data, BAS, Emergency Power and similarly related critical or emergency systems. Such provisions shall include but not be limited to temporary power, lighting, materials, equipment and/or installations (including removal and cleanup thereof) required to maintain such systems and as required to safely and properly complete the work.
- E. Contractor shall be liable for any and all damages resulting from unscheduled outages/interruptions or for those not confined to the pre-approved timeframes to complete the work.

3.03 DEMOLITION

- A. Comply with individual Division 23 sections and the following:
 1. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas.
 2. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.
 3. Equipment: Unless otherwise directed, equipment, fixtures, or fittings being removed as part of demolition process are Owner's property. Remove other items not scheduled to be reused or relocated from job site as directed by Owner.

4. Unless specifically indicated otherwise on Drawings, remove exposed, unused systems to behind finished surfaces (floor, walls, ceilings, etc.). Cap and patch surfaces to match surrounding finish.
 5. Unless specifically indicated otherwise on Drawings, remove unused equipment, fixtures, fittings, rough-ins, and connectors. Removal is to be to a point behind finished surfaces (floors, walls, and ceilings).
- B. If duct, pipe, insulation, conduits, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
 - C. Reuse of Materials: Reuse of materials is prohibited unless specifically indicated or approved by Architect.
 - D. Notify Architect in discovery of any hazardous materials.
 - E. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.04 MECHANICAL SYSTEMS - COMMON REQUIREMENTS

- A. General: Install mechanical systems as described below, unless piping Sections specify otherwise. Individual Division 23 Sections specify unique installation requirements.
- B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of systems. Indicated locations and arrangements were used to size pipe and duct and calculate friction loss, expansion, pump sizing, fan sizing, and other design considerations. Install piping and ductwork as indicated, unless deviations to layout are approved on Coordination Drawings.
- C. Install piping at indicated slope.
- D. Install components with pressure rating equal to or greater than system operating pressure.
- E. Install piping and ductwork in concealed interior and exterior locations, except in equipment rooms and service areas.
- F. Install piping and ductwork free of sags and bends.
- G. Install exposed interior and exterior piping and ductwork at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- H. Install piping and ductwork tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- I. Install piping and ductwork to allow application of insulation plus 1-inch clearance around insulation.
- J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- K. Install flexible connectors according to manufacturer's written instructions, and where indicated and specified in other Division 23 sections.
- L. Install flexible expansion loops according to manufacturer's written instructions, and where indicated and specified in other Division 23 sections.
- M. Install fittings for changes in direction and branch connections.
- N. Install couplings according to manufacturer's written instructions.
- O. Install Portable Instrument Connections in all piping systems where DDC temperature and/or pressure sensors and thermometers and/or pressure gauges are located.
- P. Do not route piping through elevator equipment rooms, unless specifically allowed by local authority.
- Q. Do not route piping over electrical panels, transformers, switchgear or other electrical equipment.

- R. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
1. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
 2. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.
 3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
 4. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
 5. Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.
- S. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
1. Cut sleeves to length for mounting flush with both surfaces.
- T. Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
1. Build sleeves into new walls and slabs as work progresses.
 2. Install sleeves large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS.
 - b. Steel, Sheet-Metal Sleeves: For pipes 6-inch NPS and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. If available, refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with non-shrink, nonmetallic grout.
 - d. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.
- U. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches in diameter and larger.
 3. Assemble and install sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- V. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using sleeve seals. Size sleeve for manufacturer's recommended clear space between pipe and sleeve.
1. Assemble and install sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
 2. Caulk exterior side of annular space once the sleeve seal is in place using an elastomeric joint sealant.
- W. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe and duct penetrations. Seal pipe and duct penetrations with firestopping materials. If available, refer to Division 7 Section "Firestopping" for materials.
- X. Verify final equipment locations for roughing-in.
- Y. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- Z. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 3. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
 4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 5. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 6. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 7. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
 8. Align threads at point of assembly.
 9. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
 10. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
 - a. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators.
 - b. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench to recommended torque values.
- AA. Piping Connections: Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
 2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.
- BB. Identification
1. Valves:
 - a. Attach 1 1/2" square brass tags stamped with designating number 1/2" high, filled in with red enamel, to each valve.
 - b. Securely fasten valve tag to valve spindle or handle with a brass chain.
 2. Schedules and Charts:
 - a. Furnish to Owner's representative three (3) complete framed plastic laminated valve tag schedules. Schedule shall indicate tag number, valve location by floor and nearest column number, valve size and fire area controlled.
 - b. Furnish three (3) framed plastic laminated diagrammatic charts showing schematically the complete sprinkler system, with major control valves and valve numbers.
 - c. Furnish one (1) framed plastic laminated placard at each sprinkler riser, indicating the basic hydraulic data as required by NFPA 13 or local Fire Marshal.
 3. Piping Identification:
 - a. Apply color coded polyvinyl chloride pipe bands identifying service and direction of flow.

- b. On exposed piping, apply bands at 20'-0" on centers at straight runs, at valve locations, and at points where piping enters and leaves a partition, wall, floor, or ceiling.
- c. On concealed piping installed above removable ceiling construction, apply bands in manner described for exposed piping.
- d. On concealed piping installed above non-removable ceiling construction, or in pipe shafts, apply bands at valves or other devices that are made accessible by means of access doors or panels.
- e. Apply bands at exit and entrance points at each piece of equipment.
- f. Band widths shall be 8" for pipes up to 10" diameter, and 16" for larger diameter piping. Letter heights stating service shall be pre-printed on band, 3/4" high for 8" bands and 1 1/4" high for 16" bands.
- g. Colors shall conform to ANSI Standard A13.1.
- h. Letter size shall conform to ANSI A13.1.
- i. Tags and bands shall be approved for this service.

3.05 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to approved submittal data.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated. Supports shall be neatly placed and properly fastened. All equipment shall be fastened in place with bolts.
- D. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

3.06 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor materials and equipment.
- B. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.07 DRAWINGS

- A. The Drawings show the general arrangement and location of the ductwork, piping and equipment. Work shall be installed in accordance with the Drawings, except for changes required by conflicts with the work of other trades. The Contractor shall provide for the support, expansion, and pitch of any rearranged piping in conformance with the intent of the Drawings, Specifications, and codes.
- B. Note that certain mechanical work is shown, wholly or in part, on Architectural Drawings.
- C. Mechanical Drawings are diagrammatic and are intended to show the approximate location of equipment and piping. Dimensions shown on Drawings shall take precedence over scaled dimensions on Drawings. All dimensions shall be verified in the field by the Contractor.
- D. The exact location of apparatus, equipment, and piping shall be ascertained from the Owner or the representative in the field, and work shall be laid out accordingly. Should the Contractor fail to ascertain such locations the work shall be changed at Contractor's own expense when so ordered by the Owner. The Engineer and owner reserve the right to make minor changes in the location of ductwork, piping and equipment up to the time of installation without additional cost.
- E. It is the intention of the Drawings and Specifications that, where certain mechanical items such as unions, expansion joints, and other mechanical components are not shown, but where such items are required by the nature of the work, shall be furnished and installed.
- F. The Mechanical Drawings and Specifications are intended to supplement each other. Any material or labor called for in one shall be furnished even though not specifically mentioned in the other.

- G. Pipe and duct sizes shown are the minimum allowable and shall be increased in size if required by code or wherever necessary to meet unusual conditions.

3.08 DAMAGE

- A. Repair any damage to the building, premises, and equipment occasioned by the work under this Section and all other Sections.
- B. Repair all damage to any part of the building or premises caused by the Work installed under this Section until the warranty period expiration date.

3.09 EARTHWORK

- A. General: Perform earthwork required for installation of new work below grade in accordance with referenced specifications.
- B. Excavate trenches to uniform widths to provide a working clearance on each side of the pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated. Grade trench bottoms to provide uniform bearing and support for each section of pipe. Form holes and depressions for joints after trench bottom has been graded. Provide temporary pumping equipment to keep excavation free from water. Install pipe bedding in rock excavation consisting of not less than 6 inch of sand or equivalent material.
- C. Provide bracing and shoring as necessary.
- D. Backfill trenches only after completion of pressure tests and inspection. Carefully compact material under pipe and bring backfill evenly up on both sides and along the full length of piping or conduit. Cover to 12-inch thickness over top of pipe. Fill and tamp remainder of backfill material in 6-inch layers. Provide backfill materials generally consisting of clean earth or sand relatively free of clods or stones. For sewer and water piping, use pea gravel. For gas piping, use sand. Backfill under, around, and to 6 inches above top of piping.
- E. Compact soil to 6-inch layer (maximum) loose thickness of backfill. Where roadway or parking area surfaces will be placed over backfill, provide moisture conditions, which will produce compacted density of 95 percent of maximum density. Elsewhere, 90 percent. Test in accordance with Divisions 1 and 2 (if applicable) and local code requirements (most stringent to prevail).
- F. Take special care in compacting under services where they enter building to prevent settling. Contractor fully responsible for damage to piping and property as a result of settling around service piping.
- G. Dispose surplus materials off-site in a suitable location.
- H. Place and maintain barricades, construction signs, torches, lanterns, and guards as required during periods of open excavation to protect persons from injury and to avoid property damage.
- I. Leave premises thoroughly clean at completion of earthwork.
- J. Wherever piping is to be installed in areas, which have been excavated below pipe inverts, for any purpose, install piping to prevent subsequent settlement. Do not install piping until backfill is to full compaction, completed to minimum 18 inch above installed pipe. Install piping in re-excavated trenches and backfill as previously specified.

3.10 CONCRETE WALLS AND CONCRETE FOOTINGS

- A. Where pipes must pass through concrete walls and footings, they shall pass through SDR 35 PVC pipe sleeves with 1/2" annular space set in place at time of construction.
- B. Ducts shall pass through 10 gauge galvanized sheetmetal sleeves. Provide sheetmetal closure collars at duct penetration.
- C. Sheetmetal sleeves set into concrete walls: Provide steel frame around opening where required by Structural Engineer.

- D. Coordinate core drilled openings with General Contractor. Coordination shall include location, size, and spacing of openings. No slot openings will be allowed. Coordinate openings to avoid critical structural items such as reinforcing bars, tensioning tendons, etc.

3.11 ELECTRICAL REQUIREMENTS - CONTROLS AND COORDINATION WITH ELECTRICAL CONTRACTOR

- A. Contractor shall coordinate with the Electrical Contractor on furnishing and installing of controls, motors, starters, etc. Coordinate means informing Electrical Contractor of items requiring electrical connection, providing copies of submittal data, installation data, scheduling work to ensure efficient progress, and promptly supplying those items to be installed by Electrical Contractor.
- B. The specific requirements for electrical power and/or devices for each and every piece of mechanical equipment requiring electrical service, supplied and/or installed under this Contract, shall be coordinated and verified with the Mechanical drawings and specifications, and with the manufacturers of the equipment supplied. This shall include the voltage, phase, and ampacity; conduit requirements; and exact location and type of disconnect, control, and/or connection required. Any changes from the Drawings and Specifications required as a result of this coordination shall be part of this Contract.
- C. Electrical Contractor shall furnish and install the following for all mechanical equipment:
 - 1. Conduit and wiring for line voltage power to the equipment.
 - 2. Disconnect switches.
 - 3. Manual motor starters.
 - 4. Magnetic motor starters when part of a motor control center. See Division 26 and Drawings for further information.
- D. The work under this Section shall include furnishing and installing all controls on low and manual line voltage, including thermostats, auxiliary switches, relay wiring, interlock wiring; equipment control panels and transformers; and controls conduit unless specifically indicated as part of other work. Materials and methods of the control installation shall be in accordance with the Electrical Specifications.
- E. The Mechanical Contractor shall review all wiring connections which have any influence on this equipment or work and verify that these connections are correct before permitting any equipment to be operated which is furnished, installed, or modified under this Contract.

3.12 ELECTRICAL EQUIPMENT ROOM PRECAUTIONS

- A. Ductwork or piping for mechanical systems shall not be installed in any switchgear room, transformer vault, telephone room or electric closet except as indicated. In any case, no ductwork or piping for mechanical systems shall be installed in the space equal to the width and depth of any electrical service equipment, switchboards, panel boards, or motor control centers and extending from the floor to a height of six feet above the equipment or to the structural ceiling, whichever is lower.

3.13 CUTTING AND REPAIRING

- A. No cutting shall be done except with approval. Cutting of structural members or footings is prohibited without the prior written consent of the structural engineer.
- B. Where cutting of paving, walls, ceilings, etc. is necessary for the installation of the mechanical work, it shall be done under the direction of this Section. Damage caused by this cutting shall be repaired to match original and adjacent surfaces without additional expense to the Owner. Cutting of new construction shall be by the installing Contractor of that construction as directed by this Contractor.

3.14 ACCESSIBILITY

- A. General: Valves, damper operators, filters, thermometers, pressure gauges, clean-out fittings, and indicating equipment or specialties requiring reading, adjusting, inspection, repairing, removal, or replacement shall be conveniently and accessibly located with reference to finished building. Thermometers and gauges installed to be easily read from floor.

- B. Panels: No unions, flanges, valves, dampers, controls, or equipment shall be placed in a location that will be inaccessible after the system is complete. Access panels or doors shall be provided where required whether or not shown on Drawings.
- C. Access Panels in Walls or Ceilings:
 - 1. Provide access panels in walls or ceilings. Milcor or approved equal, where indicated and where required to provide access to valves, dampers, and other appurtenances. Panels shall be style as selected by and as directed by wall or ceiling construction. Panel size shall be 24" x 24" unless indicated otherwise. Panels in acoustical barriers shall have same transmission loss as barrier. Panels in rated construction shall have same rating as construction in which installed.
 - 2. Door panels shall be no lighter than 14 gauge steel. Doors shall be equipped with concealed spring hinges and flush, screwdriver operated locks, except that key operated locks shall be used for all access doors in walls where door is within 6'-0" of floor. Locks for all key operated doors shall be keyed alike.
 - 3. Doors in ceramic tile surfaces shall be stainless steel or chrome plated. Doors in other finished surfaces shall be prime coated.
 - 4. Doors in fire rated grease exhaust duct shafts shall be fire rated and openable without the use of tools.
- D. Equipment Spaces: Provide aisles between equipment and ducts, electrical gear, etc. for complete service and inspection of equipment. Maintain minimum 6'-6" headroom in all access aisles. Maintain minimum 36" clearance at all service panels. Provide minimum clearances at electrical equipment per NEC. Provide 36" wide, 3/4" thick plywood covered catwalks in attics from access door to equipment.

3.15 TESTING

- A. Test all piping, ductwork, equipment, and systems as called for in the Specifications. Notify and inspection authorities prior to testing so that they may be witnessed. Protect all personnel and equipment during testing. Where Specifications do not cover specific points or methods, conform to manufacturer's specifications.

3.16 OPENINGS

- A. Locating and sizing of all openings for pipe, conduit and ductwork through walls, roof, etc. shall be done under this Division. Framing of openings shall be done by the respective trades in whose work the opening is made.

3.17 EQUIPMENT

- A. Keep all openings closed with plugs or caps to prevent entrance of foreign matter. Protect all piping, ductwork, fixtures, and equipment against dirt, water, chemical, or mechanical damage both before and after installation. Any equipment or apparatus damaged prior to final acceptance shall be restored to original condition or replaced at the discretion and at no additional cost to the Owner.
- B. Start-Up: Equipment shall be adjusted, lubricated, aligned, etc. prior to start-up. Inspect each piece of equipment prior to start-up. Start each piece of equipment in accordance with manufacturer's directions and warranty requirements.
- C. Finish: Protect all equipment and materials until in use. Any visible rust or corrosion shall be removed as directed prior to installation. All damaged factory painted finishes shall be cleaned and painted with manufacturer provided paint.

3.18 MANUFACTURER'S DIRECTIONS

- A. Materials and equipment shall be installed in accordance with manufacturer's application and recommendations, requirements, and instructions, and in accordance with Contract Documents. Where manufacturer's instructions differ from those indicated or specified, they shall be brought to attention for resolution prior to equipment ordering and installation.
- B. Where requirements indicated in Contract Documents exceed manufacturer's requirements, Contract Documents shall govern.

3.19 FURRING AND PIPE SPACES

- A. Spaces provided in the design of the building shall be utilized and the work shall be kept within the furring lines established on the Drawings.
- B. Layout: Maintain maximum head room under piping and equipment. Contractor to coordinate line locations with beams, windows, etc. to provide maximum clearance. From Drawings, ascertain heights of suspended ceilings and size of pipe shafts in which piping is concealed, and location and size of structural members in and adjacent to pipe shafts. Coordinate piping installation with ductwork, lighting, and other equipment. Ensure necessary clearances on trim plates at exposed penetrations of walls and floors. If sufficient room is not available above suspended ceiling or vertical shafts obtain clarification from before work is started.

3.20 CLEAN-UP

- A. During the course of work under this Section, all rubbish, debris, surplus materials, tools, etc. resulting from this work shall be removed from work area and shall be disposed of off-site at the end of each working day. The Owner's premises shall be left clean and in a condition acceptable to the owner.
- B. Clean all work installed under this Contract to satisfaction of Owner and submit documentation that each system has been cleaned and results witnessed by the representative.
- C. All water distribution and piping systems, including those for cold water and hot water systems, shall be flushed thoroughly until piping is cleaned to satisfaction of the owner. See other Specification Sections for additional requirements.

3.21 ENGRAVED NAMEPLATES

- A. Furnish and install plastic laminated engraved nameplates with 1/4" minimum lettering at panel mounted control devices, manual control stations, power disconnects, motor starters and pieces of equipment. Nameplates exposed to weather shall be engraved brass.

3.22 FINAL INSPECTION

- A. The Contractor shall furnish the certificates of final inspection and approval from the inspection authorities having jurisdiction.

3.23 SITE VISITS BY ENGINEER

- A. Engineer's responsibility is limited to normal construction support services only, consisting of office consultation, site visits, and reports at appropriate stages of construction such as rough-in, pre-final, and final.
- B. If the Engineer is requested for a site visit and the work performed to that point is not able to be reviewed, requiring an additional site visit, all costs incurred by the Engineer for additional site visits or office shall be paid for by that Contractor.

END OF SECTION

**SECTION 23 0513
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 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. NEMA MG 00001 - Motors and Generators; 2024.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- D. Operation Data: Include instructions for safe operating procedures.
- E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.06 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.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service and General Requirements: See equipment schedules. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors shall be non-overloading.
- B. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 104 degrees F (40 degrees C) environment.
 - 3. Design for temperature rise in accordance with NEMA MG 00001 limits for insulation class, service factor, and motor enclosure type.
- C. 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.
- D. 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 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. Applications:
 1. Commercial:
 - a. Boiler Pump:
 - 1) Operating Mode: Variable speed.
 - 2) Input / Output: Motor manufacturer to coordinate control requirements with the control board of the boiler and specified sequence of operation.

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 0516
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flexible pipe connectors.
- B. Expansion joints and compensators.
- C. Pipe loops, offsets, and swing joints.

1.02 RELATED REQUIREMENTS

- A. Section 23 2113 - Hydronic Piping.
- B. Section 23 2300 - Refrigerant Piping.

1.03 REFERENCE STANDARDS

- A. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2015a (Reapproved 2019).
- B. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
- C. EJMA (STDS) - EJMA Standards; Tenth Edition.
- D. FM (AG) - FM Approval Guide; current edition.
- E. ITS (DIR) - Directory of Listed Products; Current Edition.
- F. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot (meter) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- C. Design Data: Indicate selection calculations.
- D. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
- E. Maintenance Data: Include adjustment instructions.
- F. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements for additional provisions.
 - 2. Extra Packing for Packed Expansion Joints: One set for each joint.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Comply with UL (DIR) requirements.

2.02 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

- A. Manufacturers:
 - 1. Flex-Weld, Inc: www.kelcoind.com/#sle.
 - 2. Mercer Rubber Company: www.mercer-rubber.com/#sle.
 - 3. The Metraflex Company: www.metraflex.com/#sle.

4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Inner Hose: Stainless Steel.
- C. Exterior Sleeve: Single braided, stainless steel.
- D. Pressure Rating: 125 psi up to 12 inch (862 kPa up to 300 mm, DN).
- E. End Connections: As specified for pipe joints.
- F. Size: Use pipe sized units.
- G. Maximum offset: 3/4 inch (20 mm) on each side of installed center line.

2.03 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

- A. Manufacturers:
 1. Mercer Rubber Company: www.mercer-rubber.com/#sle.
 2. The Metraflex Company: www.metraflex.com/#sle.
 3. Unisource Manufacturing, Inc; Series 411, Bronze Braided Flex Connectors: www.unisource-mfg.com/#sle.
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Inner Hose: Bronze.
- C. Exterior Sleeve: Braided bronze.
- D. Pressure Rating: 125 psi up to 2 inch (862 kPa up to 50 mm, DN).
- E. End Connections: As specified for pipe joints.
- F. Size: Use pipe sized units.
- G. Maximum offset: 3/4 inch (20 mm) on each side of installed center line.
- H. Application: Copper piping.

2.04 EXPANSION JOINTS AND LOOPS - HOSE AND BRAID

- A. Manufacturers:
 1. Flex-Weld, Inc; Keflex Ke-Loop: www.kelcoind.com/#sle.
 2. The Metraflex Company; Metraloop: www.metraflex.com/#sle.
 3. Unisource Manufacturing, Inc; V-Loop: www.unisource-mfg.com/#sle.
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Provide flexible loops with two flexible sections of hose and braid, two 90 degree elbows, and 180 degree return with support brackets and plugged drain port for steam service.
- C. Maximum Allowable Motion: 2 inch (50.8 mm) in the x, y, and z planes with no thrust loads to the building structure
- D. Maximum Working Pressure: 150 psi (1030 kPa) at 800 degrees F (426.7 degrees C).
- E. Construction: Class 150, schedule 40, stainless steel hose and braid assembly with carbon steel fittings, including elbows and flanged end connections sized to match pipe segment
 1. Selected Product to Accommodate:
 - a. Compression and Expansion Axial Deflection: _____ inch (_____ mm).
 - b. Angular Rotation: 15 degrees.
 - c. Force developed by 1.5 times specified maximum allowable operating pressure.
 2. Provide necessary accessories including, but not limited to, swivel joints.

2.05 ACCESSORIES

- A. Stainless Steel Pipe: ASTM A269/A269M, seamless type, Grade TP304.
- B. _____
- C. Note to Specifier: The stainless steel material option above is an accessory not relating to the material of the other products below.
- D. _____

- E. Pipe Alignment Guides:
 - 1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch (25 mm) thick insulation, minimum 3 inches (75 mm) travel.
- F. Engineered Riser Anchor Clamps:
 - 1. Applications:
 - a. Provide one clamp to serve as a riser clip.
 - 1) Verify the total load of filled pipe to be supported will be a safety factor of one less than the maximum loading of the clamp per the manufacturer's instructions.
 - b. Provide one clamp above and one clamp below the slab to anchor pipe.
 - 1) Coordinate with the structural engineer to determine the maximum thrust loading calculated for the slab or floor structure. Use the maximum thrust loading calculations to verify the clamps will be a safety factor of one less than the maximum loading of clamp per the manufacturer's instructions.
 - 2. Provide two piece, ductile iron in compliance with ASTM A536. Use with metal pipes with an outer diameter of 2.5 inches (64 mm) to 8 inches (203 mm).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
- C. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- D. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

END OF SECTION

**SECTION 23 0517
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe sleeves.
- B. Pipe-sleeve seals.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 09 9113 - Exterior Painting: Preparation and painting of exterior piping systems.
- C. Section 09 9123 - Interior Painting: Preparation and painting of interior piping systems.
- D. Section 23 0523 - General-Duty Valves for HVAC Piping.
- E. Section 23 0553 - Identification for HVAC Piping and Equipment: Piping identification.
- F. Section 23 0716 - HVAC Equipment Insulation.
- G. Section 23 0719 - HVAC 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); 2022a.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).
- C. FM (AG) - FM Approval Guide; current edition.
- D. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

- A. See Section 01 3000 - 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.

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.
 - 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.

1.06 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 7800 - 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 PIPE SLEEVES

- A. Vertical Piping:
 - 1. Sleeve Length: 1 inch (25 mm) above finished floor.
 - 2. Provide sealant for watertight joint.
- B. Plastic or Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- C. 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.
- D. Pipe Passing Through Concrete Beam Flanges, except where Brass Pipe Sleeves are Specified:
 - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 - 2. Connect sleeve with floor plate except in mechanical rooms.
- E. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
 - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 - 2. Connect sleeve with floor plate except in mechanical rooms.
- F. Penetrations in concrete beam flanges are permitted but are prohibited through ribs or beams without prior approval from the Architect.
- G. Clearances:
 - 1. Provide allowance for insulated piping.
 - 2. Wall, Floor, Partitions, and Beam Flanges: 1 inch (25 mm) greater than external pipe diameter.
 - 3. All Rated Openings: Caulked tight with fire stopping material in compliance with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.02 PIPE-SLEEVE SEALS

- A. 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.
- B. 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.
- C. Pipe Sleeve Material:
 - 1. Bearing Walls: Steel, cast iron, or terra-cotta pipe.
 - 2. Masonry Structures: Sheet metal or fiber.
- D. Wall Sleeve: PVC material with waterstop collar, and nailer end-caps.

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. Structural Considerations:
 - 1. Do not penetrate building structural members unless indicated.
- E. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- F. 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.
- G. 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 0519
METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flow meters.
- B. Pressure gauges and pressure gauge taps.
- C. Thermometers and thermometer wells.
- D. Static pressure gauges.
- E. Filter gauges.

1.02 RELATED REQUIREMENTS

- A. Section 23 0923 - Direct-Digital Control System for HVAC.
- B. Section 23 2113 - Hydronic Piping.
- C. Section 23 2213 - Steam and Condensate Heating Piping.

1.03 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
- B. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi; 2004 (Reaffirmed 2017).
- C. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2020).
- D. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).
- E. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case; 2020.
- F. AWWA C701 - Cold-Water Meters -- Turbine Type, for Customer Service; 2019.
- G. AWWA C702 - Cold-Water Meters -- Compound Type; 2019.
- H. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance; 2012, with Addendum (2018).
- I. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.
- J. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - 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 Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Gauge Oil for Inclined Manometers: One bottle.
 - 3. Extra Pressure Gauges: One of each type and size.

1.05 FIELD CONDITIONS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 LIQUID FLOW METERS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. McCrometer: www.mccrometer.com/#sle.
 - 3. Venture Measurement, a Danaher Company: www.venturemeasurement.com/#sle.
 - 4. Veris Industries: www.veris.com/#sle.
 - 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Calibrated ASME MFC-3M Venturi orifice plate and flanges with valved taps, chart for conversion of differential pressure readings to flow rate, with pressure gauge in case.
- C. Annular element flow stations with meter set.
 - 1. Measuring Station: Type 316 stainless steel pitot type flow element installed in threaded nipple pipe section, with safety shut-off valves and quick coupling connections, and permanent metal tag indicating design flow rate, reading for design flow rate, metered fluid, line size, station or location number.

2.02 PRESSURE GAUGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Moeller Instrument Company, Inc: www.moellerinstrument.com/#sle.
 - 3. Omega Engineering, Inc: www.omega.com/#sle.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- 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 (115 mm) diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Psi.

2.03 PRESSURE GAUGE TAPPINGS

- A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi (1034 kPa).

2.04 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Omega Engineering, Inc: www.omega.com/#sle.
 - 3. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. 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.
 - 1. Size: 9 inch (225 mm) scale.
 - 2. Window: Clear Lexan.
 - 3. Accuracy: 2 percent, per ASTM E77.
 - 4. Calibration: Degrees F.

2.05 TEST PLUGS

- A. Test Plug: 1/4 inch (6 mm) or 1/2 inch (13 mm) brass fitting and cap for receiving 1/8 inch (3 mm) outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F (93 degrees C).

2.06 STATIC PRESSURE GAUGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Omega Engineering, Inc: www.omega.com/#sle.
 - 3. Veris Industries: www.veris.com/#sle.
 - 4. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
- B. 3-1/2 inch (90 mm) diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
- C. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch (60 mm) for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- D. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Refer to Section 23 0943. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
- E. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- F. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- G. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- H. Locate test plugs adjacent thermometers and thermometer sockets.

END OF SECTION

**SECTION 23 0523
GENERAL-DUTY VALVES FOR HVAC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Globe valves.
- B. Ball valves.
- C. Butterfly valves.
- D. Check valves.
- E. Gate valves.
- F. Plug valves.
- G. Chainwheels.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 08 3100 - Access Doors and Panels.
- C. Section 23 0548 - Vibration and Seismic Controls for HVAC.
- D. Section 23 0553 - Identification for HVAC Piping and Equipment.
- E. Section 23 0716 - HVAC Equipment Insulation.
- F. Section 23 0719 - HVAC Piping Insulation.
- G. Section 23 2113 - Hydronic 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: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. PTFE: Polytetrafluoroethylene.
- G. RS: Rising stem.
- H. TFE: Tetrafluoroethylene.
- I. WOG: Water, oil, and gas.
- J. WSP: Working steam pressure.

1.04 REFERENCE STANDARDS

- A. API STD 594 - Check Valves: Flanged, Lug, Wafer, and Butt-Welding; 2022.
- B. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- D. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- E. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves; 2022.
- F. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- G. ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2020.
- H. ASME B31.1 - Power Piping; 2020.
- I. ASME B31.9 - Building Services Piping; 2020.

- J. 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; 2021.
- K. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- L. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2019).
- M. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service; 2021.
- N. ASTM A351/A351M - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts; 2018, with Editorial Revision (2019).
- O. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).
- P. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
- Q. ASTM A582/A582M - Standard Specification for Free-Machining Stainless Steel Bars; 2022.
- R. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings; 2015 (Reapproved 2021).
- S. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.
- T. AWWA C606 - Grooved and Shouldered Joints; 2015.
- U. MSS SP-45 - Drain and Bypass Connections; 2020.
- V. MSS SP-67 - Butterfly Valves; 2022.
- W. MSS SP-68 - High Pressure Butterfly Valves with Offset Design; 2021.
- X. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends; 2011.
- Y. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.
- Z. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010a.
- AA. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends; 2011.
- BB. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
- CC. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends; 2011.
- DD. MSS SP-108 - Resilient-Seated Cast Iron Eccentric Plug Valves; 2020.
- EE. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .
- FF. MSS SP-125 - Check Valves: Gray Iron and Ductile Iron, In-Line, Spring-Loaded, Center-Guided; 2018.

1.05 SUBMITTALS

- A. See Section 01 3000 - 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 Owner'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.
- E. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.
 - 1. See Section 01 6000 - Product Requirements for additional provisions.

1.06 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Obtain valves for each valve type from single manufacturer.

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. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
 - 5. Secure check valves in either the closed position or open position.
 - 6. Adjust butterfly valves to closed or partially closed 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. Throttling (Hydronic): Butterfly, Ball, and Globe.
 - 2. Throttling (Steam): Butterfly and Gate.
 - 3. Isolation (Shutoff): Butterfly, Gate, and Ball.
 - 4. Swing Check (Pump Outlet):
 - a. Size 2 inch (50 mm, DN) and Smaller: Bronze with bronze disc.
 - b. Size 2-1/2 inch (65 mm, DN) and Larger: Iron with lever and weight, lever and spring, center-guided metal, or center-guided with resilient seat.
- 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. Required Valve End Connections for Non-Wafer Types:
 - 1. Steel Pipe:
 - a. Size 2 inch (50 mm, DN) and Smaller: Threaded ends.
 - b. Size 2-1/2 inch (65 mm, DN) and Larger: Grooved ends.
 - 2. Copper Tube:
 - a. Size 2 inch (50 mm, DN) and Smaller: Threaded ends, except solder-joint valve-ends.
 - b. Size 2-1/2 inch (65 mm, DN) and Larger: Grooved ends.
 - 3. Steam and Steam Condensate Pipe: Grooved ends not acceptable.
- F. Chilled Water Valves:
 - 1. Size 2 inch (50 mm, DN) and Smaller, Brass and Bronze Valves:
 - a. Threaded ends.
 - b. Ball: Full port, one piece, brass trim.
 - c. Swing Check: Bronze disc, Class.
 - d. Gate: NRS, Class 125.
 - e. Globe: Bronze disc, Class 125.

2. Size 2-1/2 inch (65 mm, DN) and Larger, Iron Valves:
 - a. 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN): Threaded ends.
 - b. Ball: 2-1/2 NPS (65 DN) to 10 inch (250 mm, DN), Class 150.
 - c. Single-Flange Butterfly: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), aluminum-bronze disc, EPDM seat, 200 CWP.
 - d. Grooved-End Butterfly: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), 175 CWP.
 - e. Butterfly: High performance, single flange, Class 150.
 - f. Swing Check: Metal seats, Class 125.
 - g. Swing Check with Closure Control: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), lever and spring, Class 125.
 - h. Grooved-End Check: 3 inch (80 mm, DN) to 12 inch (300 mm, DN), 300 CWP.
 - i. Center-Guided Check: Compact-wafer, metal seat, Class 125.
 - j. Gate: OS&Y, Class 125.
 - k. Globe: Class 125.
 - l. Lubricated Plug: Regular gland, threaded, Class 125.
- G. Condenser Water Valves:
1. Size 2 inch (50 mm, DN) and Smaller, Brass and Bronze Valves:
 - a. Threaded ends.
 - b. Ball: Full port, one piece, brass trim.
 - c. Swing Check: Bronze disc, Class 125.
 - d. Gate: NRS, Class 125.
 - e. Globe: Bronze disc, Class 125.
 2. Size 2-1/2 inch (65 mm, DN) and Larger, Iron Valves:
 - a. 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN): Threaded ends.
 - b. Ball: 2-1/2 inch (65 mm, DN) to 10 inch (250 mm, DN), Class 150.
 - c. Single-Flange Butterfly: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), aluminum-bronze disc, EPDM seat, 200 CWP.
 - d. Grooved-End Butterfly: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), 175 CWP.
 - e. Butterfly: High performance, single flange, Class 150.
 - f. Swing Check: Metal seats, Class 125.
 - g. Swing Check with Closure Control, 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DIN): Lever and spring, Class 125.
 - h. Grooved-End Swing Check: 3 inch (80 mm, DN) to 12 inch (300 mm, DN), 300 CWP.
- H. Heating Hot Water Valves:
1. Size 2 inch (50 mm, DN) and Smaller, Brass and Bronze Valves:
 - a. Threaded ends.
 - b. Ball: Full port, one piece, brass trim.
 - c. Swing Check: Bronze disc, Class 125.
 - d. Gate: NRS, Class 125.
 - e. Globe: Bronze disc, Class 125.
 2. Size 2-1/2 inch (65 mm, DN) and Larger, Iron Valves:
 - a. 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN): Threaded ends.
 - b. Ball: 2-1/2 inch (65 mm, DN) to 10 inch (250 mm, DN), Class 150.
 - c. Single-Flange Butterfly: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), aluminum-bronze disc, EPDM seat, 200 CWP.
 - d. Single-Flange Butterfly: 14 inch (350 mm, DN) to 24 inch (600 mm, DN), aluminum-bronze disc, EPDM seat, 150 CWP.
 - e. Grooved-End Butterfly: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), 175 CWP.
 - f. Butterfly: High performance, single flange, Class 150.
 - g. Swing Check: Metal seats, Class 125.
 - h. Swing Check: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), lever and spring closure control, Class 125.

- I. Low Pressure Steam Valves for Pressures of 15 psi (104 kPa) or Less:
 - 1. Size 2 inch (50 mm, DN) and Smaller, Brass and Bronze Valves:
 - a. Swing Check: Bronze disc, Class 125.
 - b. Gate: NRS, Class 125.
 - c. Globe: Bronze disc, Class 125.
 - 2. Size 2-1/2 inch (65 mm, DN) and Larger, Iron Valves:
 - a. Swing Check: Metal seats, Class 125.
 - b. Gate: NRS, Class 125.
 - c. Globe: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN): Class 125.
- J. High Pressure Steam Valves for Pressures Greater than 15 psi (104 kPa):
 - 1. Size 2 inch (50 mm, DN) and Smaller, Brass and Bronze Valves:
 - a. Gate: NRS, Class 125.
 - b. Globe: Bronze disc, Class 125.
 - 2. Size 2-1/2 inch (65 mm, DN) and Larger, Iron Valves:
 - a. Swing Check: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), lever and spring closure control, Class 125.
 - b. Gate: NRS, Class 125.
 - c. Globe: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), Class 125.
- K. Steam-Condensate Valves:
 - 1. Size 2 inch (50 mm, DN) and Smaller, Brass and Bronze Valves:
 - a. Gate: NRS and RS, Class 125.
 - b. Globe: Bronze disc, Class 125.
 - 2. Size 2-1/2 inch (65 mm, DN) and Larger, Iron Valves:
 - a. 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN) with threaded or flanged ends.
 - b. Swing Check: Lever and spring closure control, Class 125.
 - c. Globe: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), Class 125.

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. Gear Actuator: Quarter-turn valves 8 inch (200 mm, DN) and larger.
 - 2. Handwheel: Valves other than quarter-turn types.
 - 3. Hand Lever: Quarter-turn valves 6 inch (150 mm, DN) and smaller.
 - 4. Wrench: Plug valves with square heads.
 - 5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- D. Valves in Insulated Piping: Provide 2 inch (50 mm, DN) stem extensions and the following features:
 - 1. Gate Valves: Rising stem.
 - 2. 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.
 - 3. Butterfly Valves: Extended neck.
 - 4. Memory Stops: Fully adjustable after insulation is installed.
- E. Memory Stops: Fully adjustable after insulation is installed.
- F. Valve-End Connections:
 - 1. Threaded End Valves: ASME B1.20.1.
 - 2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.

3. Pipe Flanges and Flanged Fittings 1/2 inch (15 mm, DN) through 24 inch (600 mm, DN): ASME B16.5.
 4. Solder Joint Connections: ASME B16.18.
 5. Grooved End Connections: AWWA C606.
- G. General ASME Compliance:
1. Building Services Piping Valves: ASME B31.9.
- H. Bronze Valves:
1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.
- I. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRONZE, GLOBE VALVES

- A. CWP Rating: Class 125: 200 psi (1,380 kPa):
1. Comply with MSS SP-80, Type 1.
 2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
 3. Ends: Threaded or solder joint.
 4. Stem and Disc: Bronze or PTFE.
 5. Packing: Asbestos free.
 6. Handwheel: Malleable iron.

2.04 BRONZE, GLOBE VALVES

- A. Ratings for Class 125 and Class 250:
1. Class 125:
 - a. WOG Rating: 200 psi (1,380 kPa).
 - b. WSP Rating: 125 psi (861.8 kPa), saturated.
 2. Class 250: WOG Rating; 300 psi (2,070 kPa).
 3. Comply with MSS SP-80, Type 1.
 4. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
 5. End Connections: Threaded or solder.
 6. Bonnet: NRS; Nonrising Stem.
 7. Nonrising Stem: Bronze.
 8. Disc: PTFE.
 9. Packing: Asbestos free.
 10. Handwheel Operator: Malleable Iron.

2.05 IRON, GLOBE VALVES

- A. CWP Ratings: Class 125: 200 psi (1,380 kPa) and Class 250: 500 psi (3,450 kPa):
1. Comply with MSS SP-85, Type I.
 2. Body: Gray iron; ASTM A126, with bolted bonnet.
 3. Ends: Flanged.
 4. Trim: Bronze.
 5. Packing and Gasket: Asbestos free.
 6. Operator: Handwheel or chainwheel.

2.06 BRASS, BALL VALVES

- A. One Piece, Full Port with Brass Trim and Threaded or Soldered Connections:
1. Comply with MSS SP-110.
 2. CWP Rating: 200 psi (1,379 kPa).
 3. Body: Forged brass.
 4. Ends: Threaded.
 5. Seats: PTFE or TFE.
 6. Stem: Brass.
 7. Ball: Chrome-plated brass.

8. Operator: Handle.

2.07 BRONZE, BALL VALVES

- A. General:
 1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Two Piece, Full Port with Bronze or Brass Trim:
 1. Comply with MSS SP-110.
 2. WSP Rating: 150 psi (1,035 kPa).
 3. WOG Rating: 400 psi (2,758 kPa).
 4. Body: Forged bronze or dezincified-brass alloy.
 5. End Connections: Pipe thread or solder.
 6. Seats: PTFE.
 7. Stem: Bronze or brass.
 8. Ball: Chrome plated brass.
 9. Operator: Provide lockable handle and stem extension.

2.08 IRON, BALL VALVES

- A. Split Body, Full Port:
 1. Comply with MSS SP-72.
 2. CWP Rating: 200 psi (1380 kPa).
 3. Body: ASTM A126, gray iron.
 4. Ends: Flanged.
 5. Seats: PTFE.
 6. Stem: Stainless steel.
 7. Ball: Stainless steel.

2.09 IRON, SINGLE FLANGE BUTTERFLY VALVES

- A. Wafer Style:
 1. Comply with MSS SP-67, Type I.
 2. Wafer Style, CWP Ratings:
 - a. Sizes 2 to 12 inch (50 to 300 mm, DN): 200 psi (1380 kPa).
 - b. Sizes 14 to 24 inch (350 to 600 mm, DN): 150 psi (1034 kPa).
 - c. Vacuum Service: Down to 29.9 in-Hg (101.2 kPa).
 3. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
 4. Stem: One or two-piece stainless steel.
 5. Seat: NBR.
 6. Disc: Aluminum-bronze.

2.10 IRON, GROOVED-END BUTTERFLY VALVES

- A. CWP Rating: 175 psi (1200 kPa).
 1. Comply with MSS SP-67, Type I.
 2. Body: Coated ductile iron.
 3. Stem: Two-piece stainless steel.
 4. Disc: Coated ductile iron.
 5. Disc Seal: EPDM.

2.11 HIGH-PERFORMANCE, SINGLE FLANGE BUTTERFLY VALVES

- A. Lug type; Bidirectional dead end service without downstream flange:
 1. Comply with MSS SP-68.
 2. Class 150: CWP Rating: 285 psi (1,965 kPa) at 100 degrees F (38 degrees C).
 3. Body: Provide carbon steel, cast iron, ductile Iron, or stainless steel.
 4. Seat: Metal or reinforced PTFE.
 5. Offset stem: Stainless steel.

6. Disc: Carbon steel.

2.12 BRASS, INLINE CHECK VALVES

- A. Class 150: CWP Rating: 200 psi (1,380 kPa) .
- B. Maximum Service Temperature: 250 degrees F (121.1 degrees C).
- C. Body: Forged brass.
- D. Disc: Forged brass.
- E. Seal: PTFE, bubble tight.
- F. End-Connections: Press.

2.13 BRASS, HORIZONTAL SWING CHECK VALVES

2.14 BRONZE, LIFT CHECK VALVES

- A. 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 (1,380 kPa).
 3. Design: Vertical flow.
 4. Body: Bronze.
 5. Ends: Threaded.
 6. Disc (Type 1): Bronze.
 7. Disc (Type 2): NBR or PTFE.

2.15 BRONZE, SWING CHECK VALVES

- A. Class 125:
 1. Pressure and Temperature Rating: MSS SP-80, Type 3.
 2. Design: Y-pattern, horizontal or vertical flow.
 3. WSP Rating: 200 psi (1,380 kPa).
 4. Body: Bronze, ASTM B62.
 5. End Connections: Threaded or soldered.
 6. Disc: Bronze.
- B. Class 150:
 1. Pressure and Temperature Rating: MSS SP-80, Type 3.
 2. Design: Y-pattern, horizontal or vertical flow.
 3. CWP Rating: 300 psi (2,068 kPa).
 4. Body: Bronze, ASTM B62.
 5. End Connections: Threaded or soldered.
 6. Disc: Bronze.

2.16 IRON, FLANGED END SWING CHECK VALVES

- A. Class 125:
 1. 150 psi (1,035 kPa) with metal seats.
 2. 200 psi (1,380 kPa) with metal seats and nonmetallic-to-metal seats.
- B. Class 250:
 1. 300 psi (2,070 kPa) with metal seats.
 2. 500 psi (3,450 kPa) with metal seats.

2.17 IRON, SWING CHECK VALVES WITH CLOSURE CONTROL

- A. Class 125:
 1. Comply with MSS SP-71, Type I.
 2. Sizes 2-1/2 to 12 inch (65 to 300 mm, DN): CWP Rating; 200 psi (1,380 kPa).
 3. Sizes 14 to 24 inch (350 to 600 mm, DN): CWP Rating; 150 psi (1,035 kPa).
 4. Body Design: Clear or full waterway.

5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged.
7. Trim: Bronze.
8. Gasket: Asbestos free.
9. Closer Control: Factory installed, exterior lever, and spring or weight.

2.18 IRON, GROOVED-END SWING CHECK VALVES

- A. Class 300:
 1. CWP Rating: 300 psi (2,070 kPa).
 2. Body Material: ASTM A536, Grade 65-45-12 ductile iron.
 3. Seal: EPDM or Nitrile.
 4. Disc: Ductile iron.
 5. Coating: Black, non-lead paint.

2.19 IRON, CENTER-GUIDED CHECK VALVES

- A. Class 125, Compact-Wafer:
 1. Comply with MSS SP-125.
 2. Body Material: ASTM A126, gray iron.

2.20 BRONZE, GATE VALVES

- A. Rising Stem or OS&Y:
 1. Pressure-Temperature Range: MSS SP-80, Type I.
 2. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
 3. End Connections: Threaded or solder.
 4. Stem: Bronze.
 5. Disc: Solid wedge; bronze.
 6. Packing: Asbestos free.
 7. Handwheel Operator: Malleable iron, bronze, or aluminum.

2.21 IRON, GATE VALVES

- A. NRS or OS&Y:
 1. Comply with MSS SP-70, Type I.
 2. Body Material: Gray iron with bolted bonnet.
 3. Ends: Flanged.
 4. Trim: Bronze.
 5. Disc: Solid wedge.
 6. Packing and Gasket: Asbestos free.

2.22 LUBRICATED PLUG VALVES

- A. Regular Gland and Cylindrical with Threaded Ends:
 1. Comply with MSS SP-78, Type II.
 2. Body Material: Cast iron with lubrication sealing system.
 3. Pattern: Regular or short.
 4. Plug: Cast iron or bronze with sealant groove.

2.23 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 2. Attachment: For connection to ball and butterfly valve stems.
 3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
 4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

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. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- D. 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.
- E. Provide chainwheels on operators for valves 4 NPS (100 DN) and larger where located 96 NPS (2400 DN) or more above finished floor, terminating 60 NPS (1520 DN) above finished floor.

END OF SECTION

**SECTION 23 0529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment components.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 05 5000 - Metal Fabrications: Materials and requirements for fabricated metal supports.
- C. Section 23 0548 - Vibration and Seismic Controls for HVAC.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping; 2022.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2018.
- G. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).
- H. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2019.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
- J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2021.
- K. FM (AG) - FM Approval Guide; current edition.
- L. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- M. UL (DIR) - Online Certifications Directory; Current Edition.
- N. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 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 Architect 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 3000.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. 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.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

1.06 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.
- C. Installer Qualifications for Field-Welding: As specified in Section 05 5000.
- 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 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 with a minimum safety factor of _____. 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 or stainless steel 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. Prefabricated Trapeze-Framed Metal Strut Systems:
 1. Strut Channel or Bracket 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.
 2. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch (2.66 mm).
 3. Minimum Channel Dimensions: 1-5/8 inch (41 mm) width by 1-5/8 inch (41 mm) height.
 4. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

- C. Channel Nuts:
 - 1. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring.
- D. Hanger Rods:
 - 1. Threaded zinc-plated steel unless otherwise indicated.
- E. 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 (15 to 750 mm, DN) iron pipes.
 - d. Insulation inserts to consist of rigid polyisocyanurate (urethane) 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 (0.0092 ng/Pa s m), when tested in accordance with ASTM E96/E96M.
 - c. Thickness: 60 mil (1.524 mm).
- F. 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. Liquid Temperatures Up To 122 degrees F (50 degrees C):
 - a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
 - b. Support From Below: MSS SP-58 Types 35 through 38.
- G. 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.
- H. 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.
- I. 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 (15 to 200 mm, DN).
- J. U-Bolts:
1. MSS SP-58 Type 24, carbon steel u-bolt for pipe support or anchoring.
- K. Strut Clamps:
1. Pipe Clamp: Two-piece rigid, universal, or outer diameter type, carbon steel with epoxy copper or zinc finish.
- L. Insulation Clamps:
1. Two bolt-type clamps designed for installation under insulation.
 2. Material: Carbon steel with epoxy copper or zinc finish.
- M. 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. Clevis Hangers, Adjustable:
 - a. Copper Tube: MSS SP-58 Type 1, epoxy-plated copper.
 - b. Standard-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.
- N. Intermediate Pipe Guides:
1. Pipe Diameter 6 inch (150 mm, DN) and Smaller: Provide minimum clearance of 0.16 inch (4 mm).
 2. Pipe Sizes 8 inch (200 mm, DN): 0.625 inch (16 mm) U-bolt with double nuts providing minimum clearance of 0.28 inch (7 mm).
 3. Pipe Size 10 inch (250 mm, DN): 0.75 inch (19 mm) U-bolt.
 4. Pipe Sizes 12 to 16 inch (300 to 400 mm, DN): 0.875 inch (24 mm) U-bolt.
 5. Pipe Sizes 18 to 30 inch (450 to 750 mm, DN): 1 inch (25 mm) U-bolt.
 6. Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.
- O. Pipe Alignment Guides: Galvanized steel.
1. Pipe Sizes 8 inch (200 mm, DN) and Smaller: Spider or sleeve type.
 2. Pipe Sizes 10 inch (250 mm, DN) and Larger: Roller type.
- P. 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 (321 mm).
 - d. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
 - e. Maximum Service Temperature: 178 degrees F (81 degrees C).
 - f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
- Q. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

PART 3 EXECUTION

3.01 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 Architect, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Architect, 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. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 4000 - 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 23 0548
VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Vibration isolation requirements.
- B. Seismic control requirements.
 - 1. Includes requirements for seismic qualification of equipment not specified in this section.
- C. Vibration-isolated equipment support bases.
- D. Vibration isolators.
- E. External seismic snubber assemblies.
- F. Seismic restraint systems.
- G. Vibration-isolated and/or seismically engineered roof curbs.

1.02 RELATED REQUIREMENTS

- A. Section 01 4533 - Code-Required Special Inspections and Procedures.
- B. Section 03 3000 - Cast-in-Place Concrete.
- C. Section 05 5000 - Metal Fabrications: Materials and requirements for fabricated metal supports.
- D. Section 23 0529 - Hangers and Supports for HVAC Piping and Equipment.

1.03 DEFINITIONS

- A. HVAC Component: Where referenced in this section in regards to seismic controls, applies to any portion of the HVAC system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., ductwork, piping).
- B. Seismic Restraint: Structural members or assemblies of members or manufactured elements specifically designed and applied for transmitting seismic forces between components and the seismic force-resisting system of the structure.

1.04 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASCE 19 - Structural Applications of Steel Cables for Buildings; 2016.
- C. ASHRAE (HVAC) - ASHRAE Handbook - HVAC Applications; Most Recent Edition Cited by Referring Code or Reference Standard.
- D. FEMA 412 - Installing Seismic Restraints for Mechanical Equipment; 2014.
- E. FEMA 413 - Installing Seismic Restraints for Electrical Equipment; 2004.
- F. FEMA 414 - Installing Seismic Restraints for Duct and Pipe; 2004.
- G. FEMA E-74 - Reducing the Risks of Nonstructural Earthquake Damage; 2012.
- H. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. ICC-ES AC156 - Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components; 2010, with Editorial Revision (2015).
- J. MFMA-4 - Metal Framing Standards Publication; 2004.
- K. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2008.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment 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. Seismic Controls:
 - a. Coordinate the arrangement of seismic restraints with piping, conduit, equipment, and other potential conflicts installed under other sections or by others.
 - b. Coordinate the work with other trades to accommodate relative positioning of essential and nonessential components in consideration of seismic interaction.
 5. Notify Engineer 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 3000.

1.06 SUBMITTALS

- A. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.
 2. Seismic Controls: Include seismic load capacities.
- C. Shop Drawings - Vibration Isolation Systems:
1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators; indicate equipment weights and static deflections.
 2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable; indicate equipment mounting provisions.
- D. Shop Drawings - Seismic Controls:
1. Seismic controls and calculations shall be designed and stamped by a Professional Engineer licensed in the State of the Project Location.
 2. Include dimensioned plan views and sections indicating proposed HVAC component locations and distributed system routing, with locations and details of gravity supports and seismic restraints and associated attachments.
 3. Identify mounting conditions required for equipment seismic qualification.
 4. Identify anchor manufacturer, type, minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
 5. Indicate proposed arrangement of distributed system trapeze support groupings.
 6. Indicate proposed locations for distributed system flexible fittings and/or connections.
 7. Indicate locations of seismic separations where applicable.
 8. Include point load drawings indicating design loads transmitted to structure at each attachment location.
- E. Seismic Design Data:
1. Compile information on project-specific characteristics from the Project Structural Engineer of actual installed HVAC components necessary for determining seismic design forces required to design appropriate seismic controls, including but not limited to the following.
 - a. Component operating weight and center of gravity.
 - b. Component elevation in the building in relation to the roof elevation (z/h).
 - c. Component importance factor (Ip).

- d. For distributed systems, component materials and connection methods.
 - e. Component amplification factor (ap) and component response modification factor (Rp), determined in accordance with ASCE 7 tables.
 - f. Applicability of overstrength factor (for certain anchorage in concrete and masonry).
- 2. Include structural calculations, stamped or sealed by seismic controls designer, licensed in the State of the Project Location demonstrating suitability of seismic controls for seismic design forces.
- F. Certification for seismically qualified equipment; identify basis for certification.
- G. Evaluation Reports: For products specified as requiring evaluation and recognition by a qualified evaluation service, provide current evaluation reports.
- H. 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.
- I. Evidence of qualifications for seismic controls designer.
- J. Evidence of qualifications for manufacturer.
- K. Manufacturer's detailed field testing and inspection procedures.
- L. Field quality control test reports.

1.07 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Seismic Controls Designer Qualifications: Registered professional engineer licensed in the State in which the Project is located and with minimum five years experience designing seismic restraints for nonstructural components.
 - 1. Designer may be employed by the manufacturer of the seismic restraint products.
- D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION REQUIREMENTS

- A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing HVAC equipment and/or HVAC connections to vibration-isolated equipment.
- B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:
- C. General Requirements:
 - 1. Select vibration isolators to provide required static deflection.
 - 2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
 - 3. Select seismic type vibration isolators to comply with seismic design requirements, including conditions of equipment seismic certification where applicable.
 - 4. Select vibration isolators for outdoor equipment to comply with wind design requirements.
 - 5. Select vibration-isolated equipment support bases and associated vibration isolators to provide minimum 2-inch (50 mm) operating clearance beneath base unless otherwise indicated.
- D. Equipment Isolation: As indicated on drawings.

- E. Equipment Isolation:
1. Equipment:
 - a. Location: Outdoor.
 - b. Approximate Weight: _____ pounds (_____ kg).
 - c. Mounting: Isolated steel base, concrete inertia base, roof curb or roof rails.
 - d. Isolator Type (Nonseismic Application): Restrained spring isolators.
 - e. Isolator Type (Seismic Application): Seismic type restrained spring isolators.
- F. Piping Isolation:
1. Provide vibration isolators for piping supports:
 - a. Located in equipment rooms.
 - b. Located within 50 feet (15.2 m) of connected vibration-isolated equipment and pressure-regulating valve (PRV) stations and/or quick closing valves.
 - c. For piping over 2 inch (50 mm) located below or within 50 feet (15.2 m) of noise-sensitive areas indicated.
 2. Minimum Static Deflection:
 - a. First Three Supports Closest to Isolated Equipment: Same as static deflection of equipment; maximum of 2 inch (50 mm) deflection required.
 - b. Remainder of Supports: 0.75 inch (19 mm) deflection unless otherwise indicated.
 3. Suspended Piping, Nonseismic Applications: Use combination resilient material/spring isolator hangers.
 4. Suspended Piping, Seismic Applications: Use seismic type spring isolator hangers.
 5. Floor-Mounted Piping, Nonseismic Applications: Use open (unhoused) spring isolators.
 6. Floor-Mounted Piping, Seismic Applications: Use seismic type restrained spring isolators.
 7. Use modular seal or approved resilient material where vibration-isolated piping penetrates building elements (e.g., walls, floors) arranged to prevent vibration transmission to structure.
- G. Thrust Restraint Applications:
1. Use thrust restraints to resist horizontal motion due to thrust for fan heads, suspended fans, and base-mounted and suspended air handling equipment operating at 2.0 inches wg (0.5 kPa) or greater total static pressure.
 2. Minimum Static Deflection: Same as static deflection of equipment.
 3. Limit lateral movement to 0.25 inch (6 mm) or less unless otherwise indicated.

2.02 SEISMIC CONTROL REQUIREMENTS

- A. Design and provide HVAC component restraints, supports, and attachments suitable for seismic loads determined in accordance with applicable codes, as well as gravity and operating loads and other structural design considerations of the installed location. Consider wind loads for outdoor HVAC components.
- B. Seismic Design Criteria: As indicated on drawings.
- C. Component Importance Factor (I_p): HVAC components to be assigned a component importance factor (I_p) of in accordance with Building Code requirements. Refer to project structural drawings.
- D. Component Importance Factor (I_p): HVAC components essential to life safety to be assigned a component importance factor (I_p) of 1.5 as required. This includes but is not limited to:
1. HVAC components required to function for life safety purposes after an earthquake.
 2. HVAC components that support or otherwise contain hazardous substances.
- E. Seismic Qualification of Equipment:
1. Provide special certification for HVAC equipment furnished under other sections and assigned a component importance factor (I_p) of 1.5, certifying that equipment will remain operable following a design level earthquake.
 2. Seismic qualification to be by shake table testing in accordance with recognized testing standard procedure, such as ICC-ES AC156, acceptable to authorities having jurisdiction.

3. Notify Architect and obtain direction where mounting restrictions required by conditions of seismic certification conflict with specified requirements.
 4. Seismically qualified equipment to be furnished with factory-installed labels referencing certificate of compliance and associated mounting restrictions.
- F. Premanufactured Modular HVAC Equipment: Where not otherwise seismically qualified, premanufactured modules 6 feet (1.8 m) high and taller furnished under other sections to be designed in accordance with seismic provisions for nonbuilding structures.
- G. Seismic Restraints:
1. Provide seismic restraints for HVAC components except where exempt according to applicable codes and specified seismic design criteria, as approved by authorities having jurisdiction.
 2. Seismic restraint capacities to be verified by a Nationally Recognized Testing Laboratory (NRTL) or certified by an independent third-party registered professional engineer acceptable to authorities having jurisdiction.
 3. Seismic Type Vibration Isolators:
 - a. Comply with seismic design requirements, including conditions of equipment seismic certification where applicable.
 4. External Seismic Snubber Assemblies:
 - a. Provide quantity and arrangement of external seismic snubber assemblies as required to restrain equipment in all directions (both lateral and vertical).
 - b. Do not use external seismic snubber assemblies that restrain equipment only in one or more lateral directions (but not vertical) except where uplift forces are zero or are addressed by other restraints.
 5. Seismic Restraint Systems:
 - a. Except where otherwise restricted, use of either cable or rigid restraints is permitted.
 - b. Use only cable restraints to restrain vibration-isolated HVAC components, including distributed systems.
 - c. Use only one restraint system type for a given HVAC component or distributed system (e.g., ductwork, piping) run; mixing of cable and rigid restraints on a given component/run is not permitted.
 - d. Size restraint elements, including anchorage, to resist seismic loads as necessary to restrain HVAC component in all lateral directions; consider bracket geometry in anchor load calculations.
 - e. Use rod stiffener clips to attach bracing to hanger rods as required to prevent rod buckling from vertical (upward) compressive load introduced by cable or rigid restraints loaded in tension, in excess of downward tensile load due to supported HVAC component weight.
 - f. Select hanger rods and associated anchorage as required to accommodate vertical (downward) tensile load introduced by rigid restraints loaded in compression, in addition to downward tensile load due to supported HVAC component weight.
 - g. Clevis hangers may only be used for attachment of transverse restraints; do not use for attachment of longitudinal restraints.
 - h. Where seismic restraints are attached to clevis hangers, provide clevis bolt reinforcement accessory to prevent clevis hanger deformation.
 - i. Do not introduce lateral loads on open bar joist chords or the weak axis of beams, or loads in any direction at other than panel points unless approved by project Structural Engineer of Record.
 6. Ductwork Applications:
 - a. Provide independent support and seismic restraint for in-line components (e.g., fans, heat exchangers, humidifiers) having an operating weight greater than 75 pounds (334 N).
 - b. Positively attach appurtenances (e.g., dampers, louvers, diffusers) with mechanical fasteners.

- H. Seismic Attachments: (Coordinate and obtain approval from the project Structural Engineer)
 - 1. Do not use power-actuated fasteners.
 - 2. Do not use friction clips (devices that rely on mechanically applied friction to resist loads). Beam clamps may be used for supporting sustained loads where provided with restraining straps.
 - 3. Comply with anchor minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
 - 4. Concrete Housekeeping Pads:
 - a. Increase size of pad as required to comply with anchor requirements.
 - b. Provide pad reinforcement and doweling to ensure integrity of pad and connection and to provide adequate load path from pad to supporting structure.
- I. Seismic Interactions:
 - 1. Include provisions to prevent seismic impact between HVAC components and other structural or nonstructural components.
 - 2. Include provisions such that failure of a component, either essential or nonessential, does not cause the failure of an essential component.
 - 3. Comply with minimum clearance requirements between HVAC equipment, distribution systems, and associated supports and fire protection sprinkler system drops and sprigs.
- J. Seismic Relative Displacement Provisions:
 - 1. Use suitable fittings or flexible connections to accommodate:
 - a. Relative displacements at connections between components, including distributed systems (e.g., ductwork, piping); do not exceed load limits for equipment utility connections.
 - b. Relative displacements between component supports attached to dissimilar parts of structure that may move differently during an earthquake.
 - c. Design displacements at seismic separations.
 - d. Anticipated drifts between floors.
 - 2. Include provisions to prevent interruption of utility service due to seismic displacements.
- K. California Office of Statewide Health Planning and Development (OSHPD) Preapprovals:
 - 1. Manufacturer's certifications of seismic design of supports for nonstructural components to have current approval under OSHPD Preapproval of Manufacturer's Certification (OPM) program.
 - 2. Special seismic certifications to have current approval under OSHPD Special Seismic Certification Preapproval (OSP) program.

2.03 VIBRATION-ISOLATED EQUIPMENT SUPPORT BASES

- A. Manufacturers:
 - 1. Vibration-Isolated Equipment Support Bases:
 - a. Kinetics Noise Control, Inc
 - b. Mason Industries
 - c. Vibration Eliminator Company, Inc.
 - 2. Source Limitations: Furnish vibration-isolated equipment support bases and associated components and accessories produced by the same manufacturer as the vibration isolators and obtained from a single supplier.
- B. Vibration-Isolated Structural Steel Bases:
 - 1. Description: Engineered structural steel frames with integral mounting provisions for vibration isolators, sized and configured for mounting of equipment.
 - 2. Centrifugal Fan Applications: Provide adjustable motor slide rails as required.
- C. Vibration-Isolated Concrete Inertia Bases:
 - 1. Description: Concrete-filled engineered steel forms with integral mounting provisions for vibration isolators, sized and configured for mounting of equipment.
 - 2. Minimum Base Depth: 6 inches (152 mm).
 - 3. Minimum Base Mass (Including Concrete): 1.5 times weight of supported equipment.

4. Concrete Reinforcement: Welded or tied reinforcing bars running both ways in a single layer.
5. Concrete: Filled on site with minimum 3000 psi (20 mPa) concrete in accordance with Section 03 3000.
6. Centrifugal Fan Applications: Provide adjustable motor slide rails as required.
7. Pump Applications: Size and configure bases for piping elbow supports as required.

2.04 VIBRATION ISOLATORS

- A. Manufacturers:
 1. Vibration Isolators:
 - a. Kinetics Noise Control, Inc
 - b. Mason Industries
 - c. Vibration Eliminator Company, Inc
 2. Source Limitations: Furnish vibration-isolators and associated accessories produced by a single manufacturer and obtained from a single supplier.
- B. General Requirements:
 1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.
 2. Spring Elements for Spring Isolators:
 - a. Color code or otherwise identify springs to indicate load capacity.
 - b. Lateral Stability: Minimum lateral stiffness to vertical stiffness ratio of 0.8.
 - c. Designed to operate in the linear portion of their load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
 - d. Designed to provide additional travel to solid of not less than 50 percent of rated deflection at rated load.
 - e. Selected to provide designed deflection of not less than 75 percent of specified deflection.
 - f. Selected to function without undue stress or overloading.
 3. Seismic Snubbing Elements for Seismic Isolators:
 - a. Air Gap: Between 0.125 inches (3 mm) and 0.25 inches (6 mm) unless otherwise indicated.
 - b. Points of Contact: Cushioned with resilient material, minimum 0.25 inch (6 mm) thick; capable of being visually inspected for damage and replaced.
- C. Vibration Isolators for Nonseismic Applications:
 1. Resilient Material Isolator Pads:
 - a. Description: Single or multiple layer pads utilizing elastomeric (e.g., neoprene, rubber) isolator material.
 - b. Pad Thickness: As required for specified minimum static deflection; minimum 0.25 inch (6 mm) thickness.
 - c. Multiple Layer Pads: Provide bonded, galvanized sheet metal separation plate between each layer.
 2. Resilient Material Isolator Mounts, Nonseismic:
 - a. Description: Mounting assemblies for bolting equipment to supporting structure utilizing elastomeric (e.g., neoprene, rubber) isolator material; fail-safe type.
 3. Open (Unhoused) Spring Isolators:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) without a housing.
 - b. Bottom Load Plate: Nonskid, molded, elastomeric isolator material or steel with nonskid elastomeric isolator pad with provisions for bolting to supporting structure as required.
 - c. Furnished with integral leveling device for positioning and securing supported equipment.
 4. Housed Spring Isolators:

- a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing.
 - b. Furnished with integral elastomeric snubbing elements, nonadjustable type, for limiting equipment movement and preventing metal-to-metal contact between housing elements.
 - c. Bottom Load Plate: Steel with nonskid, elastomeric isolator pad with provisions for bolting to supporting structure as required.
 - d. Furnished with integral leveling device for positioning and securing supported equipment.
- 5. Restrained Spring Isolators, Nonseismic:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing designed to prevent movement of supported equipment above an adjustable vertical limit stop.
 - b. Bottom Load Plate: Steel with nonskid elastomeric isolator pad with provisions for bolting to supporting structure as required.
 - c. Furnished with integral leveling device for positioning and securing supported equipment.
 - d. Provides constant free and operating height.
- 6. Resilient Material Isolator Hangers, Nonseismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing elastomeric (e.g., neoprene, rubber) or fiberglass isolator material for the lower hanger rod connection.
- 7. Spring Isolator Hangers, Nonseismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) in series with an elastomeric element for the lower hanger rod connection.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.
- 8. Combination Resilient Material/Spring Isolator Hangers, Nonseismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) for the lower hanger rod connection and elastomeric (e.g., neoprene, rubber) or fiberglass isolator material for the upper hanger rod connection.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.
- 9. Thrust Restraints:
 - a. Description: Assembly utilizing free-standing, laterally stable steel spring designed for resisting horizontal motion due to thrust (e.g., air pressure from a fan), and intended for installation in pairs.
- D. Vibration Isolators for Seismic Applications:
 - 1. Resilient Material Isolator Mounts, Seismic:
 - a. Description: Mounting assemblies for bolting equipment to supporting structure utilizing elastomeric (e.g., neoprene, rubber) isolator material; specifically designed and rated for seismic applications with integral snubbing in all directions.
 - 2. Restrained Spring Isolators, Seismic:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) in series with elastomeric (e.g., neoprene, rubber) isolator material within a metal housing designed to prevent movement of supported equipment above an adjustable vertical limit stop; specifically designed and rated for seismic applications with integral snubbing in all directions.
 - b. Bottom Load Plate: Steel with provisions for bolting to supporting structure as required.
 - c. Furnished with integral leveling device for positioning and securing supported equipment.

- d. Provides constant free and operating height.
- 3. Resilient Material Isolator Hangers, Seismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing elastomeric (e.g., neoprene, rubber) isolator material for the lower hanger rod connection; specifically designed and rated for seismic applications with vertical limit stop to prevent upward travel of hanger rod and cushion impact.
- 4. Spring Isolator Hangers, Seismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) in series with an elastomeric element for the lower hanger rod connection; specifically designed and rated for seismic applications with vertical limit stop to prevent upward travel of hanger rod and cushion impact.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.
 - c. Products:
- 5. Combination Resilient Material/Spring Isolator Hangers, Seismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) for the lower hanger rod connection and elastomeric (e.g., neoprene, rubber) isolator material for the upper hanger rod connection; specifically designed and rated for seismic applications with vertical limit stop to prevent upward travel of hanger rod and cushion impact.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.

2.05 ACOUSTICAL AND VIBRATION ISOLATORS

- A. Manufacturers:
 - 1. Acoustical and Vibration Isolators:
 - a. HoldRite, a brand of Reliance Worldwide Corporation
 - 2. Source Limitations: Furnish isolators and associated accessories produced by a single manufacturer and obtained from a single supplier.
- B. General Requirements:
 - 1. Acoustical Isolation System: Through-stud isolators, pipe clamps, riser clamp pads, neoprene and felt lining material and associated support brackets.

2.06 EXTERNAL SEISMIC SNUBBER ASSEMBLIES

- A. Manufacturers:
 - 1. External Seismic Snubber Assemblies:
 - a. Kinetics Noise Control, Inc
 - b. Mason Industries; _____: w
 - c. Vibration Eliminator Company, Inc
 - 2. Source Limitations: Furnish external seismic snubber assemblies and associated accessories produced by the same manufacturer as the vibration isolators and obtained from a single supplier.
- B. Description: Steel snubbing assemblies designed for external attachment to both equipment and supporting structure that, as part of a complete system, restrain equipment motion in all directions during a seismic event while maintaining vibration isolation during normal operation.
- C. Seismic Snubbing Elements:
 - 1. Air Gap: Between 0.125 inches (3 mm) and 0.25 inches (6 mm) unless otherwise indicated.
 - 2. Points of Contact: Cushioned with resilient material, minimum 0.25 inch (6 mm) thick; capable of being visually inspected for damage and replaced.

2.07 SEISMIC RESTRAINT SYSTEMS

- A. Manufacturers:
 - 1. Seismic Restraint Systems:
 - a. AFCON, a brand of Anvil International
 - b. Eaton Corporation
 - c. Kinetics Noise Control, Inc
 - d. Mason Industries
 - 2. Source Limitations: Furnish seismic restraint system components and accessories produced by a single manufacturer and obtained from a single supplier.
- B. Description: System components and accessories specifically designed for field assembly and attachment of seismic restraints.
- C. Cable Restraints:
 - 1. Comply with ASCE 19.
 - 2. Cables: Pre-stretched, galvanized steel wire rope with certified break strength.
 - 3. Cable Connections: Use only swaged end fittings. Cable clips and wedge type end fittings are not permitted in accordance with ASCE 19.
 - 4. Use protective thimbles for cable loops where potential for cable damage exists.
- D. Rigid Restraints: Use MFMA-4 steel channel (strut), steel angle, or steel pipe for structural element; suitable for both compressive and tensile design loads.

2.08 VIBRATION-ISOLATED AND/OR SEISMICALLY ENGINEERED ROOF CURBS

- A. Manufacturers:
 - 1. Vibration-Isolated and/or Seismically Engineered Roof Curbs:
 - a. Kinetics Noise Control, Inc
 - b. Mason Industries
 - c. Vibration Eliminator Company, Inc
 - 2. Source Limitations: Furnish vibration-isolated roof curbs and associated accessories produced by the same manufacturer as the vibration isolators and obtained from a single supplier.
- B. Vibration Isolation Curbs:
 - 1. Nonseismic Curb Rail:
 - a. Location: Between existing roof curb and rooftop equipment.
 - b. Construction: Aluminum.
 - c. Integral vibration isolation to comply with requirements of this section.
 - d. Weather exposed components consist of corrosion resistant materials.
 - 2. Nonseismic Curb:
 - a. Location: Between structure and rooftop equipment.
 - b. Construction: Aluminum.
 - c. Integral vibration isolation to comply with requirements of this section.
 - d. Weather exposed components consist of corrosion resistant materials.
 - 3. Seismic Curb:
 - a. Location: Between structure and rooftop equipment.
 - b. Construction: Steel.
 - c. Integral vibration isolation to comply with requirements of this section.
 - d. Snubbers consist of minimum 0.25 inch (6 mm) thick resilient pads to avoid metal-to-metal contact without compromising vibration isolating capabilities.
 - e. Weather exposed components consist of corrosion resistant materials.
- C. Seismic Type Nonisolated Curb and Fabricated Equipment Piers:
 - 1. Location: Between structure and rooftop equipment.
 - 2. Construction: Steel.
 - 3. Weather exposed components consist of corrosion resistant materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.
- B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 CODE-REQUIRED SPECIAL INSPECTIONS

- A. Arrange work to accommodate tests and/or inspections performed by Special Inspection Agency employed by Owner or Architect in accordance with Section 01 4533 and statement of special inspections as required by applicable building code.
- B. Frequency of Special Inspections: Where special inspections are designated as continuous or periodic, arrange work accordingly.
 - 1. Continuous Special Inspections: Special Inspection Agency to be present in the area where the work is being performed and observe the work at all times the work is in progress.
 - 2. Periodic Special Inspections: Special Inspection Agency to be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.
- C. Seismic special inspections include, but are not limited to:
 - 1. Seismically Qualified Equipment: Verification that label, anchorage, and mounting comply with the certificate of compliance.
 - 2. Installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units for Seismic Design Categories C, D, E, and F; periodic inspection.
 - 3. Installation and anchorage of ductwork designed to carry hazardous materials for Seismic Design Categories C, D, E and F; periodic inspection.
 - 4. Installation and anchorage of vibration isolation systems for Seismic Design Categories C, D, E, and F where the approved Contract Documents require a nominal clearance of 1/4 inch (6.4 mm) or less between equipment support frame and seismic restraint; periodic inspection.
 - 5. Verification of required clearances between HVAC equipment, distribution systems, and associated supports and fire protection sprinkler system drops and sprigs for Seismic Design Categories C, D, E, and F; periodic inspection.
- D. Prior to starting work, Contractor to submit written statement of responsibility to authorities having jurisdiction and to Owner acknowledging awareness of special requirements contained in the statement of special inspections.
- E. Special Inspection Agency services do not relieve Contractor from performing inspections and testing specified elsewhere.

3.03 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Secure fasteners according to manufacturer's recommended torque settings.
- D. Field-Welding (where approved by Architect): Comply with Section 05 5000.
- E. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.
- F. Vibration Isolation Systems:
 - 1. Vibration-Isolated Equipment Support Bases:
 - a. Provide specified minimum clearance beneath base.
 - 2. Spring Isolators:

- a. Position equipment at operating height; provide temporary blocking as required.
 - b. Lift equipment free of isolators prior to lateral repositioning to avoid damage to isolators.
 - c. Level equipment by adjusting isolators gradually in sequence to raise equipment uniformly such that excessive weight or stress is not placed on any single isolator.
 - 3. Isolator Hangers:
 - a. Use precompressed isolator hangers where required to facilitate installation and prevent damage to equipment utility connection provisions.
 - b. Locate isolator hangers at top of hanger rods in accordance with manufacturer's instructions.
 - 4. Thrust Restraints:
 - a. Adjust restraint movement under normal operating static pressure.
 - 5. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
 - 6. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
 - 7. Adjust isolators to be free of isolation short circuits during normal operation.
 - 8. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.
- G. Seismic Controls:
- 1. Provide specified snubbing element air gap; remove any factory-installed spacers, debris, or other obstructions.
 - 2. Use only specified components, anchorage, and hardware evaluated by seismic design. Comply with conditions of seismic certification where applicable.
 - 3. Where mounting hole diameter exceeds bolt diameter by more than 0.125 inch (3 mm), use epoxy grout, elastomeric grommet, or welded washer to reduce clearance to 0.125 inch (3 mm) or less.
 - 4. Equipment with Sheet Metal Housings:
 - a. Use Belleville washers to distribute stress over a larger surface area of the sheet metal connection interface as approved by manufacturer.
 - b. Attach additional steel as approved by manufacturer where required to transfer loads to structure.
 - c. Where mounting surface is irregular, do not shim housing; reinforce housing with additional steel as approved by manufacturer.
 - 5. Concrete Housekeeping Pads:
 - a. Size in accordance with seismic design to meet anchor requirements.
 - b. Install pad reinforcement and doweling in accordance with seismic design to ensure integrity of pad and associated connection to slab.
 - 6. Seismic Restraint Systems:
 - a. Do not attach seismic restraints and gravity supports to dissimilar parts of structure that may move differently during an earthquake.
 - b. Install restraints within permissible angles in accordance with seismic design.
 - c. Install cable restraints straight between component/run and structural attachment; do not bend around other nonstructural components or structural elements.
 - d. Install cable restraints for vibration-isolated components slightly slack to prevent short-circuiting of isolation.
 - e. Install hanger rod stiffeners where indicated using only specified clamps; do not weld stiffeners to hanger rod.

3.04 FIELD QUALITY CONTROL

- A. Inspect vibration isolation and/or seismic control components for damage and defects.
- B. Provide manufacturer representative or authorized technician services to assist with inspection and testing of vibration isolation systems and seismic controls. Submit a detailed copy of manufacturer recommended inspection, testing, and field report procedures.

- C. Vibration Isolation Systems:
 - 1. Verify isolator static deflections.
 - 2. Verify required clearance beneath vibration-isolated equipment support bases.
 - 3. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.
- D. Seismic Controls:
 - 1. Verify snubbing element air gaps.
- E. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.
- F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.05 ATTACHMENTS

- A. Statement of special inspections.

END OF SECTION

SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Stencils.
- E. Pipe markers.
- F. Ceiling tacks.

1.02 RELATED REQUIREMENTS

- A. Section 09 9123 - Interior Painting: Identification painting.

1.03 REFERENCE STANDARDS

- A. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Control Panels: Nameplates.
- D. Dampers: Ceiling tacks, where located above lay-in ceiling.
- E. Ductwork: Nameplates.
- F. Heat Transfer Equipment: Nameplates.
- G. Instrumentation: Tags.
- H. Major Control Components: Nameplates.
- I. Piping: Tags.
- J. Pumps: Nameplates.
- K. Small-sized Equipment: Tags.
- L. Tanks: Nameplates.
- M. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- N. Water Treatment Devices: Nameplates.

2.02 NAMEPLATES

- A. Letter Color: White.
- B. Letter Height: 1/4 inch (6 mm).
- C. Background Color: Black.
- D. Plastic: Comply with ASTM D709.

2.03 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch (40 mm) diameter.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 ADHESIVE-BACKED DUCT MARKERS

- A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch (0.76 mm); printed with UV and chemical resistant inks.
- B. Style: Individual Label.
- C. Color: Yellow/Black.

2.05 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
 - 1. 3/4 to 1-1/4 inch (20-30 mm) Outside Diameter of Insulation or Pipe: 8 inch (200 mm) long color field, 1/2 inch (15 mm) high letters.
 - 2. 1-1/2 to 2 inch (40-50 mm) Outside Diameter of Insulation or Pipe: 8 inch (200 mm) long color field, 3/4 inch (20 mm) high letters.
 - 3. 2-1/2 to 6 inch (65-150 mm) Outside Diameter of Insulation or Pipe: 12 inch (300 mm) long color field, 1-1/4 inch (30 mm) high letters.
 - 4. 8 to 10 inch (200-250 mm) Outside Diameter of Insulation or Pipe: 24 inch (600 mm) long color field, 2-1/2 inch (65 mm) high letters.
 - 5. Over 10 inch (250 mm) Outside Diameter of Insulation or Pipe: 32 inch (800 mm) long color field, 3-1/2 inch (90 mm) high letters.
 - 6. Ductwork and Equipment: 2-1/2 inch (65 mm) high letters.

2.06 PIPE MARKERS

- A. 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.
- B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.
- C. Color code as follows:
 - 1. Heating, Cooling, and Boiler Feedwater: Green with white letters.
 - 2. Toxic and Corrosive Fluids: Orange with black letters.
 - 3. Compressed Air: Blue with white letters.

2.07 CEILING TACKS

- A. Description: Steel with 3/4 inch (20 mm) diameter color coded head.

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. Apply stencil painting in accordance with Section 09 9123.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

- E. Use tags on piping 3/4 inch (20 mm) diameter and smaller.
- 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 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic systems.
- C. Measurement of final operating condition of HVAC systems.

1.02 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2024.
- C. NEBB (TAB) - Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems; 2019, with Errata (2022).
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2023.

1.03 SUBMITTALS

- A. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor 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. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
 - 2. 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, 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. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - d. Final test report forms to be used.
 - e. Expected problems and solutions, etc.
 - f. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
 - g. 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. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 5. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
 - 6. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.

- d. Project name.
 - e. Project location.
 - f. Report date.
- D. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

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. SMACNA (TAB).
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. 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.
- D. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of three 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.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- E. 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.
 - 6. Fans are rotating correctly.
 - 7. Fire and 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. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

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 5 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.
- F. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

3.06 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. 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.
- E. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- F. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- G. 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.
- H. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- I. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- J. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure near the building entries.

3.07 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

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.
- 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.
- C. Combustion Equipment:
 - 1. Boiler manufacturer.
 - 2. Model number.
 - 3. Serial number.
 - 4. Firing rate.
- D. Chillers:
 - 1. Identification/number.
 - 2. Manufacturer.
 - 3. Capacity.
 - 4. Model number.
 - 5. Serial number.
 - 6. Evaporator entering water temperature, design and actual.
 - 7. Evaporator leaving water temperature, design and actual.
 - 8. Evaporator pressure drop, design and actual.
 - 9. Evaporator water flow rate, design and actual.
- E. Heat Exchangers:
 - 1. Identification/number.
 - 2. Location.
 - 3. Service.
 - 4. Model number.
 - 5. Serial number.
 - 6. Primary water entering temperature, design and actual.
 - 7. Primary water leaving temperature, design and actual.
 - 8. Primary water flow, design and actual.
 - 9. Primary water pressure drop, design and actual.
 - 10. Secondary water leaving temperature, design and actual.
 - 11. Secondary water flow, design and actual.
 - 12. Secondary water pressure drop, design and actual.
- F. Cooling Coils:
 - 1. Identification/number.
 - 2. Location.
 - 3. Service.
 - 4. Manufacturer.
 - 5. Air flow, design and actual.

6. Entering air DB temperature, design and actual.
 7. Entering air WB temperature, design and actual.
 8. Leaving air DB temperature, design and actual.
 9. Leaving air WB temperature, design and actual.
 10. Water flow, design and actual.
 11. Water pressure drop, design and actual.
 12. Entering water temperature, design and actual.
 13. Leaving water temperature, design and actual.
 14. Air pressure drop, design and actual.
- G. Heating Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Water flow, design and actual.
 7. Water pressure drop, design and actual.
 8. Entering water temperature, design and actual.
 9. Leaving water temperature, design and actual.
 10. Entering air temperature, design and actual.
 11. Leaving air temperature, design and actual.
 12. Air pressure drop, design and actual.
- H. Air Moving Equipment (DOAS):
1. Location.
 2. Manufacturer.
 3. Model number.
 4. Serial number.
 5. Arrangement/Class/Discharge.
 6. Air flow, specified and actual.
 7. Return air flow, specified and actual.
 8. Outside air flow, specified and actual.
 9. Total static pressure (total external), specified and actual.
 10. Inlet pressure.
 11. Discharge pressure.
 12. Fan RPM.
 13. Supply Air Temperature
 14. Outside Air Temperature
 15. Return Air Temperature
 16. Exhaust Air Temperature
- I. 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. Fan RPM.
- J. Duct Traverses:
1. System zone/branch.
 2. Duct size.
 3. Test air flow.

4. Duct static pressure.
- K. 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. Leakage.
- L. Air Distribution Tests:
1. Air terminal number.
 2. Room number/location.
 3. Terminal type.
 4. Terminal size.
 5. Test (final) air flow.
 6. Percent of design air flow.

END OF SECTION

**SECTION 23 0713
DUCT INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Duct insulation.
- B. Duct liner.
- C. Weather barrier coatings.
- D. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 07 8400 - Firestopping.
- C. Section 09 9113 - Exterior Painting: Painting insulation jackets.
- D. Section 09 9123 - Interior Painting: Painting insulation jackets.
- E. Section 23 0553 - Identification for HVAC Piping and Equipment.
- F. Section 23 3100 - HVAC Ducts and Casings: Glass fiber ducts.

1.03 REFERENCE STANDARDS

- A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019.
- C. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2019).
- D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- E. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2017.
- F. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2020a.
- G. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
- H. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).
- I. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2018).
- J. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2020.
- K. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2019.
- L. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation; 2021.
- M. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts; 2016 (Reapproved 2021).
- N. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings; 2025.
- O. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers; 2015 (Reapproved 2022).

- P. ASTM C1410 - Standard Specification for Cellular Melamine Thermal and Sound-Absorbing Insulation; 2017 (Reapproved 2023).
- Q. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation; 2021.
- R. ASTM C1775 - Standard Specification for Laminate Protective Jacket and Tape for Use over Thermal Insulation for Outdoor Applications; 2014.
- S. 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; 2017 (Reapproved 2021).
- T. ASTM D93 - Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester; 2020.
- U. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
- V. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2021.
- W. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).
- X. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant; 2016b.
- Y. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- Z. UL 181A - Closure Systems for Use with Rigid Air Ducts; Current Edition, Including All Revisions.
- AA. UL 181B - Closure Systems for Use with Flexible Air Ducts and Air Connectors; Current Edition, Including All Revisions.
- BB. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Samples: Submit two samples of any representative size illustrating each insulation type.
- C. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section.

1.06 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.

1.07 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 FIBER, FLEXIBLE (REFER TO DRAWING SCHEDULE)

- A. Manufacturer:
 - 1. CertainTeed Corporation.
 - 2. Johns Manville.
 - 3. JP Lamborn Co
 - 4. Knauf Insulation
 - 5. Owens Corning Corporation.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. K (Ksi) value: 0.36 at 75 degrees F (0.052 at 24 degrees C), when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 1,200 degrees F (649 degrees C).
 - 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 (0.029 ng/(Pa s m)), 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.
- F. Outdoor Vapor Barrier Mastic:
 - 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- G. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter (1.29 mm diameter).

2.03 GLASS FIBER, RIGID (REFER TO DRAWING SCHEDULE)

- A. Manufacturer:
 - 1. CertainTeed Corporation.
 - 2. Johns Manville.
 - 3. Knauf Insulation.
 - 4. Owens Corning Corporation
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
 - 1. K (Ksi) Value: 0.24 at 75 degrees F (0.036 at 24 degrees C), when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 450 degrees F (232 degrees C).
 - 3. Maximum Water Vapor Absorption: 5.0 percent.
 - 4. Maximum Density: 8.0 pcf (128 kg/cu m).
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng/(Pa s m)), 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. Protective Coating:
 - 1. Manufacturers:
 - a. Design Polymerics; DP 2510 Water Based, Low VOC, Duct Liner Protective Coating: www.designpoly.com/#sle.
- F. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight, glass fabric.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION (REFER TO DRAWING SCHEDULE)

- A. Manufacturers:
 - 1. Aeroflex USA, Inc
 - 2. Armacell LLC
 - 3. K-Flex USA LLC
- B. 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 (Minus 40 degrees C).
 - 2. Maximum Service Temperature: 180 degrees F (82 degrees C).
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- D. Weather Barrier Coating: Air dried, contact adhesive, compatible with insulation and ASTM E84 compliant.
 - 1. Manufacturers:
 - a. Design Polymerics; DP 5050 Water Based, Zero VOC, High Strength, Weather Barrier Coating.
 - b. Vimasco Corporation.

2.05 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. Manufacturers:
 - a. H.B. Fuller Construction Products, Inc; Childers - CP Series Weather Barrier Coating.
 - b. Substitutions: See Section 01 6000 - Product Requirements.
 - 2. 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.
 - 3. Water Vapor Permeance: Greater than 1.0 perm (57 ng/(Pa s m)) in accordance with ASTM E96/E96M.
 - 4. Resistance to Fungal Growth: No growth when tested in accordance with ASTM D5590.
 - 5. Color: As selected by Architect.

2.06 JACKETING AND ACCESSORIES

- A. Canvas Jacket: UL listed 6 oz/sq yd (220 g/sq m) plain weave cotton fabric treated with dilute fire-retardant lagging adhesive.
 - 1. Lagging Adhesive:
 - a. Manufacturers:
 - 1) Design Polymerics; DP 3050 Water Based, Zero VOC, Premium Quality, Lagging Adhesive, and Vapor Retarder: www.designpoly.com/#sle.
 - b. Compatible with insulation.
- B. Aluminum Jacket:
 - 1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch (0.41 mm) with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
 - 2. Thickness: 0.016 inch (0.40 mm) sheet.

3. Finish: Smooth.
 4. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
 5. Fittings: 0.016 inch (0.40 mm) thick die-shaped fitting covers with factory-attached protective liner.
 6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (0.38 mm) thick aluminum.
 7. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.
- C. 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 (0.86 mm).
 3. Finish: Embossed.
 4. Color: Silver.
 5. Water Vapor Transmission: 0.002 perm inch (0.0029 ng/(Pa s m)), 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.
 8. Manufacturers:
 - a. Polyguard Products; Alumaguard.
- D. Reinforced Tape:
1. Manufacturers:
 - a. Ideal Tape Co., Inc.
 2. FSK tape suitable for sealing seams between insulation, insulated elbows, 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 (0.00 ng/(Pa s m)), when tested in accordance with ASTM E96/E96M.
 5. Finish: Match insulation.
- E. UL181 Tape for Rigid and Flexible Ductwork:
1. Manufacturers:
 - a. Ideal Tape Co., Inc.
 2. Comply with UL 181A for rigid ductwork.
 3. Comply with UL 181B for flexible ductwork.
 4. Aluminum foil coated with pressure-sensitive adhesive on paper release liner.
 5. Foil tape suitable for sealing seams between insulation, insulated elbows, and fittings resulting in a tight, smooth surface without wrinkles.
 6. Finish: Printed with UL Listing for identification.

2.07 DUCT LINER (REFER TO DRAWING SCHEDULE)

- A. Manufacturers:
1. Armacell LLC
 2. CertainTeed Corporation.
 3. Ductmate Industries, Inc, a DMI Company.
 4. Johns Manville.
 5. Knauf Insulation.
 6. Owens Corning Corporation
- B. Note: Choose the liner type - Elastomeric Foam or Glass Fiber. *Remove this note after editing*
- C. Elastomeric Foam 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 (Minus 40 degrees C).
 2. Maximum Service Temperature: 180 degrees F (82 degrees C).
 3. Fungal Resistance: No growth when tested according to ASTM G21.

4. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F (0.045 at 24 degrees C).
 5. Minimum Noise Reduction Coefficients:
 - a. 1/2 inch (13 mm) Thickness: 0.30.
 - b. 1 inch (25 mm) Thickness: 0.40.
 - c. 1-1/2 inches (40 mm) Thickness: 0.50.
 - d. 2 inch (50 mm) Thickness: 0.60.
 6. Erosion Resistance: Does not show evidence of breaking away, flaking off, or delamination at velocities of 10,000 fpm (50.8 m/s) when tested in accordance with ASTM C1071.
 7. Connection: Waterproof vapor barrier adhesive.
- D. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.
- E. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket, rigid board, and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
1. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F (0.045 at 24 degrees C).
 2. Service Temperature: Up to 250 degrees F (121 degrees C).
 3. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm (25.4 m/s), minimum.
 4. Minimum Noise Reduction Coefficients:
 - a. 1/2 inch (13 mm) Thickness: 0.30.
 - b. 1 inch (25 mm) Thickness: 0.45.
 - c. 1-1/2 inches (40 mm) Thickness: 0.60.
 - d. 2 inch (50 mm) Thickness: 0.70.
- F. Glass Fiber Liner Adhesive: Waterproof, fire-retardant type, ASTM C916.
1. Manufacturers:
 - a. Design Polymerics
 - b. Elgen Manufacturing Company, Inc
 - c. Vimasco Corporation
- G. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.
1. Manufacturers:
 - a. Elgen Manufacturing Company, Inc; Peel and Press Insulation Hangers: www.elgenmfg.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Refer to drawing schedules for insulation type specified.
- B. Test ductwork for design pressure prior to applying insulation materials.
- C. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. 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, fire dampers, flexible connections, and expansion joints.
- D. 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.
- E. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor) ((below 3 meters above finished floor)): Finish with canvas jacket sized for finish painting.
- F. Exterior Applications: Provide insulation with vapor barrier jacket.
- G. Slope exterior ductwork to shed water.
- H. 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.
- I. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 90 percent coverage.
 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
 3. Seal and smooth joints. Seal and coat transverse joints.
 4. Seal liner surface penetrations with adhesive.
 5. Duct dimensions indicated are net inside dimensions required for air-flow, unless noted otherwise. Increase duct size to allow for insulation thickness.

3.03 HYDROUS CALCIUM SILICATE INSULATION

- A. Manufacturers:
1. Johns Manville Corporation
- B. Insulation: ASTM C533 and ASTM C795; rigid molded, asbestos free, gold color.
1. K (Ksi) Value: 0.40 at 300 degrees F (0.057 at 149 degrees C) when tested in accordance with ASTM C177 or ASTM C518.
 2. Maximum Service Temperature: 1200 degrees F (649 degrees C).
 3. Density: 15 pcf (240 kg/cu m).
- C. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.
- D. Insulating Cement: ASTM C449.
- E. High Temperature Adhesive: Fire-retardant, sodium silicate based adhesive with fibers treated in compliance with ASTM D93.
1. Manufacturers:
 - a. Vimasco Corporation

END OF SECTION

**SECTION 23 0716
HVAC EQUIPMENT INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Equipment insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Weather barrier coatings.
- D. Jacketing and accessories.
- E. Breeching insulation.

1.02 RELATED REQUIREMENTS

- A. Section 09 9123 - Interior Painting: Painting insulation covering.
- B. Section 23 0553 - Identification for HVAC Piping and Equipment.
- C. Section 23 2113 - Hydronic Piping: Placement of hangers and hanger inserts.
- D. Section 23 2114 - Hydronic Specialties.
- E. Section 23 2300 - Refrigerant Piping: Placement of inserts.

1.03 REFERENCE STANDARDS

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
- B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019.
- D. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2019).
- E. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2019).
- F. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- G. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2017.
- H. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2020a.
- I. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2022.
- J. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
- K. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2022a.
- L. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).
- M. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation; 2021.
- N. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation; 2021.
- O. ASTM C1695 - Standard Specification for Fabrication of Flexible Removable and Reusable Blanket Insulation for Hot Service; 2022.

- P. ASTM C1775 - Standard Specification for Laminate Protective Jacket and Tape for Use over Thermal Insulation for Outdoor Applications; 2014.
- Q. ASTM D93 - Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester; 2020.
- R. 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; 2017 (Reapproved 2021).
- S. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
- T. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2021.
- U. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant; 2016b.
- V. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

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.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled 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.

1.07 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 FIBER, FLEXIBLE

- A. Manufacturers:
 - 1. CertainTeed Corporation
 - 2. Johns Manville Corporation
 - 3. Knauf Insulation; Atmosphere Duct Wrap:
 - 4. Owens Corning Corporation
 - 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Insulation: ASTM C553; flexible, noncombustible.
 - 1. K (Ksi) Value: 0.36 at 75 degrees F (0.052 at 24 degrees C), when tested in accordance with ASTM C177 or ASTM C518.

2. Maximum Service Temperature: 1,000 degrees F (538 degrees C).
3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 1. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng/(Pa s m)), when tested in accordance with ASTM E96/E96M.
 2. Secure with self-sealing longitudinal laps and butt strips.
 3. Secure with outward clinch expanding staples and vapor barrier mastic.
- D. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.
- E. Vapor Barrier Lap Adhesive: Compatible with insulation.
- F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.03 GLASS FIBER, RIGID

- A. Manufacturer:
 1. CertainTeed Corporation; _____
 2. Johns Manville Corporation
 3. Knauf Insulation; Earthwool Insulation Board:
 4. Owens Corning Corporation
 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
 1. K (Ksi) Value: 0.25 at 75 degrees F (0.036 at 24 degrees C), when tested in accordance with ASTM C177 or ASTM C518.
 2. Maximum Service Temperature: 1,200 degrees F (649 degrees C).
 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
 4. Maximum Density: 8.0 pcf (128 kg/cu m).
- C. Aluminum-Foil Laminate Jacket:
 1. Manufacturers:
 - a. H.B. Fuller Construction Products, Inc; Foster - Vapor-Fas:
 2. Factory-applied, pressure sensitive adhesive jacketing to comply with ASTM C1775.
- D. Vapor Barrier Jacket:
 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng/(Pa s m)), when tested in accordance with ASTM E96/E96M.
 3. Secure with self-sealing longitudinal laps and butt strips.
 4. Secure with outward clinch expanding staples and vapor barrier mastic.
- E. Facing: 1 inch (25 mm) galvanized steel hexagonal wire mesh stitched on one face of insulation.
- F. Vapor Barrier Lap Adhesive: Compatible with insulation.
- G. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.04 CELLULAR GLASS

- A. Manufacturer:
 1. Owens Corning Corporation; FOAMGLAS:
- B. Pipe and Tubing Insulation: ASTM C552, Type II, Grade 6.
 1. K (Ksi) Value: 0.35 (0.050) at 100 degrees F (38 degrees C).
 2. Service Temperature Range: From 250 degrees F (121 degrees C) to 800 degrees F (427 degrees C).
 3. Water Vapor Permeability: 0.005 perm inch (0.007 ng/(Pa s m)) maximum per inch.
 4. Water Absorption: 0.5 percent by volume, maximum.
 5. Density: At least 6.12 pcf (98 kg/cu m), minimum.

- C. Block Insulation: ASTM C552, Type I, Grade 6.
 - 1. K (Ksi) Value: 0.35 at 100 degrees F (0.050 at 38 degrees C).
 - 2. Service Temperature: 800 degrees F (427 degrees C), maximum.
 - 3. Water Vapor Permeability: 0.005 perm inch (0.007 ng/(Pa s m)) maximum per inch.
 - 4. Water Absorption: 0.5 percent by volume, maximum.
 - 5. Density: 6.12 pcf (98 kg/cu m), minimum.

2.05 HYDROUS CALCIUM SILICATE

- A. Manufacturer:
 - 1. Johns Manville Corporation
- B. Insulation: ASTM C533; rigid molded, asbestos free, gold color.
 - 1. K (Ksi) Value: 0.40 at 300 degrees F (0.057 at 148 degrees C), when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 1,200 degrees F (649 degrees C).
 - 3. Density: 15 pcf (249 kg/cu m).
- C. Tie Wire: 0.048 inches (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.
- D. Insulating Cement: ASTM C449.
- E. High Temperature Adhesive: Fire-retardant, sodium silicate based adhesive with fibers treated in compliance with ASTM D93.
 - 1. Manufacturers:
 - a. Vimasco Corporation

2.06 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Aeroflex USA, Inc; Aerocel AC Sheet and Roll:
 - 2. Armacell LLC; ArmaFlex Ultra with FlameDefense:
 - 3. K-Flex USA LLC; Insul-Sheet:
- B. 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 (Minus 40 degrees C).
 - 2. Maximum Service Temperature: 220 degrees F (104 degrees C).
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.07 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. Manufacturers:
 - a. H.B. Fuller Construction Products, Inc; Childers - CP Series Weather Barrier Coating
 - b. Substitutions: See Section 01 6000 - Product Requirements.
 - 2. 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.
 - 3. Water Vapor Permeance: Greater than 1.0 perm (57 ng/(Pa s m)) in accordance with ASTM E96/E96M.
 - 4. Resistance to Fungal Growth: No growth when tested in accordance with ASTM D5590.
 - 5. Color: As selected by Architect.

2.08 JACKETING AND ACCESSORIES

- A. PVC Plastic:
 - 1. Manufacturers:
 - a. Johns Manville Corporation

2. Jacket: Sheet material, off-white color.
 - a. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
 - b. Maximum Service Temperature: 150 degrees F (66 degrees C).
 - c. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng/(Pa s m)), when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil, 0.010 inch (0.25 mm).
 - e. Connections: Brush on welding adhesive.
 3. Covering Adhesive Mastic: Compatible with insulation.
- B. Aluminum Jacket:
1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch (0.41 mm) with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
 2. Thickness: 0.016 inch (0.40 mm) sheet.
 3. Finish: Smooth.
 4. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
 5. Fittings: 0.016 inch (0.40 mm) thick die-shaped fitting covers with factory-attached protective liner.
 6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (0.38 mm) thick aluminum.
 7. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.
- C. Stainless Steel Jacket: ASTM A666, Type 304 stainless steel.
1. Thickness: 0.010 inch (0.25 mm).
 2. Finish: Smooth.
 3. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.
- D. Reinforced Tape:
1. Manufacturers:
 - a. Ideal Tape Co., Inc
 - b. Substitutions: See Section 01 6000 - Product Requirements.
 2. FSK tape suitable for sealing seams in 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 (0.00 ng/(Pa s m)), when tested in accordance with ASTM E96/E96M.
 5. Finish: Match insulation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that equipment 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. Factory Insulated Equipment: Do not insulate.
- C. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- F. Insulated equipment containing fluids below ambient temperature; insulate entire system.
- G. Fiber glass insulated equipment containing fluids below ambient temperature; provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.

- H. For hot equipment containing fluids 140 degrees F (60 degrees C) or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
- I. For hot equipment containing fluids over 140 degrees F (60 degrees C), insulate flanges and unions with removable sections and jackets.
- J. Fiber glass insulated equipment containing fluids above ambient temperature; provide standard jackets, with vapor barrier, factory-applied. Finish with glass cloth and adhesive.
- K. Inserts and Shields:
 - 1. Application: Equipment 1-1/2 inches (40 mm) diameter or larger.
 - 2. Shields: Galvanized steel between hangers and inserts.
 - 3. Insert Location: Between support shield and equipment and under the finish jacket.
 - 4. Insert Configuration: Minimum 6 inches (150 mm) 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.
- L. Finish insulation at supports, protrusions, and interruptions.
- M. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.
- N. Exterior Applications:
 - 1. Provide vapor barrier jacket.
 - 2. Cover with aluminum or stainless steel.
- O. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- P. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

3.03 SCHEDULE

- A. Heating Systems:
 - 1. Air Separators
 - 2. Hot Thermal Storage Tanks
- B. Cooling Systems:
 - 1. Air Separators:
 - 2. Cold Thermal Storage Tanks:

END OF SECTION

**SECTION 23 0719
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 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 09 9123 - Interior Painting: Painting insulation jacket.
- C. Section 23 2113 - Hydronic Piping: Placement of hangers and hanger inserts.
- D. Section 23 2213 - Steam and Condensate Heating Piping: Placement of hangers and hanger inserts.
- E. Section 23 2300 - Refrigerant Piping: Placement of inserts.

1.03 REFERENCE STANDARDS

- A. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2019.
- B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019.
- D. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2019).
- E. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- F. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2020a.
- G. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2019.
- H. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2022.
- I. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
- J. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2019.
- K. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2018).
- L. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation; 2019.
- M. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation; 2021.
- N. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation; 2021.
- O. ASTM C1775 - Standard Specification for Laminate Protective Jacket and Tape for Use over Thermal Insulation for Outdoor Applications; 2014.
- P. ASTM D610 - Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces; 2008 (Reapproved 2019).

- Q. ASTM D1621 - Standard Test Method for Compressive Properties Of Rigid Cellular Plastics; 2016.
- R. ASTM D1623 - Standard Test Method for Tensile And Tensile Adhesion Properties of Rigid Cellular Plastics; 2017.
- S. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
- T. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2021.
- U. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant; 2016b.
- V. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

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 GLASS FIBER, FLEXIBLE

- A. Manufacturers:
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. K (Ksi) Value: 0.36 at 75 degrees F (0.052 at 24 degrees C), when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 1,200 degrees F (649 degrees C).
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Aluminum-Foil Laminate Jacket:
 - 1. Factory-applied, pressure sensitive adhesive jacketing to comply with ASTM C1775.
- D. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng/(Pa s m)), when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure-sensitive tape.
- E. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film with pressure-sensitive rubber-based adhesive.
- F. Outdoor Vapor Barrier Mastic:
 - 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

- G. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter (1.29 mm diameter).

2.03 GLASS FIBER, RIGID

- A. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
1. K (Ksi) Value: ASTM C177, 0.24 at 75 degrees F (0.035 at 24 degrees C).
 2. Maximum Service Temperature: 850 degrees F (454 degrees C).
 3. Maximum Moisture Absorption: 0.2 percent by volume.
- B. Aluminum-Foil Laminate Jacket:
1. Factory-applied, pressure sensitive adhesive jacketing to comply with ASTM C1775.
- 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-inches (0.029 ng/(Pa s m)).
- D. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.
- E. Vapor Barrier Lap Adhesive: Compatible with insulation.
- F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.04 FLEXIBLE REMOVABLE AND REUSABLE BLANKET INSULATION

- A. Insulation: ASTM C553 Type V; flexible, noncombustible.
1. K (Ksi) Value: 0.37 at 100 degrees F (0.053 at 38 degrees C), when tested in accordance with ASTM C177 or ASTM C518.
 2. Minimum Service Temperature: 32 degrees F (0 degrees C).
 3. Maximum Service Temperature: 500 degrees F (260 degrees C).
 4. Maximum Water Vapor Absorption: 5.0 percent by weight.

2.05 CELLULAR GLASS

- A. Pipe and Tubing Insulation: ASTM C552, Type II, Grade 6.
1. K (Ksi) Value: 0.35 (0.050) at 100 degrees F (38 degrees C).
 2. Service Temperature Range: From 250 degrees F (121 degrees C) to 800 degrees F (427 degrees C).
 3. Water Vapor Permeability: 0.005 perm inch (0.007 ng/(Pa s m)) maximum per inch.
 4. Water Absorption: 0.5 percent by volume, maximum.
 5. Density: A minimum of 6.12 pcf (98 kg/cu m).

2.06 EXPANDED POLYSTYRENE

- A. Insulation: ASTM C578; rigid closed cell.
1. K (Ksi) Value: 0.23 at 75 degrees F (0.033 at 24 degrees C).
 2. Maximum Service Temperature: 165 degrees F (74 degrees C).
 3. Maximum Water Vapor Permeance: 5.0 perm (287 ng/(Pa s sq m)).

2.07 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. 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 (Minus 40 degrees C).
 2. Maximum Service Temperature: 180 degrees F (82 degrees C).
 3. Connection: Waterproof vapor barrier adhesive.
- 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.

2.08 RIGID, CELLULAR PHENOLIC

- A. Insulation: ASTM C1126, Type III, Grade 1.
1. Nominal Density: 3.75 pcf (60 kg/cu m).

2. Preliminary Initial Minimum K (Ksi) Value: 0.145 at 50 degrees F (0.021 at 10 degrees C) based on density of 2.5 pcf (40 kg/cu m).
3. Maximum Service Temperature: 248 degrees F (120 degrees C).
4. Minimum Service Temperature: Minus 292 degrees F (Minus 180 degrees C).
5. Minimum compressive strength as determined by ASTM D1621.
6. Minimum tensile strength as determined by ASTM D1623.

2.09 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 (minus 18 degrees C).
 - b. Maximum Service Temperature: 150 degrees F (66 degrees C).
 - c. Moisture Vapor Permeability: 0.002 perm inch (0.0029 ng/(Pa s m)), maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil, 0.010 inch (0.25 mm).
 - e. Connections: Brush on welding adhesive.
 2. Covering Adhesive Mastic: Compatible with insulation.
- B. Aluminum Jacket:
 1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch (0.41 mm) with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
 2. Thickness: 0.016 inch (0.40 mm) sheet.
 3. Type: Factory-applied, self-adhesive jacketing.
 4. Finish: Embossed.
 5. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
 6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.
- C. Reinforced Tape:
 1. FSK tape suitable for sealing seams between insulation, insulated pipe bends, and fittings resulting in a tight, smooth surface without wrinkles.
 2. Comply with UL 723, ASTM E84.
 3. Moisture Vapor Permeability: 0.00 perm inch (0.00 ng/(Pa s m)), when tested in accordance with ASTM E96/E96M.

2.10 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. Outlet Cover Color: Gray.
- B. Insulation Protection System: Refrigerant piping insulation PVC protective cover.
 1. PVC Insulation Cover Color: Black with full-length velcro fastener.
 2. Flame Spread and Smoke Development Rating of 24/450: Comply with ASTM E84 or UL 723.

2.11 ACCESSORIES

- A. General Requirements:
 1. Furnish compatible materials which do not contribute to corrosion, soften, or otherwise attack surfaces to which applied, in either the wet or dry state.
 2. Comply with ASTM C795 requirements for materials to be used on stainless steel surfaces.
 3. Supply materials that are asbestos free.
- B. Corrosion Inhibitors:
 1. Corrosion Control Gel:
 - a. Corrosion Protection: Comply with ASTM B117 and ASTM D610.

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, pump bodies, and expansion joints.
- D. 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.
- E. For hot piping conveying fluids 140 degrees F (60 degrees C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- F. For hot piping conveying fluids over 140 degrees F (60 degrees C), insulate flanges and unions at equipment.
- G. 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.
- H. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches (40 mm) 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 (150 mm) 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.
- I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 8400.
- J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet (3 meters) above finished floor): Finish with PVC jacket and fitting covers.
- K. 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 without jacketing.
- L. Buried Piping: Provide factory-fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil, 0.001 inch (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

- M. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

END OF SECTION

**SECTION 23 0913
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC**

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Building Automation System (BAS) Contractor shall provide and install: A fully integrated Building System (BAS), incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified.
- B. The project's (KCC Childcare Learning Center) BAS shall be built as a stand-alone system with all graphics, programming, alarms, and trends built locally on the building controller.
- C. Following construction completion, the BAS Contractor shall integrate the project's building controller with the KCC campus supervisor controller.
- D. Provide engineering, installation, calibration, software, software programming, and checkout for complete and fully operational BAS. The following shall be included:
 - 1. Workstation operator interface terminal (desktop computer workstation). Coordinate with the Owner's Representative for exact location.
 - 2. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.
 - 3. Implement the detailed design for analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.
 - 4. Design, provide, and install equipment cabinets, panels, data communication network cables needed, and associated hardware.
 - 5. Electronic controls for items indicated on Drawings and described hereinafter including sensors, switches, relays, transformers, thermostats, temperature sensors, control panels and central processing hardware and software.
 - 6. Graphics programming for systems and functions indicated and required.
 - 7. Install interconnecting cables between supplied cabinets, application controllers, and input/output devices.
 - 8. Provision and installation of interconnecting cables between operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.
 - 9. Provide complete manufacturer's specifications for items that are supplied. Include vendor name of every item supplied.
 - 10. Provide supervisory specialists and technicians at the job site to assist in each phase of system installation, startup, and commissioning.
 - 11. A comprehensive operator and technician training program as described herein.
 - 12. As-built documentation, operator's terminal software, diagrams, and other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.
 - 13. New sensors, dampers, valves, and install only new electronic actuators. No used components shall be used as any part or piece of installed system.
 - 14. Adjustment and validation of control system. System testing. System demonstration to Mechanical Engineer and Owner's Representative.
 - 15. No gateways shall be used for communication to controllers installed under this section. Gateways may be used for communication to existing systems or to systems installed under other sections.

1.02 WORK BY OTHERS:

- A. Installation of wells, valves, taps, dampers, flow switches, flow stations, etc. furnished by BAS manufacturer.
- B. Provided under Division 26:

1. Wiring of power feeds to disconnects where starters or VFD's are furnished as an integral part of equipment.
2. Wiring between disconnects and starters to electrical motors and variable speed drives where starters or drives are not an integral part of equipment.

1.03 SYSTEM DESCRIPTION

- A. System shall use the BACnet IP protocol for communication to the operator workstation or web server and for communication between control modules. The entire Building Automation System (BAS) shall be based on BACnet IP. BACnet protocol shall be ANSI/ASHRAE Standard 135-2020 or higher. This system will control mechanical equipment, including unitary equipment such as VAV terminal units, heat pumps, fan coils, AC units, etc. and air handlers, boilers, chillers, and any other listed equipment using native BACnet compliant components. Non BACnet compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.
- B. The control system shall consist of a high-speed, peer-to-peer network of DDC controllers and a web-based operator interface. Depict each mechanical system and building floor plan by a point-and-click graphic. A web server with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.
- C. The system shall directly control HVAC equipment as specified on drawings. Furnish energy conservation features such as optimal start and stop, night setback, request-based logic, and demand level adjustment of setpoints as specified in the sequence.
- D. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. Energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator's terminal. Operator's terminal software is to be used for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.
- E. Schedules, points, setpoints, trends, and alarms specified on drawings shall be BACnet objects.
- F. Application specific controllers for each equipment type (fan coil units, air handlers, etc.) and any other piece of controlled equipment shall be fully programmable. Application specific controllers shall be mounted near the controlled equipment.
- G. Provide for future system expansion to include monitoring of occupant card access, fire alarm, and lighting control systems.

1.04 APPROVED CONTROL SYSTEMS AND VENDORS

- A. Direct Digital Control system shall be built on the Tridium Niagara framework. Control system and components shall be as manufactured, designed, and installed by:
 1. Facility Explorer by Johnson Controls, installed by local or regional factory branch, or installer approved by Owner.
 2. Distech Controls, installed by local or regional factory branch, or installer approved by Owner.
 3. Honeywell, installed by local or regional factory branch, or installer approved by Owner.
- B. The Contractor shall use only operator workstation software, controller software, custom application programming language, and controllers from the corresponding manufacturer and product line unless Owner approves use of multiple manufacturers.
- C. Other products specified herein (such as sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

1.05 QUALITY ASSURANCE

- A. The BAS system shall be designed and installed, commissioned and serviced by manufacturer factory trained personnel or manufacturer representative.
- B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.
- C. BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.
- D. BAS shall comply with UL 864 UUKL and 864 UDTZ, and other subsystem listings as applicable, and herein specified, and be so listed at time of bid.
- E. Electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
- F. Control Valves:
- G. Pressure independent valves and actuators.

1.06 REFERENCE STANDARDS

- A. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2025).
- B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
- C. ProfiBus/ProfiNet SSG - ProfiBus, ProfiNet, and IO-Link Specifications, Standards and Guidelines; Current Edition.
- D. UL 916 - Energy Management Equipment; Current Edition, Including All Revisions.
- E. UL 917 - Clock-Operated Switches; Current Edition, Including All Revisions.

1.07 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting two weeks before starting work of this section; require attendance by all affected installers.
- B. Except as otherwise indicated the system supplier shall secure and pay for permits, inspections, and certifications required for his work and arrange for necessary approvals by the governing authorities.

1.08 SUBMITTALS

- A. See Section 01 3000 - 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. Project Record Documents: Record actual location of control components, including panels, thermostats, and sensors.
- E. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements for additional provisions.

1.09 WARRANTY

- A. Warranty shall cover costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance. Warranty shall apply equally to both hardware and software. Provide updates to operator workstation software, project-specific software, graphic

software, database software, and firmware that resolve Contractor identified software deficiencies at no charge during warranty period. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

1.10 TRAINING

- A. Contractor shall provide training in operation, maintenance, and programming of DDC system for Owner Designated Personnel. Training shall be presented by factory trained instructor, provided through installing control system manufacturer, to give full instruction to designated personnel in operation of system installed. Instructors shall be thoroughly familiar with subject matter they are to teach. Training shall conform to, and include, the following:
 - 1. Provide 8 hours of training for Owner's designated operating personnel.
 - 2. Students shall be provided with binder containing product and system specific training modules for system installed. Minimum of one copy per student plus one extra copy.
 - 3. Training shall be held during normal working hours of 8:00 am to 4:30 PM weekdays, on dates and times as selected by Owner.
 - 4. Explanation of drawings, operations and maintenance manuals.
 - 5. Walk-through of job to locate control components.
 - 6. Operator workstation and peripherals.
 - 7. DDC controller and ASC operation/function.
 - 8. Operator control functions including graphic generation and field panel programming.
 - 9. Operation of portable operator's terminal.
 - 10. Explanation of adjustment, calibration and replacement procedures.
- B. Provide for video recording of full extent of Training sessions.
- C. Since Owner may require personnel to have more comprehensive understanding of hardware and software, additional training must be available from the Contractor. If such training is required by Owner, it will be contracted at a later date.
- D. Provide application engineer to instruct owner in operation of systems and equipment.
- E. Provide system operator's training to include (but not limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data, execution of commands and request of logs.

PART 2 PRODUCTS

2.01 GENERAL

- A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.02 NETWORKING COMMUNICATIONS

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-2020, BACnet.
- B. Install new wiring and network devices as required to provide a complete and workable control network.
- C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.

2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- E. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. System shall automatically adjust for daylight saving and standard time.
- F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.
- G. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards specified by the Web Services Interoperability Organization (WS-I) Basic Profile 1.0 or higher. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.
 1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
 2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
 3. For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.
 4. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.

2.03 OPERATOR'S INTERFACE

- A. General structure of workstation interaction shall be a standard client/server relationship. Server shall be used to archive data and store system database. Clients shall access server for archived data. Each client shall include flexibility to access graphics from server or local drive. Server shall support a minimum of 50 clients simultaneously.
- B. Operators workstation or web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information.
- C. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135-2020, BACnet Annex J.
- D. Workstation/web server hardware:
 1. Type: Desktop computer. Coordinate requirements with owner.
- E. BACnet Conformance:
 1. Operator's workstation shall as a minimum support Point-to-Point (PTP) and Ethernet BACnet LAN types. It shall communicate directly via these BACnet LANs as a native BACnet device. Operator's terminal shall comply with the requirements of a BACnet conformance class 3 device and support BACnet services necessary to provide the following BACnet functional groups:
 - a. Clock Functional Group
 - b. Event Response Functional Group
 - c. Time Master Functional Group
 - d. Device Communications

2. Refer to section 22.2, BACnet Functional Groups, in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. Proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. Necessary tools shall be supplied for working with proprietary information.
3. Standard BACnet object types accessed by the workstation shall include as a minimum: Analog Value, Analog Input, Analog Output, Binary Value, Binary Input, Binary Output, Calendar, Device, Event Enrollment, File, Notification Class, Program and Schedule object types. Proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. Necessary tools shall be supplied for working with proprietary information.
4. The Operator Workstation shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus area networks (CANs). Workstation shall support Foreign Device Registration to allow temporary workstation connection to IP network.

F. Displays:

1. Operator's workstation shall display data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings and wiring diagrams from as-built drawings. Operator's workstation shall display data using three-dimensional graphic representations of mechanical equipment. System shall be capable of displaying graphic file, text, and dynamic object data together on each display and shall include animation. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. Information on any display shall be dynamically updated without any action by the user. Workstation shall allow user to change field-resident EMCS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.
2. Displays and programming shall be generated and customized by the local EMCS supplier and installer. Systems requiring or using factory development of graphics or programming of DDC logic are specifically prohibited.
3. Binary objects shall be displayed as ACTIVE/INACTIVE/NULL or with customized text. Text shall be justified left, right or center as selected by the user. Also, allow binary objects to be displayed as individual change-of-state graphic objects on the display screen such that they overlay the system graphic. Each binary object displayed in this manner shall be assigned up to three graphic files for display when the point is ON, OFF or in alarm. For binary outputs, toggle the object's commanded status when the graphic item is selected with the system mouse. Similarly, allow the workstation operator to toggle the binary object's status by selecting with the mouse a graphic of a switch or light, for example, which then displays a different graphic (such as an "ON" switch or lighted lamp). Additionally, allow binary objects to be displayed as an animated graphic. Animated graphic objects shall be displayed as a sequence of multiple graphics to simulate motion. For example: when a pump is in the OFF condition, display a stationary graphic of the pump. When the operator selects the pump graphic with the mouse, the represented object's status is toggled and the graphic of the pump's impeller rotates in a time-based animation. The operator shall be able to click on an animated graphical object or switch it from the OFF position to ON, or ON to OFF. Allow operator to change graphic file assignment and also create new and original graphics online. System shall be supplied with a library of standard graphics, which may be used unaltered or modified by the operator. Systems that do not allow customization or creation of new graphic objects by the operator (or with third-party software) shall not be allowed.

4. Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual graphic items on the display screen as an overlay to the system graphic. Each analog input object may be assigned a minimum of five graphic files, each with high/low limits for automatic selection and display of these graphics. As an example, a graphic representation of a thermometer would rise and fall in response to either the room temperature or its deviation from the controlling setpoint. Analog output objects, when selected with the mouse, shall be displayed as a prompted dialog (text only) box. Selection for display type shall be individual for each object. Analog object values may be changed by selecting either the "increase" or "decrease" arrow in the analog object spinner box without using the keypad. Pressing the button on the right side of the analog object spinner box allows direct entry of an analog value and accesses various menus where the analog value may be used, such as trendlogs.
 5. Analog objects may also be assigned to an area of a system graphic, where the color of the defined area changes based on the analog object's value. For example, an area of a floor-plan graphic served by a single control zone would change color with respect to the temperature of the zone or its deviation from setpoint. Editing and area assignment shall be created or modified online using simple icon tools.
 6. A customized menu label (push-button) shall be used for display selection. Menu items on a display shall allow penetration to lower level displays or additional menus. Dynamic point information and menu label push buttons may be mixed on the same display to allow sub-displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. A security level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.
 7. A mouse shall be used to move the pointer arrow to the desired item for selection of new display or to allow the operator to make changes to object data.
- G. Password Protection:
1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on. This includes displays as outlined above.
 2. Each operator's terminal shall provide security for 200 users minimum. Each user shall have an individual User ID, User Name and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID shall be 0–8 characters, User Name shall be 0–29 characters, and Password shall be 4–8 characters long. Each system user shall be allowed individual assignment of only those control functions and menu items to which that user requires access. All passwords, user names, and access assignments shall be adjustable online at the operator's terminal. Each user shall also have a set security level, which defines access to displays and individual objects the user may control. System shall include 10 separate and distinct security levels for assignment to users.
 3. System shall include an Auto Logout Feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.
- H. Operator Activity Log:
1. Operator Activity Log shall be included with system that tracks operator changes and activities. System shall track what is changed in the system, who performed this change, date and time of system activity and value of the change before and after operator activity. Operator shall be able to display activity, sort the changes by user and also by operation.
 2. Log shall be gathered and archived to hard drive on operator workstation as needed. Operator shall be able to export data for display and sorting in a spreadsheet.

3. Any displayed data, that is changeable by the operator, may be selected using the right mouse button and the operator activity log shall then be selectable on the screen. Selection of the operator activity log using this method shall show operator changes of just that displayed data.
- I. Scheduling:
1. Operator's workstation shall show information in easy-to-read daily format including calendar of this month and next. Schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily with events being the highest.
 2. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.
 3. Operator shall be able to change information for a given weekly or exception schedule if logged on with the appropriate security access.
 4. System shall include a Schedule Wizard for set up of schedules. Wizard shall walk user through steps necessary for schedule generation. Wizard shall have its own pull-down selection for startup or may be started by right clicking on value displayed on graphic and then selecting Schedule.
 5. Scheduling shall include optimum start based on outside air temperature, current heating/cooling setpoints, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on parameters listed. User shall input schedules to set time that occupied setpoint is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to setpoint. User shall be able to set a limit for the maximum startup time allowed.
- J. Alarm Indication and Handling:
1. Operator's workstation shall provide audible, visual, and printed means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s), currently running. Printout of alarms shall be sent to the assigned terminal and port.
 2. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment and identification of operator acknowledging alarm .
 3. Alarm messages shall be in user-definable text (English or other specified language) and shall be entered either at the operator's terminal or via remote communication.
 4. Alarms shall be configured to either annunciate at selected workstations, print, page, or email in any combination.
 5. System shall include an Alarm Wizard for set up of alarms. Wizard shall walk user through steps necessary for alarm generation. Wizard shall have its own pull-down selection for startup or may be started by right clicking on value displayed on graphic and then selecting alarm setup.
- K. Trendlog Information:
1. System server shall periodically gather historically recorded data stored in the building controllers and archive the information Archived files shall be appended with new sample data, allowing samples to be accumulated. Systems that write over archived data shall not be allowed, unless limited file size is specified. Samples may be viewed at the operator's workstation. Operator shall be able to scroll through trended data. Trendlog information shall be displayed in standard engineering units.
 2. Software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x, y) graphs that display up to ten object types at the same time in different colors. Graphs shall show object values relative to time.

3. Operator shall be able to change trend log setup information. This includes the information to be logged as well as the interval at which it is to be logged. Input, output, and value object types in the system may be logged. Operations shall be password protected. Setup and viewing may be accessed directly from graphics on which object is displayed.
 4. System shall include a trend Wizard for setup of logs. Wizard shall walk user through necessary steps. Wizard shall have its own pull-down selection for startup, or may be started by right clicking on value displayed on graphic, and then selecting Trendlogs from the displayed menu.
- L. Energy Log Information:
1. System server shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display energy log information in standard engineering units.
 2. Data shall be stored in data base file format for direct use by third-party programs. Operation of system shall stay completely online during graphing operations.
 3. Operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. Meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.
 4. System shall display archived data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format the user shall be able to select a specific period of data to view.
- M. Configuration/Setup:
1. Provide means for operator to display and change system configuration. This shall include, but not be limited to, system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.
- N. Field Engineering Tools
1. Operator's workstation software shall include field-engineering tools for programming controllers supplied. Controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.
 2. User shall be able to pick graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.
 3. Programming tools shall include a real time operation mode. Function blocks shall display real time data and be animated to show status of data inputs and outputs when in real time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.
 4. Field engineering tools shall also include a database manager of applications that include logic files for controllers and associated graphics. Operator shall be able to select unit type, input/output configuration and other items that define unit to be controlled. Supply minimum of 250 applications as part of workstation software.
 5. Field engineering tool shall include Device Manager for automatic detection of devices connected anywhere on the system network by scanning of the entire network. This function shall display device instance, network identification, model number and description of connected devices. It shall record and display software file loaded into each controller. A copy of each file shall be stored on the computer's hard drive. If needed, this file shall be downloaded to the appropriate controller by selection using the mouse.

6. System shall include backup/restore function that will back up entire system to selected medium and then restore system from that media.
- O. Software:
1. At the conclusion of project, contractor shall leave with owner a backup of the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the owner to completely restore the system in the case of a computer malfunction.

2.04 WEB INTERFACE

- A. General:
1. BAS supplier shall provide web-based access to the system as part of standard installation. User shall be able to access displays of real-time data that are part of the BAS via a standard Web browser. Web browser shall tie into the network via owner-supplied Ethernet network connection. Web-page host shall be a separate device that resides on the BAS network, but is not the BAS server for the control system. BAS server must be a separate computer from the Web-page host device to ensure data and system integrity. The web-page software shall not require a per user licensing fee or annual fees. The web-page host must be able to support on average 50 simultaneous users with the ability to expand the system to accommodate an unlimited number of users.
- B. Browser Technology:
1. Browser shall be standard version of Microsoft IE 6.0 or later. No special vendor-supplied software shall be needed on computers running browser. Displays shall be viewable and the Web-page host shall directly access real-time data from the BAS network. Data shall be displayed in real time and update automatically without user interaction. User shall be able to change data on displays if logged in with the appropriate user name and password.
- C. Communications:
1. Web-page host shall include two Ethernet network connections. One network connection shall be dedicated to BAS network and shall be used to gather real-time data from the system devices that form the BAS. This network shall communicate via BACnet, allowing the Web-page host to gather data directly from units on the local LAN or from other projects connected over a WAN. This network shall also provide the connection to the BAS server for Web page generation.
 2. The second Ethernet connection shall provide the physical connection to the Internet or an IP-based WAN. It shall be the port that is used for the browser to receive Web pages and data from the Web-page host. The Web-page host shall act as a physical barrier between the BAS network and the WAN or Internet connection that allows the browser to receive web pages and data. The two separate network connections provide for a physical barrier to prevent raw BACnet traffic being exposed on the IP network.
 3. The Web-page host shall provide for complete isolation of the IP and BACnet networks by not routing networking packets between the two networks.
 4. BAS BACnet Ethernet network shall be provided and installed by the BAS supplier. Owner shall provide and incur any monthly charges of WAN/Internet connection.
 5. Web server shall directly communicate to devices on the BAS network using BACnet protocol. No intermediate devices shall be necessary.
- D. Display of Data:
1. Web page graphics shown on browser shall be replicas of the BAS displays. User shall need no additional training to understand information presented on Web pages when compared to what is shown on BAS displays. Web page displays shall include animation just as BAS displays. Fans shall turn, pilot lights shall blink, coils shall change colors, and so on.
 2. Real-time data shall be shown on browser Web pages. This data must be directly gathered via the BACnet network and automatically updated on browser Web page

- displays without any user action. Data on the browser shall automatically refresh as changes are detected without re-drawing the complete display.
3. It shall be possible for user from browser Web page to change data if the user is logged on with the appropriate password. Clicking on a button or typing in a new value shall change digital data. Using pull-down menus or typing in a new value shall change analog data.
 4. Data displays shall be navigated using pushbuttons on the displays that are simply clicked on with the mouse to select a new display. Alternatively, the standard back and forward buttons of the browser can be used for display navigation.
 5. Time Schedule Adjustment:
 6. Web access shall allow user to view and edit schedules in the system. This includes standard, holiday and event schedules as described in BAS specification. Display of schedules shall show interaction of schedules on a single display so user sees an overview of how work together. User shall be able to edit schedules from this display.
 7. Display of 3 schedules must show ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show points and zones affected. User shall be able to set time for one day and select days of the week that shall be affected as a recurrence of that same schedule for that given day.
 8. Schedule list shall show schedules currently defined. This list shall include standard, holiday and event schedules. In addition, user shall be able to select a list that shows scheduled points and zones.
- E. Logging of Information:
1. User shall use standard browser technology to view trend logs in system. User shall be able to view logged data in tabular form or graphical format. User shall be able to adjust time interval of logged data viewed and shall be able to adjust y axis of data viewed in graphical format. User shall also be able to down-load data through the web interface to local computer. Data shall be in CSV format.
- F. Alarm Handling:
1. Web interface shall display alarms as they occur. User shall be able to acknowledge alarms using browser technology. In addition, user shall be able to view history of alarm occurrence over a user selected time frame. In addition, those alarms may be filtered for viewing per user selected options. A single selection shall display alarms that have not been acknowledged.
- G. Web Page Generation:
1. Web pages shall be generated automatically from the BAS displays that reside on the BAS server. User shall access Web-page host via the network and shall initiate a web page generation utility that automatically takes the BAS displays and turns them into Web pages. The Web pages generated are automatically installed on the Web page host for access via any computer's standard browser. Any system that requires use of an HTML editor for generation of Web pages shall not be considered.
- H. Password Security and Activity Log:
1. Access via Web browser shall utilize the same hierarchical security scheme as BAS system. User shall be asked to log in once the browser makes connection to Web-page host. Once the user logs in, changes that are made shall be tracked by the BAS system. The user shall be able to change only those items that the user has authority to change. A user activity report shall show activity of the users that have logged in to the system regardless of whether those changes were made using a browser or via the BAS workstation.

2.05 BUILDING CONTROLLER

A. General Requirements:

1. Building Controller shall be of modular construction such that various modules may be selected to fit the specific requirements of a given project. Modules shall consist of a power supply module, a BACnet Ethernet-MS/TP module, and a BACnet MS/TP only module as a minimum. Ethernet communications and controllers including central plant controllers, advanced application specific controllers and unitary controllers supplied by BMS manufacturer shall utilize the BACnet protocol standard.
2. Modules shall be selected to fit the particular project application. Up to 7 modules shall be powered by a single power supply module. Modules shall be panel mounted on DIN rail for ease of addition and shall be interconnected via simple plug in cable. A module in the middle shall be replaceable without removing any other modules.
3. Modules shall be capable of providing global control strategies for the system based on information from any objects in the system regardless if the object is directly monitored by the building controller module or by another controller. The software program implementing these strategies shall be completely flexible and user definable. Software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, via a wide area network or downloaded via remote communications are not acceptable. Changing global strategies via firmware changes is also unacceptable.
4. Programming shall be object-oriented using control function blocks, supporting DDC functions, 1000 Analog Values and 1000 Binary Values. Flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation. The same tool shall be used for controllers.
5. Provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed via the operator's workstation or field computer.
6. Controller shall have a memory needed to ensure high performance and data reliability. Battery shall provide power for orderly shutdown of controller and storage of data in nonvolatile flash memory. Battery backup shall maintain real-time clock functions for a minimum of 20 days.
7. Global control algorithms and automated control functions shall execute via 32-bit processor.
8. Schedules:
 - a. Each building controller module shall support a minimum of 80 BACnet Schedule Objects and 80 BACnet Calendar Objects.
 - b. Building controller modules shall provide normal 7 day scheduling, holiday scheduling and event scheduling.
9. Logging Capabilities:
 - a. Each building controller shall log as minimum 320 values. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
 - b. Logs may be viewed both on-site and off-site via WAN or remote communication.
 - c. Building controller shall periodically upload trended data to networked operator's workstation for long term archiving if desired.
 - d. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.
10. Alarm Generation:
 - a. Alarms may be generated within the system for any object change of value or state either real or calculated. This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
 - b. Each alarm may be dialed out as noted elsewhere.
 - c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site via remote communications.
 - d. Controller must be able to handle up to 320 alarm setups stored as BACnet event enrollment objects – system destination and actions individually configurable.

11. Standard BACnet object types supported shall include as a minimum: Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program and Schedule object types. Proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. Necessary tools shall be supplied for working with proprietary information.
 12. The Building Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus area networks (CANs) and function as a BACnet Broadcast Management Device (BBMD).
 13. Refer to section 22.2, BACnet Functional Groups, and Annex L in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. Proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. Necessary tools shall be supplied for working with proprietary information.
 - a. BACnet Conformance: Device shall communicate directly via these BACnet LANs as a native BACnet device and shall support simultaneous routing functions between supported LAN types. Global controller shall be BTL Certified BACnet B-BC profile. Including BACnet services necessary to provide the following BACnet functional groups:
 - 1) Clock Functional Group
 - 2) Files Functional Group
 - 3) Reinitialize Functional Group
 - 4) Device Communications Functional Group
 - 5) Event Initiation Functional Group
- B. Ethernet – MS/TP Module:
1. Ethernet – MS/TP Module shall support every function as listed under paragraph A, General Requirements, of this section and the following.
 2. Communication with operator workstation and application specific controllers shall be via BACnet. Building controller Ethernet – MS/TP module shall incorporate as a minimum, the functions of a 2-way BACnet router. Controller shall route BACnet messages between the high-speed LAN (Ethernet 10/100MHz) and master slave token passing (MS/TP) LAN. Ethernet – MS/TP module shall also route messages from other Building Controller modules onto the BACnet Ethernet network.
 - a. MS/TP LAN must be software configurable from 9.6 to 76.8Kbps.
 - b. The RJ-45 Ethernet connection must accept either 10Base-T or 100Base-TX BACnet over twisted pair cable (UTP).
 - c. Ethernet – MS/TP module shall as a minimum support MS/TP and Ethernet BACnet LAN types.
- C. MS/TP Module:
1. MS/TP Module shall support every function as listed under paragraph A, General Requirements, of this section and the following.
 2. Building Controller MS/TP module communications shall be via BACnet master slave token passing (MS/TP) LAN to advanced application and application specific controllers. MS/TP module shall also route messages to Ethernet-MS/TP module for communication over WAN.
 - a. MS/TP LAN must be software configurable from 9.6 to 76.8Kbps
 - b. Configuration shall be via RS-232 connection.
 - c. MS/TP module shall as a minimum support MS/TP BACnet LAN type.
- D. Power Supply Module:
1. Power supply module shall power up to 7 Building Controller Modules. Input for power shall accept between 17 and 30 VAC, 47 to 65 Hz.

2. Power supply module shall include rechargeable battery for orderly shutdown of controller modules including storage of data in flash memory and for continuous operation of real time clocks for minimum of 20 days.

2.06 EQUIPMENT - GENERAL

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.07 APPLICATION SPECIFIC CONTROLLERS

- A. Provide one native BACnet Application Specific Controller for each piece of unitary mechanical equipment that adequately covers objects listed in object list for unit or a BACnet communicating programmable thermostat. Controllers shall interface to building controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include inputs, outputs and programmable, self-contained logic program as needed for complete control of unit.
- B. BACnet Conformance:
 1. ASCs shall as a minimum support MS/TP BACnet LAN types and shall communicate directly via this BACnet LAN, as a native BACnet device. Application specific controllers shall be BTL Certified BACnet B-ASC profile. Including BACnet services necessary to provide the following BACnet functional groups and support BACnet services necessary to provide the following BACnet functional groups:
 - a. Files Functional Group
 - b. Reinitialize Functional Group
 - c. Device Communications Functional Group
 2. Refer to section 22.2, BACnet Functional Groups, and Annex L in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. Proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. Necessary tools shall be supplied for working with proprietary information.
 3. Standard BACnet object types supported shall include as a minimum—Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File and Program Object Types. Proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. Necessary tools shall be supplied for working with proprietary information.
- C. ASCs shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5 VDC, 4–20 mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.
- D. Program sequences shall be stored on board controller in EEPROM or flash memory. No batteries shall be needed to retain logic program. Program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application specific controller shall be completely modifiable in the field over installed BACnet LANs or remotely via modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application specific controller shall be programmed using same programming tools as building controller and as described in operator workstation section. Programming tools shall be provided and installed as part of system.
- E. ASC shall include support for intelligent room sensor. Display on room sensor shall be programmable at controller and include an operating mode and a field service mode. Button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

- F. For VAV terminal units, provide duct temperature sensor at discharge of each VAV terminal unit that is connected to controller for reporting back to operator workstation.

2.08 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. Provide common keying for all panels.

2.09 CONTROL VALVES

- A. Ball Valves and Actuators:
1. Manufacturers:
 - a. Belimo Aircontrols (USA), Inc; _____: www.belimo.com/#sle.
 - b. Johnson Controls International, PLC; _____: www.johnsoncontrols.com/#sle.
 2. Service: Use for brine (30 percent glycol), chilled water, or hot water.
 3. Flow Characteristic: Include 2-way and 3-way diverting operation configured to fail normally closed (NC).
 4. Rangeability: 500 to 1.
 5. Body Size:
 - a. Under 2-1/2 inches (64 mm):
 - 1) Connection: NPT.
 - 2) Materials:
 - (a) Body: Brass.
 - (b) Flanges: Ductile iron.
 - (c) Ball: Chrome-plated brass.
 - (d) Stem: Nickel-plated brass.
 - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - (f) Stem Seal: EPDM O-Rings.
 - (g) Flow Control Disk: Thermoplastic synthetic-resin.
 - b. 2-1/2 inches (64 mm) and Above:
 - 1) Connection Type: Flanged.
 - 2) Materials:
 - (a) Body: Brass.
 - (b) Flanges: Ductile iron.
 - (c) Ball: 300 series stainless steel.
 - (d) Stem: 300 series stainless steel.
 - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - (f) Stem Seal: EPDM O-Rings.
 - (g) Flow Control Disk: Thermoplastic synthetic-resin.
 - c. Service Temperature:
 - 1) Fluid Side: 0 to 284 degrees F (0 to 140 degrees C) liquid or 25 psig (172.4 kPa) steam.
 - 2) Ambient Side: From minus 4 to 122 degrees F (minus 20 to 50 degrees C).
 6. Actuator Requirements:
 - a. Assembly: Factory-mounted.
 - b. Accessories: Provide with valve position indicator and manual override.
- B. Globe Pattern:
1. Up to 2 inches (50 mm): Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
 2. Over 2 inches (50 mm): Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
 3. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F (860 kPa at 121 degrees C).

- b. Provide two-way valves with equal percentage characteristics and three-way valves with linear characteristics. Size two-way valve operators to close valves against pump shut-off head.
- C. Butterfly Pattern:
 - 1. Iron body, bronze disc, resilient replaceable seat for service to 180 degrees F (82 degrees C) wafer or lug ends, extended neck.
 - 2. Hydronic Systems:
 - a. Size for 1 psig (7 kPa) maximum pressure drop at design flow rate.

2.10 PRESSURE INDEPENDENT VALVES AND ACTUATORS

- A. Size 2 inch (50 mm) and Smaller:
 - 1. Provide ball or globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.
 - 2. Metal construction materials consist of bronze or brass.
 - 3. Nonmetal construction materials consist of Teflon, EPDM, or engineered resin.
- B. Size 2.5 inch (64 mm) and Larger:
 - 1. Provide ball, globe, or butterfly style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
 - 2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
 - 3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, or engineered resin.
- C. Actuator Requirements:
 - 1. Assembly: Factory-mounted.
 - 2. Input: 0 to 5 VDC configured for proportional control.
 - 3. Accessories: Provide with fail-safe battery pack, manual override, and valve position indicator.

2.11 CONTROL DAMPERS AND ACTUATOR

- A. General:
 - 1. BAS supplier shall provide automatic control dampers not specified to be supplied integral to HVAC equipment.
 - 2. Damper mounting arrangements shall comply to the following:
 - 3. The ventilation subcontractor shall furnish and install damper channel supports and sheet metal collars.
 - 4. No jack shafting of damper sections shall be allowed.
 - 5. Multi-section dampers shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per section.
 - 6. Size damper sections based on actuator manufacturers specific recommendations for face velocity, differential pressure and damper type. In general:
 - 7. Damper section shall not exceed 24 ft-sq. with face velocity 1500 FPM.
 - 8. Damper section shall not exceed 18 ft-sq. with face velocity 2500 FPM.
 - 9. Damper section shall not exceed 13 ft-sq. with face velocity 3000 FPM.
 - 10. Multiple section dampers of two or more shall be arranged to allow actuators to be direct shaft mounted on the outside of the duct.
 - 11. Multiple section dampers of three or more sections wide shall be arranged with a 3-sided vertical channel (8" wide by 6" deep) within the duct or fan housing and between adjacent damper sections. Vertical channel shall be anchored at the top and bottom to the fan housing or building structure for support. The sides of each damper frame shall be connected to the channels. Holes in the channel shall allow damper drive blade shafts to pass through channel for direct shaft mounting of actuators. Open side of channel shall be faced down stream of the airflow, except for exhaust air dampers.

12. Multiple section dampers to be mounted flush within a wall or housing opening shall receive either vertical channel supports as described above or sheet metal standout collars. Sheet metal collars (12" minimum) shall bring each damper section out of the wall to allow direct shaft mounting of the actuator on the side of the collar.
- B. Automatic Dampers - Extruded Aluminum Airfoil:
1. Description: Extruded aluminum, airfoil blade, low leakage.
 2. Blade Action: Parallel blade, except where opposed blade is noted on Drawings.
 3. Blades: 6 inches wide, extruded aluminum, airfoil shape.
 4. Blade Length: Not to exceed 48 inches in length. Provide multiple sections for dampers over 48 inches.
 5. Frames: 16 ga. galvanized steel or extruded aluminum.
 6. Blade-to-blade Linkage: Concealed within frame.
 7. Blade Axles: 1/2 inch diameter hexagonal or square zinc-plated steel; or 7/8 inch diameter hexagonal extruded aluminum.
 8. Bearings: Oil-impregnated sintered bronze or molded synthetic.
 9. Control Shaft: 1/2 inch diameter, extends 6 inches beyond frame.
 10. Blade Edge Seals: Extruded vinyl or rubber.
 11. Jamb Seals: Flexible stainless steel.
 12. Damper Leakage Rating: AMCA Class 1A, maximum leakage rate of 3 cfm/ft² at 1.0 in w.g. when tested in accordance with AMCA Standard 500D 1998.
 13. Performance Ratings: Certified in accordance with AMCA Standard 500.
 14. Manufacturer: Ruskin, Greenheck, Cesco, or approved. Similar to Ruskin CD50.
- C. Automatic Dampers - Galvanized Steel Airfoil:
1. Description: Galvanized steel, airfoil blade, low leakage.
 2. Blade Action: Parallel blade, except where opposed blade is noted on Drawings.
 3. Blades: 6 inches wide, galvanized steel, airfoil shape.
 4. Blade Length: Not to exceed 48 inches in length. Provide multiple sections for dampers over 48 inches.
 5. Frames: 16 ga. galvanized steel or extruded aluminum.
 6. Blade-to-blade Linkage: Concealed within frame.
 7. Blade Axles: 1/2 inch diameter hexagonal or square zinc-plated steel; or 7/8 inch diameter hexagonal extruded aluminum.
 8. Bearings: Oil-impregnated sintered bronze or stainless steel.
 9. Control Shaft: 1/2 inch diameter, extends 6 inches beyond frame.
 10. Blade Edge Seals: Extruded vinyl or rubber.
 11. Jamb Seals: Flexible stainless steel.
 12. Damper Leakage Rating: AMCA Class 1A, maximum leakage rate of 3 cfm/ft² at 1.0 in w.g. when tested in accordance with AMCA Standard 500D 1998.
 13. Performance Ratings: Certified in accordance with AMCA Standard 500.
 14. Manufacturer: Ruskin, Greenheck, Cesco, or approved. Similar to Ruskin CD60.
- D. Automatic Dampers (A):
1. Description: Extruded aluminum, airfoil blade, low leakage, single or multiple blade type as required.
 2. Blade Action: Parallel blade, except where opposed blade is noted on Drawings.
 3. Blades: Extruded aluminum, airfoil shape. Damper blades shall not exceed 6 inches in width, and 48 inches in length. Provide multiple sections for dampers over 48".
 4. Frames: 13 ga. galvanized steel or extruded aluminum, flanges for mounting.
 5. Blade-to-blade Linkage: Damper drive shaft to be directly bolted to damper blade, with no slip-on or keyed connection and no jackshaft. Drive shaft to extend through damper frame, into damper blade.
 6. Blade Axles: 1/2" diameter hexagonal or square zinc plated steel; or 7/8" diameter hexagonal extruded aluminum.

7. Bearings: Oil-impregnated sintered bronze or bearing grade molded synthetic.
8. Control Shaft: 1/2" diameter, extends 6" beyond frame.
9. Blade Edge Seals: Extruded vinyl or rubber.
10. Jamb Seals: Flexible stainless steel.
11. Leakage Rate: Maximum of 4 cfm per sq ft at 1 inch w.g.
12. Performance Ratings: Certified in accordance with AMCA Standard 500.

E. Damper Actuators:

1. Damper operators shall be electronic type and shall be fully proportioning unless otherwise specified. Damper operators shall have metal bodies. Operators shall have ample power to overcome friction of damper linkage and air pressure acting on damper blades plus 50% safety factor. Damper operator mounting arrangement shall be outside airstream wherever possible. Operators shall have external adjustable stops to limit stroke. Operator linkage arrangement shall be such as to permit normally open or normally closed positions of damper as indicated.
2. Outside air, return air, relief air, and exhaust air damper actuators shall be mechanical spring return. Capacitors or other non-mechanical forms of fail-safe are not acceptable. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the damper as required.
3. Damper operators on modulating dampers that are to be sequenced with other control devices shall, where required to meet sequencing needs, have pilot positioner of full relay type with interconnecting linkage to provide mechanical feedback so as to accurately position and control damper.
4. One electronic actuator shall be direct shaft mounted per damper section. No connecting rods or jackshafts shall be needed. Small outside air and return air economizer dampers may be mechanically linked together if one actuator has sufficient torque to drive both and damper drive shafts are both horizontal installed.
5. Multi-section dampers with electric actuators shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per damper section. (See below execution section for more installation details.)
6. Electric damper actuators (including VAV box actuators) shall be direct shaft mounted and use a V-bolt and toothed V-clamp causing a cold weld effect for positive gripping. Single bolt or setscrew type fasteners are not acceptable.
7. Air handler damper actuators shall utilize analog control (2-10vdc, 4-20ma), floating control is not acceptable.
8. VAV terminal unit damper actuation shall be floating type or analog (2-10vdc, 4-20ma).
9. Normal (fail) Position:
10. Outside Air: Normally closed, spring return.
11. Return Air: Normally open, spring return.
12. Relief Air: Normally closed, spring return.
13. Exhaust Air: Normally closed, spring return.
14. Manufacturer: Belimo

2.12 HVAC&R SENSORS

A. Room Temperature Sensors (Typical Zone Thermostat)

1. DDC room sensor. Sensor shall include a touch screen backlit LCD digital display and user function keys along with temperature sensor. Sensor shall function as room control unit, and shall allow occupant to raise and lower setpoint, and activate systems for override use—all within limits as programmed by building operator.
2. Room Sensor shall simultaneously display room setpoint, room temperature, outside temperature, and CO2 (if applicable) at each unit. The sensor shall be programmable, allowing flexibility to configure the display to match the application. The sensor shall be programmable to display time-of-day, room humidity and outdoor humidity.
3. 10k Ohm thermister.

4. Temperature Range: 40 to 90 deg F with +/- 0.5 degrees F at factory calibrated point of 70 deg F.
 5. Humidity Range: 0-95% RH with $\pm$ 2% accuracy.
 6. Override button for initiation of occupied mode during unoccupied hours. Override time may be set and viewed in half-hour increments. Override time countdown shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word "OFF" in unoccupied mode unless a function button is pressed.
 7. Set point adjustment: The high accuracy set point adjustment incorporates dual temperature scale indication.
 8. Digital temperature display: LCD digital temperature display provides room temperature value in degrees Fahrenheit.
 9. Built-in port allows connection of portable operators terminal to query and modify operating parameters on room level sensor.
 10. Cover color: White.
- B. 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 (26 degrees C).
 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 (0.28 degrees C) minimum.
 - 2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F (0.28 degrees C) minimum.
 - 3) Chilled Water Accuracy: Plus/minus 0.50 degrees F (0.28 degrees C) minimum.
 - 4) All Other Accuracy: Plus/minus 0.75 degrees F (0.42 degrees C) minimum.
 - 5) Range: Minus 40 degrees F (Minus 40 degrees C) through 220 degrees F (104.4 degrees C) minimum.
 - b. Thermistor:
 - 1) Accuracy (All): Plus/minus 0.36 degrees F (0.20 degrees C) minimum.
 - 2) Range: Minus 25 degrees F (Minus 13 degrees C) through 122 degrees F (50 degrees C) minimum.
 6. Outdoor Air Sensors shall include watertight inlet fitting shielded from direct rays of the sun. Assembly shall include sensing element, transmitter, and mounting enclosure.
 7. Duct temperature sensors shall be rigid or averaging as required by sequence of operations. Averaging sensors shall have sufficient length to span duct diagonally.
- C. Static Pressure (Air Pressure) Sensors:
1. Duct static pressure range: -2" to +7.0" w.c.
 2. Accuracy: +/-0.05" w.c.
- D. Current Sensors:
1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 in-wc (0 to 1,250 Pa).
 2. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- E. High Limit Thermostats
1. High limit thermostats shall be manual reset type set at 120 degrees F.
- F. Low Limit Thermostats

1. Electric low temperature detection cut-out and alarm thermostat with remote vapor filled sensing element. Thermostat shall actuate when any one foot length of the element is exposed to temperatures below thermostat setting.
 2. Element Length: 20 foot minimum.
 3. Contacts: Main and auxiliary contacts. Electrical rating as required for application.
 4. Setpoint Adjustment Range: 15 to 55 deg. F.
 5. Differential: 5 deg. F. minimum.
 6. Reset: Manual button.
- G. Current Transformers
1. Current transformer switches shall be furnished for status purposes in air and water applications.
 2. The current transformers shall be designed to be installed or removed without dismantling the primary bus or cables. The transformer shall be of a split core design. The core and windings shall be completely encased in a UL approved thermoplastic rated 94VA. No metal parts shall be exposed other than the terminals. The current transformers shall meet the following specifications:
 3. Accuracy: 1% at 5.0 to 25.0 VA accuracy class with U.P.F. burden.
 4. Provide a disconnect switch for each current transformer.
- H. Air Differential Pressure Switch
1. Differential pressure switches shall be diaphragm type, with die-cast aluminum housing and adjustable set point. Switch rating shall be a minimum 5 amps at 120 VAC. Switches shall be SPDT and be used for fan status as specified in the point schedule. Switch pressure range shall be suited for application. (e.g. filter 0-2.0", fan status 0-5.0", etc.).
- I. Carbon Dioxide Sensors, Duct and Wall:
1. General: Provide nondispersive infrared (NDIR), diffusion sampling CO2 sensors with integral transducers, linear output.
 2. Air Temperature: Range of 32 to 122 degrees F (0 to 50 degrees C).
 3. Relative Humidity: Range of 0 to 95 percent (noncondensing).
 4. Calibration Characteristics:
 - a. Automatically compensating algorithm for sensor drift due to sensor degradation.
 - b. Maximum Drift: 2 percent.
 - c. User calibratable with a minimum calibration interval of 5 years.
 5. Construction:
 - a. Sensor Chamber: Noncorrosive material for neutral effect on carbon dioxide sample.
 - b. Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.
 - c. Housing: High impact plastic.
 6. Measurement range: 0-2000 ppm.
 7. Accuracy: ± 30 ppm
- J. Space Pressurization Sensors
1. Indoor Space Pressure Sensor
 - a. Material: aluminum welded casing.
 - b. Construction: Ceiling mounted shielded static pressure sensor with multiple sensing ports, pressure impulse suppression chamber, airflow shielding and 1/8 inch FPT takeoff fitting.
 - c. Measurement: within 1% of actual pressure value while being subjected to maximum airflow of 1000 fpm from a radial source.
 2. Space Differential Pressure Transmitter
 - a. Output Signal: 0-5 VDC proportional to the differential of the spaces and reference static pressure input signals.
 - b. Span: not greater than three times the design space differential pressure.
 - c. Accuracy: $\pm 0.5\%$ of span.

- d. Dead Band and Hysteresis: less than 0.3% of output.
- e. Linearity: within 0.4% of span.
- f. Repeatability: within 0.2% of output.
- g. Response: less than 0.5 second for full span input.
- h. Temperature stability: less than 0.01% output shift per degree temperature change.
- 3. Outdoor Pressure Sensor (Reference)
 - a. Material: heavy gauge aluminum with hard-anodized finish and 2 inch diameter FPT connection.
 - b. Construction: two circular perforated parallel plates with an integral pressure sensing chamber.
 - c. Measurement: within 2% of actual value when being subjected to varying wind flows with velocities up to 80 miles per hour with approach angles up to 30 degrees to the horizontal.

K.

2.13 MISCELLANEOUS

- A. Condensate Overflow Detectors (cooling coil auxiliary drain connections):
 - 1. Operation: Detects the overflow of water and alarms BAS.
 - 2. Float switch for installation in 3/4" threaded drain pan auxiliary drain connection.
 - 3. N.C. solid state contacts (opens or closes on alarm).
 - 4. Input Rating: 24 VAC/DC @ 2.5 A max.
 - 5. UL 508 for compliance with 2022 OMSC.
- B. Condensate Overflow Level Sensor (cooling coil drain pan mounted):
 - 1. Operation: Detects the overflow of water and alarms BAS.
 - 2. Float switch for installation in drain pan, with attachment to pan rim.
 - 3. N.C. solid state contacts (opens or closes on alarm).
 - 4. Input Rating: 24 VAC/DC @ 2.5 A max.
 - 5. UL 508 for compliance with 2022 OMSC.
- C. Enclosures
 - 1. All controllers, power supplies and relays shall be mounted in enclosures.
 - 2. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment. Outdoor enclosures shall be NEMA 3R with provision for ventilation of electrical equipment such as variable speed drives.
 - 3. Enclosures shall have hinged, locking doors.
 - 4. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 1/8" thick sized appropriately to make label easy to read.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install products in accordance with manufacturer's instructions.
- C. Provide miscellaneous devices, hardware, software, interconnections installation and programming required to ensure a complete operating system in accordance with the sequences of operation.
- D. Contractor shall collaborate with Owner directly to determine Owner's preference for naming conventions, etc. before entering data in system.
- E. Prepare and start logic control system under provisions of this section.
- F. Provide Owner's Representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

- G. Check and verify location of thermostats with plans and room details before installation. Align with lighting switches.
- H. Provide conduit and electrical wiring in accordance with Section 26 0583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.02 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- C. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.
- D. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others.
- E. Do not begin work until unsatisfactory conditions are resolved.

3.03 ELECTRICAL AND WIRING

- A. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for communications trunks.
- B. Wiring shall be installed neatly and professionally, in accordance with Specification Division 26 and national, state and local electrical codes.
- C. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of control equipment with the owner's representative prior to rough-in.
- D. Provide auxiliary pilot duty relays on motor starters as required for control function:
 - 1. Provide required interposing relays for motor starters and contactors.
 - 2. Motor starters, pilot power transformers, and enclosures provided under Division 26. Coordinate 120 VAC or 24 VAC requirements with Division 26.
- E. NEC Class 1 (line voltage) wiring shall be UL Listed in approved conduit according to NEC and Division 26 requirements.
- F. Low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub fused when required to meet Class 2 current limit.)
- G. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in conduit may be used provided that cables are UL Listed for the intended application. For example, cables used in ceiling plenums shall be UL Listed specifically for that purpose.
- H. Provide power for control components from nearest electrical control panel or as indicated on the electrical drawings—coordinate with electrical contractor.
- I. Control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in raceways. Other wiring to be installed neatly and inconspicuously per local code requirements. If local code allows, control wiring above accessible ceiling spaces may be run with plenum rated cable (without conduit).
- J. Wiring in mechanical, electrical, or service rooms—or where subject to mechanical damage—shall be installed in conduit.

3.04 IDENTIFICATION

- A. Provide nameplates for switches, starters, and control devices in accordance with specifications.
- B. Nameplate wording shall be consistent with device names used on shop drawings and in Contract Documents.
- C. Point name and address shall be indicated at each end of control wire connections to DDC equipment.
- D. Identifiers shall match record documents.

3.05 PROTECTION

- A. The contractor shall protect work and material from damage by its employees and/or subcontractors and shall be liable for damage thus caused.
- B. The contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted.

3.06 COORDINATION

- A. Site
 - 1. The project coordination between trades is the responsibility of the prime contractor who is the one tier higher contractual partner such as mechanical contractor, general contractor, construction manager, owner or owner's representative as applicable.
 - 2. The controls contractor shall follow prime contractor's job schedule and coordinate project related activities through the prime contractor except otherwise agreed or in minor job site issues. Reasonable judgment shall be applied.
 - 3. Where the work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment.
 - 4. If the contractor deviates from the job schedule and installs work without coordinating with other trades, so as to cause interference with work of other trades, the contractor shall make the necessary changes to correct the condition without extra charge.
 - 5. Coordinate and schedule work with other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.
- B. Test and Balance
 - 1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
 - 2. The contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
 - 3. In addition, the contractor shall provide a qualified technician for duration of [8] hours to assist in the test and balance process.
 - 4. The tools used during the test and balance process shall be returned at the completion of the testing and balancing.
- C. Life Safety
 - 1. Duct smoke detectors required for air handler shutdown are supplied under Division 26. The contractor shall interlock smoke detectors to air handlers for shutdown as described in Sequence of Operation.
 - 2. Smoke dampers and actuators required for duct smoke isolation are provided under a Section 23 33 00 Ductwork Accessories. The contractor shall interlock these dampers to the air handlers as described in Sequence of Operation.
 - 3. Fire/smoke dampers and actuators required for fire rated walls are provided under another Section 23 33 00 Ductwork Accessories. Control of these dampers shall be by Division 26.

3.07 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.08 LOCATION AND INSTALLATION OF SENSORS AND COMPONENTS

- A. General
 - 1. Install sensors in accordance with the manufacturer's recommendations.
 - 2. Mount sensors rigidly and adequately for the environment within which the sensor operates.
 - 3. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
 - a. Mount space temperature sensors approximately 48 inches above finished floor or adjacent to room light switch/sensor, where shown on Drawings. Coordinate with architect for exact height requirements.
 - 4. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
 - 5. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type.
 - 6. Instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.
 - a. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections—sized to suit pipe diameter without restricting flow.
 - 7. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across the full face of the coil.
 - 8. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
 - 9. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.
 - 10. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3'-0" clear access space in front of units. Obtain approval on locations from owner's representative prior to installation. This includes, but is not limited to space temperature sensors, carbon dioxide sensors, etc.
- B. Differential Air Static Pressure
 - 1. Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - 2. Return Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
 - 3. Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
 - 4. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.

5. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork.
6. Mount transducers in a location accessible for service without use of ladders or special equipment.

3.09 ACTUATORS

- A. Mount and link control damper actuators according to manufacturer's instructions.
- B. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
- C. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
- D. Provide all mounting hardware and linkages for actuator installation.
- E. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.
- F. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.10 SPLIT SYSTEMS

- A. Provide low voltage control wiring between indoor unit and outdoor unit (approximately 9 wires)
- B. Provide low voltage control wiring between indoor unit and thermostat (approximately 6 wires). Thermostats furnished with heat pumps, installed by this section.
- C. Set thermostat setpoints and test and adjust controls for proper operation.

3.11 DDC OBJECT TYPE SUMMARY

- A. Provide database generation.
- B. Displays:
 1. System displays shall show analog and binary object types within the system. They shall be logically laid out for easy use by the owner. Provide outside air temperature indication on system displays associated with economizer cycles.
 2. Provide software HOAs for major pieces of equipment such as fans, pumps, valves, and dampers.
- C. Run Time Totalization:
 1. At a minimum, run time totalization shall be incorporated for each monitored supply fan, return fan, exhaust fan, hot water and chilled water pumps. Warning limits for each point shall be entered for alarm and or maintenance purposes.
- D. Trendlog:
 1. Binary and analog object types (including zones) shall have the capability to be automatically trended.
- E. Alarm:
 1. Analog inputs (High/Low Limits) and selected binary input alarm points shall be prioritized and routed (locally or remotely) with alarm message per owner's requirements.
- F. Database Save:
 1. Provide back-up database for stand-alone application controllers on disk.

3.12 START-UP, COMMISSIONING, AND DEMONSTRATION

- A. Start-up and commission systems. Allow sufficient time for start-up and commissioning. Coordinate requirements with Commissioning Authority.

- B. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
- C. Control equipment shall be tested under operating conditions by a qualified technician in the employ of the Controls Manufacturer, in the presence of Owner's representative. Upon completion of testing and adjustments, submit written certification to Mechanical Engineer that controls have been calibrated, adjusted and are operating satisfactorily.
- D. The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
- E. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
- F. Demonstrate the following:
 - 1. Specified facility management software is installed and operational.
 - 2. Compliance with sequences of operation through all modes of operation.
 - 3. Complete operation of operator interface.
 - 4. DDC control loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC control loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
 - 5. Demonstrate supply air reset.
 - 6. BAS system equipment start/stop, and manually start/stop from BAS terminal.
 - 7. Commandable equipment fails to the desired state on ASC power failure.
 - 8. Equipment under BAS control start and stop automatically as required by the stop/start program or by an operator defined schedule.
 - 9. Temperature control systems under BAS control operate correctly to maintain respective temperatures within acceptable limits.
 - 10. Equipment monitored for safety or information purposes generates the required response when a condition needing attention occurs.
 - 11. Air handlers and fans shut off upon activation of their respective freeze stat or smoke detectors, and remain off until manually reset.
 - 12. Equipment subject to night setback operation starts automatically when temperature drops to the night setback temperature during unoccupied time.
 - 13. Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
 - 14. Interface to the building fire alarm system.
- G. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete tests.

END OF SECTION

SECTION 23 0934
VARIABLE-FREQUENCY MOTOR CONTROLLERS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.
- B. Overcurrent protective devices for motor controllers, including overload relays.

1.02 RELATED REQUIREMENTS

- A. Section 23 0529 - Hangers and Supports for HVAC Piping and Equipment.
- B. Section 23 0553 - Identification for HVAC Piping and Equipment: Identification products and requirements.
- C. Section 26 0526 - Grounding and Bonding for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).
- B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.
- C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).
- E. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; 2017.
- F. NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (Reaffirmed 2016).
- G. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives; 2020.
- H. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems; 2022.
- I. NEMA ICS 7.2 - Application Guide for AC Adjustable Speed Drive Systems; 2021.
- J. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems; 2005.
- K. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).
- L. NEMA MG 00001 - Motors and Generators; 2024.
- M. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.
- N. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- O. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.
- P. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- Q. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- R. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2); Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Coordinate work to provide motor controllers suitable for use with actual motors to be installed.
2. Coordinate work to provide controllers and associated wiring suitable for interface with control devices to be installed.
3. Coordinate arrangement with dimensions and clearance requirements of actual equipment to be installed.
4. Verify with manufacturer that conductor terminations are suitable for use with conductors to be installed.
5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
- B. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 1. Include dimensioned plan and elevation views of controllers and adjacent equipment with required clearances indicated.
 2. Include wiring diagrams showing factory and field connections.
- C. Derating Calculations: Indicate ratings adjusted for applicable service conditions.
- D. Specimen Warranty: Submit sample of manufacturer's warranty.
- E. Manufacturer qualification statement.
- F. Installer qualification statement.
- G. Maintenance contractor qualification statement, if different entity from installer.
- H. Manufacturer's certification that products meet or exceed specified requirements.
- I. Manufacturer's Installation 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.
- J. Source quality control test reports.
- K. Manufacturer's detailed field testing procedures.
- L. Field quality control test reports.
- M. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
 1. Include contact information for entity providing contract maintenance and trouble call-back service.
- N. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- O. Maintenance contracts.
- P. Project Record Documents: Record actual installed locations of controllers and final equipment settings.
 1. Include nameplate data of actual installed motors and associated overload relay selections and settings.
 2. Motor Circuit Protectors: Include magnetic instantaneous trip settings.
- Q. Maintenance Materials: Furnish following for Owner's use in maintenance of project.
 1. Electronic Trip Circuit Breakers: Provide one portable test set.
 2. Indicating Lights: Two of each different type.
 3. Air Filters: Two of each different type.

4. See Section 26 2813 for requirements for spare fuses and spare fuse cabinets.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain copy of each referenced document that prescribes execution requirements at project site.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
 1. Authorized service facilities located within 200 miles (320 km) of project site.
- D. Installer Qualifications: Company with minimum three years documented experience with variable-frequency motor control systems of similar size, type, and complexity; manufacturer's authorized installer.
- E. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
 1. Contract maintenance office located within 200 miles (320 km) of project site.
- F. 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. Store in clean, dry space. Maintain factory wrapping or provide 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 internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide minimum 18 month manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB; _____: www.abb.com/#sle.
- B. Source Limitations: Furnish variable-frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

- A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.
- B. Provide products listed, classified, and labeled as suitable for purpose intended.
- C. Variable-Frequency Motor Controller:
 1. Configuration: Packaged controller, nonbypass.
 2. Rectifier/Converter: Diode-based, 6-pulse type.
 3. Control Method: Vector; open-loop, without feedback.
 4. Filtering: Provide input/line reactor and output/load reactor.
 5. Input/Output Connections: Refer to contract drawings.
 6. Pilot Devices: Refer to contract drawings.
 7. Features:
 - a. Braking chopper/resistor.

- b. PID control.
 - c. Safety interlock.
 - d. Damper/valve control.
 - e. PTC motor thermistor input.
- D. Controller Assemblies: Comply with NEMA ICS 7, NEMA ICS 7.1, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.
- E. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA ICS 7.2, NEMA MG 00001 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
 - 1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 00001 design letter or inverter duty rating for induction motors.
 - 2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
 - 3. Motor nameplate data.
 - 4. Requirements for speed control range, speed regulation, and braking.
 - 5. Motor suitability for bypass starting method, where applicable.
- F. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.
- G. Operating Requirements:
 - 1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
 - 2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
 - 3. Efficiency: Minimum of 96 percent at full speed and load.
 - 4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
 - 5. Overload Rating:
 - a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
 - b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.
- H. Power Conversion System: Microprocessor-based, pulse width modulation type consisting of rectifier/converter, DC bus/link, and inverter.
 - 1. Rectifier/Converter: Diode-based, 6-pulse type unless otherwise indicated.
- I. Control System:
 - 1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
 - 2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
 - 3. Control Functions:
 - a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
 - 1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
 - 2) Vector Control: Provide selectable autotuning function.
 - b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
 - c. Selectable braking control; DC injection or flux braking.
 - 1) Dynamic Braking: Provide braking chopper circuit and appropriately sized braking resistor where indicated.
 - d. Adjustable minimum/maximum speed limits.
 - e. Adjustable pulse width modulation switching carrier frequency.
 - f. Adjustable motor slip compensation.

- g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.
 - h. Automatic response to loss of speed reference; selectable to run motor at last known speed or run motor at designated speed.
 - i. PID Control: Provide integral PID controller employing feedback for closed-loop control where indicated or required.
 - j. Selectable frequency-skipping; minimum of three independently adjustable bands.
 - k. Automatic catching of rotating motor.
 - l. Energy-saving algorithms.
 - m. Safety Interlock: Provide permissive run safety interlock capability where indicated or required; upon activation of designated input, stop and prevent operation of motor; operational in both drive and bypass modes where applicable.
 - n. Damper/Valve Control: Provide damper/valve control capability where indicated or required; upon receiving motor start command, activate designated damper/valve output and delay motor start until activation of designated end switch input confirms damper/valve operation.
4. Status Indications:
- a. Motor run/stop status.
 - b. Motor forward/reverse status.
 - c. Local/remote control status.
 - d. Output voltage.
 - e. Output current.
 - f. Output frequency.
 - g. DC bus voltage.
 - h. Motor speed.
 - i. Speed reference.
 - j. Instantaneous power.
 - k. Energy.
 - l. Elapsed run time.
 - m. Controller temperature.
 - n. Discrete input/output status.
 - o. Analog input/output values.
5. Protective Functions/Alarm Indications:
- a. Overcurrent.
 - b. Motor overload.
 - c. Undervoltage.
 - d. Overvoltage.
 - e. Controller overtemperature.
 - f. Input/output phase loss.
 - g. Output short circuit protection.
 - h. Output ground fault protection.
 - i. Motor stalled/overtorque.
 - j. Motor underload.
 - k. External fault.
6. Inputs:
- a. Digital Input(s): Three.
 - b. Analog Input(s): Two.
 - c. PTC motor thermistor input where indicated.
7. Outputs:
- a. Analog Output(s): One.
 - b. Relay Output(s): Two.
8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.

- a. Serial Communications: RS-485; support for Modbus RTU protocol.
 - b. Ethernet Communications: Support for BACnet IP protocol.
 - c. Remote Monitoring Capabilities:
 - 1) Motor run/stop status.
 - 2) Hand-off-auto status.
 - 3) Fault information.
 - 4) Discrete input/output status.
 - 5) Analog input/output values.
 - d. Remote Control Capabilities:
 - 1) Motor run/stop command.
 - 2) Hand-off-auto selection.
 - 3) Speed adjustment.
 - 4) Fault reset.
- 9. Features:
 - a. Password-protected security access.
 - b. Event log.
 - c. Remote monitoring and programming capability via web browser.
- J. Power Conditioning/Filtering:
 - 1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.
 - 2. Provide LCL filter for controllers with IGBT-based active front end rectifier/converter.
 - 3. Provide input surge protection.
 - 4. Provide where indicated:
 - a. Input/line reactor.
 - b. Input tuned passive filter.
 - c. Output/load reactor.
 - d. Output dV/dt filter.
 - e. Output sine wave filter.
 - 5. Reactor Impedance: 3 percent, unless otherwise indicated or required.
- K. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
 - 1. Disconnects: Circuit breaker or disconnect switch type.
 - a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
 - b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
 - c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
 - 2. Provide door-mounted remote operator interface.
 - 3. Packaged Controllers with Bypass: Provide contactors and controls to enable removal of variable-frequency controller from circuit.
 - a. Bypass Method: Manual, unless otherwise indicated.
 - b. Bypass Configuration: 3-contactor type, with contactors for bypass, drive output, and drive input.
 - c. Bypass Motor Starting Method: Full-voltage (across-the-line) with overload relay, unless otherwise indicated or required.
 - d. Overload Relays: Solid state or bimetallic thermal type.
 - 4. Pilot Devices Required:
 - a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings, except where equivalent function is provided by remote operator interface.
 - b. Packaged Controllers with Bypass:

- 1) Bypass Mode Selector Switch: DRIVE/OFF/BYPASS.
- 2) Motor Control Selector Switch: HAND/OFF/AUTO.
- 3) Indicating Lights: For drive/bypass mode status, drive/bypass run status, and drive/bypass fault status.
- 4) Speed potentiometer.
- 5) Pushbuttons:
- c. Packaged Controllers without Bypass:
 - 1) Pushbuttons:
 - 2) Selector Switches:
 - 3) Indicating Lights:
- L. Seismic Qualification: Provide controllers and associated components suitable for application under seismic design criteria specified in Section 23 0548 where required. Include certification of compliance with submittals.
- M. Service Conditions:
 1. Provide controllers and associated components suitable for operation under following service conditions without derating:
 - a. Altitude: Less than 3,300 feet (1,000 m).
 - b. Ambient Temperature: Between 32 degrees F (0 degrees C) and 104 degrees F (40 degrees C).
- N. Short Circuit Current Rating:
 1. Provide controllers with listed short circuit current rating not less than available fault current at installed location as indicated on drawings.
 2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.
 3. Label equipment utilizing series ratings as required by NFPA 70.
- O. Conductor Terminations: Suitable for use with conductors to be installed.
- P. Enclosures:
 1. Comply with NEMA ICS 6.
 2. NEMA EN 10250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified, for following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1 or Type 12.
 - b. Outdoor Locations: Type 3R or Type 4.
 - c. Hazardous/Classified Locations: Type 7/9, as required for classification of installed location.
 3. Finish: Manufacturer's standard unless otherwise indicated.
 4. Cooling: Forced air or natural convection as determined by manufacturer.
 5. Enclosure Space Heaters:
 - a. Provide in each controller enclosure installed outdoors and in unconditioned indoor spaces.
 - b. Size according to manufacturer's recommendations for worst case ambient temperature to prevent condensation.
 - c. Heater Control: Thermostat.
 - d. Heater Power Source: Provide connection to transformer factory-installed in enclosure or suitable external branch circuit as indicated or as required.
- Q. Instrument Transformers:
 1. Comply with IEEE C57.13.
 2. Select suitable ratio, burden, and accuracy as required for connected devices.
 3. Current Transformers: Connect secondaries to shorting terminal blocks.
 4. Potential Transformers: Include primary and secondary fuses with disconnecting means.
- R. Interface with Other Work:
 1. Provide products compatible with other systems requiring interface with controllers.

2. Interface with building automation system
 - a. Capable of remote monitoring and control of controllers.
 3. Interface with fire alarm control system as specified in Section 28 4600.
 - a. Capable of affecting operation of selected HVAC equipment for selected fire alarm system events.
- S. Products:
1. ABB; ACH580: www.abb.com/#sle.

2.03 OVERCURRENT PROTECTIVE DEVICES

- A. Overload Relays:
1. Provide overload relays and, where applicable, associated current elements/heaters selected for actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
 2. Comply with NEMA ICS 2.
 3. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
 4. Trip-free operation.
 5. Visible trip indication.
 6. Resettable:
 - a. Employ manual reset unless otherwise indicated.
 - b. Employ automatic reset or remote reset where indicated.
 7. Bimetallic Thermal Overload Relays:
 - a. Provide ambient temperature compensation.
 - b. Interchangeable current elements/heaters.
 - c. Adjustable trip; plus/minus 10 percent of nominal, minimum.
 - d. Designed for quicker trip response under phase loss condition.
 - e. Trip test function.
 - f. Provide isolated alarm contact where indicated.
 8. Melting Alloy Thermal Overload Relays:
 - a. Interchangeable current elements/heaters.
 - b. Provide isolated alarm contact where indicated.
 9. Solid State Overload Relays:
 - a. Selectable inverse-time trip class rating; available ratings of Class 10, 20, and 30, minimum.
 - b. Adjustable full load current.
 - c. Phase loss protection.
 - d. Phase imbalance protection.
 - e. Ground fault protection.
 - f. Ambient temperature insensitive.
 - g. Thermal memory.
 - h. Repeat Trip Accuracy: Plus/minus 2 percent, minimum.
 - i. Trip test function.
 - j. Provide isolated alarm contact.
 - k. Provide communication capability where indicated: Compatible with system indicated.
- B. Fusible Disconnect Switches:
1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA BS 31047, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated or as required.
 2. Fuse Clips: As required to accept indicated fuses.
 - a. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

3. Provide externally operable handle with means for locking in OFF position. Provide means for locking switch cover in closed position. Provide safety interlock to prevent opening of cover with switch in ON position with capability of overriding interlock for testing purposes.
- C. Circuit Breakers:
1. Motor Circuit Protectors:
 - a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of listed combination motor controller with overload protection; ratings, configurations, and features as indicated or as required.
 - b. Provide field-adjustable magnetic instantaneous trip setting.
 - c. Provide following features and accessories where indicated or where required to complete installation:
 - 1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - 2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.
 - 3) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
 - 4) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
 - 5) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.
 2. 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; ratings, configurations, and features as indicated or as required.
 - 1) Provide thermal magnetic circuit breakers unless otherwise indicated.
 - 2) Provide electronic trip circuit breakers where indicated.
 - b. Interrupting Capacity:
 - 1) Provide circuit breakers with interrupting capacity as required to provide short circuit current rating indicated, but not less than specified minimum requirements.
 - 2) Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than short circuit current rating indicated.
 - 3) Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than short circuit current rating indicated.
 - c. 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.
 - 2) Provide interchangeable trip units where indicated.
 - d. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - 1) Provide 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.

- e. Provide following features and accessories where indicated or where required to complete installation:
 - 1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - 2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.
 - 3) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
 - 4) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
 - 5) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.04 ACCESSORIES

- A. Auxiliary Contacts:
 - 1. Comply with NEMA ICS 5.
 - 2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each bypass motor starter, minimum.
- B. Pilot Devices:
 - 1. Comply with NEMA ICS 5; heavy-duty type.
 - 2. Nominal Size: 30 mm.
 - 3. Pushbuttons: Unless otherwise indicated, provide momentary, nonilluminated type with flush button operator; normally open or normally closed as indicated or as required.
 - 4. Selector Switches: Unless otherwise indicated, provide maintained, nonilluminated type with knob operator; number of switch positions as indicated or as required.
 - 5. Indicating Lights: Push-to-test type unless otherwise indicated.
 - 6. Provide LED lamp source for indicating lights and illuminated devices.
- C. Control and Timing Relays:
 - 1. Comply with NEMA ICS 5.
 - 2. Provide number and type of relays indicated or required to perform necessary functions.
 - 3. Timing Relays: Electronic.
 - a. Adjustable Timing Range: As required for application.
- D. Control Power Transformers:
 - 1. Size to accommodate burden of contactor coil(s) and connected auxiliary devices plus 10% spare capacity.
 - 2. Include primary and secondary fuses.
- E. Control Terminal Blocks: Include 25 percent spare terminals.

2.05 SOURCE QUALITY CONTROL

- A. Factory test controllers in accordance with NEMA ICS 61800-2.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings of controllers are consistent with indicated requirements.
- C. Verify that mounting surfaces are ready to accept controllers.
- 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. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.

- C. Do not exceed manufacturer's recommended maximum cable length between controller and motor.
- 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 23 0529.
- F. Provide required seismic controls in accordance with Section 23 0548.
- G. Install controllers plumb and level.
- H. Unless otherwise indicated, mount floor-mounted controllers on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 03 3000.
- I. Provide grounding and bonding in accordance with Section 26 0526.
- J. Install field-installed devices, components, and accessories.
- K. Provide fuses complying with Section 26 2813 for fusible switches as indicated.
- L. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- M. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.
- N. Identify controllers in accordance with Section 23 0553.

3.03 FIELD QUALITY CONTROL

- A. Provide services of manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.17. Insulation-resistance test on control wiring listed as optional is not required.
- D. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- E. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1. Tests listed as optional are not required.
 - 1. Perform insulation-resistance tests on control wiring with respect to ground.
 - 2. Test functions of trip unit by means of secondary injection.
- F. Packaged Controllers with Bypass: Test for proper operation in both drive and bypass modes.
- G. Test for proper interface with other systems.
- H. Correct deficiencies and replace damaged or defective controllers or associated components.
- I. Submit detailed reports indicating inspection and testing results and corrective actions taken.

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 controller enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.

- C. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.
- D. Training: Train Owner's personnel on operation, adjustment, and maintenance of controllers and associated devices.
 - 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 controllers from subsequent construction operations.

3.08 MAINTENANCE

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide to Owner a proposal as alternate to base bid, a separate maintenance contract for service and maintenance of controllers for two years from date of Substantial Completion; Include complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with detailed schedule.
- C. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.
- D. Provide trouble call-back service upon notification by Owner:
 - 1. Include allowance for call-back service during normal working hours at no extra cost to Owner.

END OF SECTION

**SECTION 23 1123
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 8400 - Firestopping.
- B. Section 08 3100 - Access Doors and Panels.
- C. Section 09 9113 - Exterior Painting.
- D. Section 09 9123 - Interior Painting.
- E. Section 23 0516 - Expansion Fittings and Loops for HVAC Piping.
- F. Section 23 0548 - Vibration and Seismic Controls for HVAC.
- G. Section 23 0553 - Identification for HVAC Piping and Equipment.
- H. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.
- I. Section 31 2316 - Excavation.
- J. Section 31 2316.13 - Trenching.
- K. Section 31 2323 - Fill.

1.03 REFERENCE STANDARDS

- A. ANSI LC 1/CSA 6.26 - Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing; 2019.
- B. ANSI Z21.18/CSA 6.3 - Gas Appliance Pressure Regulators; 2019.
- C. ANSI Z21.80/CSA 6.22 - Line Pressure Regulators; 2019.
- D. ANSI Z223.1 - National Fuel Gas Code; 2024.
- E. 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; 2021.
- F. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- G. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- H. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- I. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; 2018.
- J. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- K. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- L. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- M. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2019.
- N. ASTM B68/B68M - Standard Specification for Seamless Copper Tube, Bright Annealed; 2019.
- O. ASTM B75/B75M - Standard Specification for Seamless Copper Tube; 2020.
- P. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2020.
- Q. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.

- R. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2020.
- S. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.
- T. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2016.
- U. ASTM D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings; 2020.
- V. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing; 2020.
- W. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
- X. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 2024.
- Y. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- Z. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2022).
- AA. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2015.
- BB. ICC-ES AC106 - Acceptance Criteria for Pre drilled Fasteners (Screw Anchors) in Masonry Elements; 2015.
- CC. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2015.
- DD. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- EE. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends; 2011.
- FF. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

1.04 SUBMITTALS

- A. See Section 01 3000 - 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. Welders' Certificates: Submit certification of welders' 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.
- E. Sustainable Design Documentation: For soldered copper joints, submit installer's certification that the specified installation method and materials were used.
- F. Project Record Documents: Record actual locations of valves.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Valve Repacking Kits: One for each type and size of valve.

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, and ASTM specification.

1.06 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.

1.07 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 NATURAL GAS PIPING, BURIED

- A. Polyethylene Pipe: ASTM D2513, SDR 11 listed for natural gas.
 - 1. Fittings: ASTM D2683 or ASTM D2513 socket type.
 - 2. Joints: Fusion welded.

2.02 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: Threaded or welded to ASME B31.1.

2.03 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 2" and Under:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded unions.
- B. Flanges for Pipe Size Over 2" :
 - 1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.04 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.
 - 5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.
 - 6. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
 - a. Bases: High density polypropylene.
 - b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
 - e. Height: Provide minimum clearance of 6 inches (150 mm) under pipe to top of roofing.
 - f. Manufacturers:

1) PHP Systems/Design; _____: www.phpsd.com/#sle.

- B. Hanger Fasteners: Attach hangers to structure using appropriate fasteners. Coordinate attachments to structure with the project Structural Engineer

2.05 BALL VALVES

- A. Manufacturers:
1. Apollo Valves
 2. Grinnell Products
 3. Milwaukee Valve Company
 4. Nibco, Inc
- B. Construction, 2 Inches (100 mm) and Smaller: two piece, listed for natural gas, MSS SP-110, Class 150, 400 psi (2760 kPa) CWP, bronze body, 304 stainless steel or chrome plated brass ball, full port, Teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded ends with union.

2.06 PLUG VALVES

- A. Construction 2-1/2 Inches (65 mm) and Larger: MSS SP-78, 175 psi (1200 kPa) CWP, cast iron body and plug, pressure lubricated, Teflon or Buna N packing, flanged ends. Provide lever operator with set screw.

2.07 STRAINERS

- A. Manufacturers:
1. Armstrong International, Inc
 2. Green Country Filter Manufacturing
 3. WEAMCO; _____: www.weamco.com/#sle.
- B. Size 2 inch (50 mm) and Under:
1. Class 150, threaded bronze body 300 psi (2070 kPa) CWP, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
- C. Size over 2-1/2 inch to 4 inch
1. Class 125, flanged iron body, Y pattern with 1/16 inch (1.6 mm) stainless steel perforated screen.
- D. Size 6 inch and Larger:
1. Class 125, flanged iron body, basket pattern with 1/8 inch (3.2 mm) stainless steel perforated screen.

2.08 LINE PRESSURE REGULATORS AND APPLIANCE REGULATORS (REFER TO DRAWINGS)

- A. Manufacturers:
1. Maxitrol Company; _____: www.maxitrol.com/#sle.
 2. Substitutions: See Section 01 6000 - Product Requirements.
- B. Compliance Requirements:
1. Appliance Regulator: ANSI Z21.18/CSA 6.3.
 2. Line Pressure Regulator: ANSI Z21.80/CSA 6.22.
- C. Materials in Contact With Gas:
1. Housing: Aluminum, steel (free of non-ferrous metals).
 2. Seals and Diaphragms: NBR-based rubber.
- D. Maximum Inlet Operating Pressure: 10 psi (68.9 kPa).
1. Appliance Regulator: 5 psi (34.5 kPa).
 2. Line Pressure Regulator: 10 psi (68.9 kPa).
- E. Maximum Body Pressure: 10 psi (1000 mbar).
- F. Inlet and Output Pressure: Refer to drawings.

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. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 0516.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed.
 - 1. Coordinate size and location of access doors with Section 08 3100.
- I. Establish elevations of buried piping outside the building to ensure not less than 18 inches of cover per Code. If less than 18 inches of cover, provide steel pipe sleeve for protection.
- J. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- L. Provide support for utility meters in accordance with requirements of utility companies.
- M. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
 - 1. Painting of interior piping systems and components is specified in Section 09 9123.
 - 2. Painting of exterior piping systems and components is specified in Section 09 9113.
- N. Excavate in accordance with Section 31 2316.
- O. Backfill in accordance with Section 31 2323. Include metal detaction wire for non-metalic gas piping below grade.
- P. Install valves with stems upright or horizontal, not inverted.
- Q. Pipe vents from gas pressure reducing valves to outdoors and arrange to prevent water from entering pipe.
- R. Sleeve pipes passing through partitions, walls and floors.
- S. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Support horizontal piping as indicated.
 - 3. Install hangers to provide minimum 1/2 inch (15 mm) space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inch (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 - a. Painting of interior piping systems and components is specified in Section 09 9123.
 - b. Painting of exterior piping systems and components is specified in Section 09 9113.
9. Provide hangers adjacent to motor driven equipment with vibration isolation.

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. Install ball valves for throttling, bypass, or manual flow control services.
- D. Provide plug valves in natural gas systems for shut-off service.

3.05 SCHEDULES

- A. Pipe Hanger Spacing:
 1. Metal Piping:
 - a. Pipe Size: 1/2 inches (15 mm) to 1-1/4 inches (32 mm):
 - 1) Maximum Hanger Spacing: 6.5 ft (2 m).
 - 2) Hanger Rod Diameter: 3/8 inches (9 mm).
 - b. Pipe Size: 1-1/2 inches (40 mm) to 2 inches (50 mm):
 - 1) Maximum Hanger Spacing: 10 ft (3 m).
 - 2) Hanger Rod Diameter: 3/8 inch (9 mm).
 - c. Pipe Size: 2-1/2 inches (65 mm) to 3 inches (75 mm):
 - 1) Maximum Hanger Spacing: 10 ft (3 m).
 - 2) Hanger Rod Diameter: 1/2 inch (13 mm).
 - d. Pipe Size: 4 inches (100 mm) to 6 inches (150 mm):
 - 1) Maximum Hanger Spacing: 10 ft (3 m).
 - 2) Hanger Rod Diameter: 5/8 inch (15 mm).

END OF SECTION

SECTION 23 2113 HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Chilled water piping, buried.
- D. Chilled water piping, above grade.
- E. Equipment drains and overflows.
- F. Pipe hangers and supports.
- G. Unions, flanges, mechanical couplings, and dielectric connections.
- H. Valves:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.
 - 4. Pressure independent temperature control valves and balancing valves.
- I. Flow controls.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 08 3100 - Access Doors and Panels.
- C. Section 09 9123 - Interior Painting.
- D. Section 23 0516 - Expansion Fittings and Loops for HVAC Piping.
- E. Section 23 0523 - General-Duty Valves for HVAC Piping.
- F. Section 23 0548 - Vibration and Seismic Controls for HVAC.
- G. Section 23 0553 - Identification for HVAC Piping and Equipment.
- H. Section 23 0719 - HVAC Piping Insulation.
- I. Section 23 2114 - Hydronic Specialties.
- J. Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A. ANSI/FCI 70-2 - Control Valve Seat Leakage; 2021.
- B. 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; 2021.
- C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- D. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- E. ASME B16.15 - Cast Copper Alloy Threaded Fittings: Classes 125 and 250; 2024.
- F. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- G. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- H. ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2020.
- I. ASME B31.9 - Building Services Piping; 2020.
- J. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.

- K. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service; 2019a.
- L. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2019.
- M. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
- N. ASTM B32 - Standard Specification for Solder Metal; 2020.
- O. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2020.
- P. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- Q. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- R. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings; 2022.
- S. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2020.
- T. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2021.
- U. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2024.
- V. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping; 2020.
- W. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020.
- X. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 2024.
- Y. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing; 2022a, with Editorial Revision.
- Z. ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems; 2022.
- AA. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2019).
- BB. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- CC. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2022).
- DD. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.
- EE. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2021.
- FF. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2017.
- GG. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2017, with Errata (2018).
- HH. AWWA C606 - Grooved and Shouldered Joints; 2015.
- II. DIN 4726 - Warm Water Surface Heating Systems and Radiator Connecting Systems - Plastics Piping Systems and Multilayer Piping Systems; 2017.
- JJ. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of all systems with size, location and installation of service utilities.

- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
- C. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturers catalog information.
 - 3. Indicate valve data and ratings.
 - 4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
- D. Shop Drawings: Provide coordinated shop drawings indicating all piping layouts, including plan and elevation views that show routing, sizes, slopes (where applicable), and coordination with structural and architectural elements. Identify all piping systems and clearly label pipe sizes and material types. Include all fittings, valves, and accessories with locations and access requirements. Show all hydronic equipment, pipe transitions, equipment connections, and penetrations through walls, floors, or roofs, including sleeve sizes and firestopping where required. Indicate joint types and installation methods. Coordinate with other trades to avoid conflicts, particularly in congested ceiling spaces.
- E. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- F. Project Record Documents: Record actual locations of valves and provide valve schedule including size and performance characteristics.
- G. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Valve Repacking Kits: One for each type and size of valve.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type 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 minimum 5 years of experience.
- C. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
- D. Date stamp all castings used for coupling housings, fittings, valve bodies, etc. for quality assurance and traceability.
- E. Coupling Manufacturer:
 - 1. Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.
 - 2. A distributor's representative is not considered qualified to perform the training.

1.07 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.

1.08 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. 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 joining dissimilar metals.
 - 3. Press fittings may be used with owner approval.
 - a. Use rigid joints unless otherwise indicated.
 - 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.
- D. Valves: Provide valves where indicated:
 - 1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch (20 mm) ball valves with cap; pipe to nearest floor drain.
 - 2. On discharge of pumps, use spring-loaded check valves.
 - 3. Isolate equipment using appropriate type of isolation valve for the size of pipe.
 - 4. For throttling, bypass, or manual flow control services, use globe valves.
 - 5. For throttling and isolation service in chilled and condenser water systems, use only butterfly valves.
 - 6. In heating water, chilled water, or condenser water systems, butterfly valves may be used interchangeably with gate and globe valves.
 - 7. For shut-off and to isolate parts of systems or vertical risers, use gate, ball, or butterfly valves.

2.02 HEATING WATER AND GLYCOL PIPING, BURIED

- A. Polyethylene (PEX) Pipe: ASTM F876 or ASTM F877.
 - 1. Verify requirements and recommendations with snowmelt system manufacturer.
 - 2. Manufacturers:
 - a. Viega
 - b. Uponor, Inc; Wirsbo hePEX: www.uponorpro.com/#sle.
 - c. Engineer approved equal.
 - 3. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.000044 grains per cu ft/day (0.10 mg per cu m/day) at 104 degrees F (40 degrees C) in accordance with DIN 4726.

2.03 HEATING WATER AND GLYCOL PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
 - 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 - 2. Threaded Joints: ASME B16.3, malleable iron fittings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), 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.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.04 CHILLED WATER AND GLYCOL PIPING, BURIED

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black with AWWA C105/A21.5 polyethylene jacket, or double layer, half-lapped polyethylene tape.
 1. Fittings: ASTM A234/A234M, wrought steel welding type with double layer, half-lapped polyethylene tape.
 2. Joints: Welded in accordance with AWS D1.1/D1.1M.
 3. Casing: Closed glass cell insulation.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A) annealed.
 1. Fittings: ASME B16.22, wrought copper.
 2. Joints: Solder, lead-free, ASTM B32 HB alloy (95-5 tin-antimony), or tin and silver.
 3. Casing: Closed glass cell insulation.
- C. Ductile Iron Pipe: AWWA C151/A21.51.
 1. Fittings: AWWA C110/A21.10, ductile iron, standard thickness.
 2. Joints: AWWA C111/A21.11, Styrene-butadiene rubber (SBR) or vulcanized SBR gasket with 3/4-inch (19 mm) diameter rods.

2.05 CHILLED WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 2. Threaded Joints: ASME B16.3, malleable iron fittings.
 3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), hard 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.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
 2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
 3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.06 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 galvanized; using one of the following joint types:
 1. Threaded Joints: Galvanized cast iron, or ASME B16.3 malleable iron fittings.
 2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), 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 Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- C. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.

1. Fittings: ASTM D2466 or D2467, PVC.
 2. Joints: Solvent welded in accordance with ASTM D2855.
- D. ABS Pipe: ASTM D2680.
1. Fittings: Compatible with piping material.
 2. Joints: Solvent welded with ASTM D2235 cement.

2.07 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 (13 to 38 mm): Malleable iron, adjustable swivel, split ring.
 3. Hangers for Cold Pipe Sizes 2 Inches (50 mm) and Greater: Carbon steel, adjustable, clevis.
 4. Hangers for Hot Pipe Sizes 2 to 4 Inches (50 to 100 mm): Carbon steel, adjustable, clevis.
 5. Hangers for Hot Pipe Sizes 6 Inches (150 mm) and Greater: Adjustable steel yoke, cast iron roll, double hanger.
 6. Multiple or Trapeze Hangers: Steel channels or strut with welded spacers and hanger rods.
 7. Multiple or Trapeze Hangers for Hot Pipe Sizes 4 inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
 8. Vertical Support: Steel riser clamp.
 9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 10. Floor Support for Hot Pipe Sizes to 4 Inches (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 11. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 12. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 13. 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.

2.08 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe of 2 Inches (50 mm, DN) and Less:
1. Ferrous Piping: 150 psi (1034 kPa) brass or malleable iron, threaded.
 2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe 2 Inches (50 mm, DN) and Greater:
1. Ferrous Piping: 150 psig (1034 kPa) forged steel, slip-on.
 2. Copper Piping: Bronze.
- C. Mechanical Couplings for Grooved and Shouldered 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. Housing Material: Ductile iron, galvanized complying with ASTM A536.
 4. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F (minus 34 degrees C) to 230 degrees F (110 degrees C).
 5. Gasket Material: Nitrile rubber suitable for operating temperature range from minus 20 degrees F to 180 degrees F (minus 29 degrees C to 82 degrees C).

6. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 7. When pipe is field grooved, provide coupling manufacturer's grooving tools.
 8. Manufacturers:
 - a. Anvil International
 - b. Shurjoint Piping Products
 - c. Victaulic Company; _____: www.victaulic.com/#sle.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- D. 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 1 Inches (15 to 25 mm): Brass solder to galvanized FPT.
 - b. 1/2 to 2 Inches (15 to 50 mm): Brass solder to galvanized FPT.
 - c. 1/2 to 1 Inches (15 to 25 mm): Brass to galvanized FPT or FIP (Female Iron Pipe).
 - d. 3/4 to 1/2 Inch (20 to 15 mm) Reducer: Brass solder to galvanized FPT.
 - e. Service: 250 psi (1,723.6 kPa), minus 20 to 180 deg F (minus 28.9 to 82.2 deg F).

2.09 BALL VALVES

- A. Up To and Including 2 Inches (50 mm):
 1. Full port Bronze one piece body, stainless steel ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder or threaded ends with union.
- B. Over 2 Inches (50 mm):
 1. Ductile iron body, chrome plated stainless steel ball, teflon or Virgin TFE seat and stuffing box seals, lever handle or gear operated, flanged ends.

2.10 BUTTERFLY VALVES

- A. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, or grooved ends, extended neck.
- B. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, or Buna-N encapsulation.
- C. Stem: Stainless steel with stem offset from the centerline to provide full 360-degree circumferential setting.
- D. Operator: 10 position lever handle.

2.11 SWING CHECK VALVES

- A. Up To and Including 2 Inches (50 mm):
 1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder ends.
- B. Over 2 Inches (50 mm):
 1. Iron body, bronze trim, stainless steel or bronze swing disc, renewable disc and seat, flanged or grooved ends.

2.12 SPRING LOADED CHECK VALVES

- A. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer, or threaded lug ends.

2.13 FLOW CONTROLS

- A. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- B. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi (13.7 kPa).

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- 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.
- F. After completion, fill, clean, and treat systems. See Section 23 2500 for additional requirements.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install heating water, glycol, chilled water, condenser water, and engine exhaust piping to ASME B31.9 requirements.
- C. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- D. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- E. Install piping to conserve building space and to avoid interference with use of space.
- F. Group piping whenever practical at common elevations.
- G. Sleeve pipe passing through partitions, walls, and floors.
- H. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- I. Slope piping and arrange to drain at low points.
- J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 23 0516.
 - 1. Use flexible couplings in expansion loops.
- K. 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 (100 mm).
 - 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.
- L. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
 - 2. Support horizontal piping as scheduled.

3. Install hangers to provide minimum 1/2-inch (13 mm) space between finished covering and adjacent work.
 4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
 5. Use hangers with 1-1/2 inches (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 6. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 8. Provide copper plated hangers and supports for copper piping.
 9. Prime coat exposed steel hangers and supports. See Section 09 9123. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- M. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 23 0719.
- N. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 3100 .
- O. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- P. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. See Section 09 9123.
- Q. Install valves with stems upright or horizontal, not inverted.

3.03 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
1. 1/2 Inch (15 mm) and 3/4 inch (20 mm): Maximum span, 5 feet (1500 mm); minimum rod size, 1/4 inch (6 mm).
 2. 1 Inch (25 mm): Maximum span, 6 feet (1800 mm); minimum rod size, 1/4 inch (6 mm).
 3. 1-1/2 Inches (40 mm) and 2 Inches (50 mm): Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9 mm).
 4. 2-1/2 Inches (65 mm): Maximum span, 9 feet (2700 mm); minimum rod size, 3/8 inch (9 mm).
 5. 3 Inches (80 mm): Maximum span, 10 feet (3.0 m); minimum rod size, 3/8 inch (9 mm).
 6. 4 Inches (100 mm): Maximum span, 12 feet (3.6 m); minimum rod size, 1/2 inch (13 mm).
 7. 6 Inches (150 mm): Maximum span, 14 feet (4.2 m); minimum rod size, 1/2 inch (13 mm).
 8. 8 Inches (200 mm): Maximum span, 16 feet (4.8 m); minimum rod size, 5/8 inch (16 mm).
- B. Hanger Spacing for Steel Piping.
1. 1/2 Inch (15 mm), 3/4 Inch (20 mm), and 1 Inch (25 mm): Maximum span, 7 feet (2100 mm); minimum rod size, 1/4 inch (6 mm).
 2. 1-1/4 Inches (32 mm): Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9 mm).
 3. 1-1/2 Inches (40 mm): Maximum span, 9 feet (2700 mm); minimum rod size, 3/8 inch (9 mm).
 4. 2 Inches (50 mm): Maximum span, 10 feet (3.0 m); minimum rod size, 3/8 inch (9 mm).
 5. 2-1/2 Inches (65 mm): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9 mm).
 6. 3 Inches (80 mm): Maximum span, 12 feet (3.6 m); minimum rod size, 3/8 inch (9 mm).
 7. 4 Inches (100 mm): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).
 8. 6 Inches (150 mm): Maximum span, 17 feet (5.1 m); minimum rod size, 1/2 inch (13 mm).
 9. 8 Inches (200 mm): Maximum span, 19 feet (5.8 m); minimum rod size, 5/8 inch (16 mm).
 10. 10 Inches (250 mm): Maximum span, 20 feet (6.1 m); minimum rod size, 3/4 inch (19 mm).

11. 12 Inches (300 mm): Maximum span, 23 feet (7.0 m); minimum rod size, 7/8 inch (22 mm).
 12. 14 Inches (350 mm): Maximum span, 25 feet (7.6 m); minimum rod size, 1 inch (25 mm).
 13. 16 Inches (400 mm): Maximum span, 27 feet (8.2 m); minimum rod size, 1 inch (25 mm).
 14. 18 Inches (450 mm): Maximum span, 28 feet (8.5 m); minimum rod size, 1-1/4 inches (38 mm).
 15. 20 Inches (500 mm): Maximum span, 30 feet (9.1 m); minimum rod size, 1-1/4 inches (38 mm).
- C. Hanger Spacing for Plastic Piping.
1. 1/2 Inch (15 mm): Maximum span, 42 inches (1000 mm); minimum rod size, 1/4 inch (6 mm).
 2. 3/4 Inch (20 mm): Maximum span, 45 inches (1100 mm); minimum rod size, 1/4 inch (6 mm).
 3. 1 Inch (25 mm): Maximum span, 51 inches (1300 mm); minimum rod size, 1/4 inch (6 mm).
 4. 1-1/4 Inches (32 mm): Maximum span, 57 inches (1400 mm); minimum rod size, 3/8 inch (9 mm).
 5. 1-1/2 Inches (40 mm): Maximum span, 63 inches (1600 mm); minimum rod size, 3/8 inch (9 mm).
 6. 2 Inches (50 mm): Maximum span, 69 inches (1700 mm); minimum rod size, 3/8 inch (9 mm).
 7. 3 Inches (80 mm): Maximum span, 7 feet (2100 mm); minimum rod size, 3/8 inch (9 mm).
 8. 4 Inches (100 mm): Maximum span, 8 feet (2400 mm); minimum rod size, 1/2 inch (13 mm).
 9. 6 Inches (150 mm): Maximum span, 10 feet (3.0 m); minimum rod size, 1/2 inch (13 mm).

END OF SECTION

**SECTION 23 2114
HYDRONIC SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Expansion tanks.
- B. Air vents.
- C. Air separators.
- D. Hydraulic separators.
- E. Dirt separators.
- F. Strainers.
- G. Suction diffusers.
- H. Pump connectors.
- I. Pressure-temperature test plugs.
- J. Balancing valves.
- K. Automatic flow control valves.
- L. Flow meters.
- M. Radiator valves.
- N. Relief valves.
- O. Pressure reducing valves.
- P. Glycol system.

1.02 RELATED REQUIREMENTS

- A. Section 22 1006 - Plumbing Piping Specialties: Backflow preventers.
- B. Section 23 2113 - Hydronic Piping.
- C. Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- B. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- C. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded; 2021.
- D. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2021.
- E. NSF 61 - Drinking Water System Components - Health Effects; 2021.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of all systems 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.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.

- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
- C. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.07 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 EXPANSION TANKS

- A. Manufacturers:
 - 1. American Wheatley, a company of Global Flow Products, LLC; _____: www.wheatleyhvac.com/#sle.
 - 2. Amtrol Inc; _____: www.amtrol.com/#sle.
 - 3. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 - 4. Taco, Inc; _____: www.taco-hvac.com/#sle.
 - 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, adjustable flexible EPDM diaphragm or bladder seal factory precharged to 12 psi (80 kPa), and steel support stand.
- C. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.
- D. Accessories: Provide air-charging fitting, bulls eye sight glass, pressure gauge, and tank drain ball valve.

2.02 AIR VENTS

- A. Manufacturers:
 - 1. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 - 2. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 - 3. Nexus Valve, Inc; _____: www.nexusvalve.com/#sle.
 - 4. Taco, Inc; _____: www.taco-hvac.com/#sle.
 - 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Manual Air Vent: Short vertical sections of 2-inch (50 mm, DN) diameter pipe to form air chamber, with 1/8 inch (6 mm, DN) brass needle valve at top of chamber.
- C. Float Air Vent:
 - 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
 - 2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.
- D. Hygroscopic Air Vent:

1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring-loaded ball check valve.
- E. Maximum Fluid Pressure: 150 psi (1,034 kPa).
- F. Maximum Fluid Temperature: 250 degrees F (121.1 degrees C).

2.03 AIR SEPARATORS

A. In-line Air Separators:

1. Manufacturers:
 - a. American Wheatley, a company of Global Flow Products, LLC; _____: www.wheatleyhvac.com/#sle.
 - b. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 - c. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 - d. Taco, Inc; _____: www.taco-hvac.com/#sle.
 - e. Substitutions: See Section 01 6000 - Product Requirements.
2. Cast iron for sizes 1-1/2 inch (40 mm, DN) and smaller, or steel for sizes 2 inch (50 mm, DN) and larger; tested and stamped in accordance with ASME BPVC-VIII-1; for 125 psi (860 kPa) operating pressure.
3. Maximum Allowable Service Temperature: 450 degrees F (232.2 degrees C).
4. Accessories: Provide drain ball valve and removable strainer.

B. Centrifugal Air Separators/Strainers:

1. Manufacturers:
 - a. American Wheatley, a company of Global Flow Products, LLC; _____: www.wheatleyhvac.com/#sle.
 - b. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 - c. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 - d. Taco, Inc; _____: www.taco-hvac.com/#sle.
 - e. Substitutions: See Section 01 6000 - Product Requirements.
2. Primed steel body, tested and stamped in accordance with ASME BPVC-VIII-1 with integral bronze strainer, tangential flanged inlet and outlet connections, and internal stainless steel air collector tube.
3. Maximum Service Flow and Pressure: 16 gpm (60.6 Lpm) at 125 psi (860 kPa).

C. Coalescing Air/Dirt Separators:

1. Manufacturers:
 - a. American Wheatley, a company of Global Flow Products, LLC; _____: www.wheatleyhvac.com/#sle.
 - b. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 - c. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 - d. Spirotherm, Inc; _____: www.spirotherm.com/#sle.
2. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1 for maximum fluid service subject to application requirements and manufacturer's standard maximum operating conditions.
3. Coalescing Medium: Provide structured copper or stainless steel medium filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location.
4. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi (1,034 kPa), threaded to top of separator.
5. End Connections: Class 150 flanged for 2-1/2 inch (65 mm, DN) and larger otherwise threaded.
6. Blowdown Connection: Threaded.
7. Size: Match system flow capacity.
8. Maximum Fluid Service Pressure: 150 psi (1,034 kPa).
9. Maximum Fluid Service Temperature: 250 degrees F (121.1 degrees C).

2.04 HYDRAULIC SEPARATORS

- A. Hydraulic Separator/Buffer Tank:
 - 1. Carbon-steel based, primer-base coated vertical-mounted buffer tank with flanged inlet-outlet pipe connections, and ASME BPVC-VIII-1 tested and stamped for maximum allowed operating pressure of 150 psi (1,034 kPa).
 - 2. Flow Rate Capacity and Pipe Connections: 40 gpm (151.4 Lpm) and 2 inch (50 mm, DN).
 - 3. Threaded Connections: Aquastat, drain, and air vent. Provide aquastat, ball type drain valve, and air vent for field installation.
- B. Coalescing Hydraulic Separators:
 - 1. Carbon-steel based, primer-base coated, vertical-mounted buffer tank with internal coalescing media basket, flanged inlet-outlet pipe connections, and ASME BPVC-VIII-1 tested and stamped for maximum allowed operating pressure of 150 psi (1,034 kPa).
 - 2. Flow Rate Capacity and Pipe Connections: 40 gpm (151.4 Lpm) and 2 inch (50 mm, DN).
 - 3. Threaded Connections: Aquastat, drain/blow down, and air vent. Provide aquastat, ball type drain valve, and air vent for field-installation.

2.05 DIRT SEPARATORS

- A. Brass combined with high-grade plastics, 3/4 to 2 inch (20 to 50 mm, DN) rotating female threaded connection for use with cold water, hot water, and glycol mixes with maximum working pressure of 145 psi (1,000 kPa) over a temperature range of 14 to 248 degrees F (minus 10 to 120 degrees C).

2.06 STRAINERS

- A. Size 2 inch (50 mm, DN) and Under:
 - 1. Provide threaded, grooved, or sweat brass or iron body for up to 175 psi (1,200 kPa) working pressure, Y-pattern strainer with 1/32 inch (0.8 mm) stainless steel perforated screen.
 - 2. Body Material by Fluid Service:
 - a. Cast Iron or Brass:
 - 1) Steam: Up to 250 psi at 450 degrees F (1,723.6 kPa at 232.2 degrees C).
 - 2) Liquids: Up to 400 psi at 150 degrees F (2,758 kPa at 65.6 degrees C).
 - b. Stainless Steel:
 - 1) Steam: Up to 600 psi at 486 degrees F (4,136.8 kPa at 252.2 degrees C).
 - 2) Liquids: Up to 1,440 psi at 100 degrees F (9,928.4 kPa at 37.8 degrees C).
- B. Size 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN):
 - 1. Provide flanged or grooved iron body for up to 175 psi (1,200 kPa) working pressure, up to 250 degrees F (121.1 degrees C) working temperature, Y-pattern strainer with 1/16 inch (1.6 mm) or 3/64 inch (1.2 mm) stainless steel perforated screen.
 - 2. Body Material by Fluid Service:
 - a. Cast Iron:
 - 1) Steam: Up to 125 psi at 350 degrees F (861.8 kPa at 51.7 degrees C).
 - 2) Liquids: Up to 200 psi at 150 degrees F (1,379 kPa at 65.6 degrees C).
 - b. Stainless Steel:
 - 1) Liquids: Up to 285 psi at 100 degrees F (1,965 kPa at 37.8 degrees C).
- C. Size 5 inch (125 mm, DN) and Larger:
 - 1. Provide flanged or grooved iron body for up to 175 psi (1200 kPa) working pressure, basket pattern with 1/8 inch (3.2 mm) stainless steel perforated screen.
 - 2. Liquid Fluid Service: Up to 285 psi at 100 degrees F (1,965 kPa at 37.8 degrees C).
- D. Basket-Type, Size 1 to 30 inch (25 to 750 mm, DN) for Liquid Service:
 - 1. Flanged carbon steel body with 1/8 inch (3.2 mm) stainless steel perforated basket screen, bottom drain and capped air vent.
 - 2. Fluid Service: Up to 285 psi at 100 degrees F (1,965 kPa at 37.8 degrees C).
- E. Basket-Type, Size 2 to 24 inch (50 to 600 mm, DN) for Steam and WOG Service:

1. Flanged cast iron body with 1/8 inch (3.2 mm) stainless steel perforated basket screen, and bottom drain.
2. Fluid Service:
 - a. Steam: Up to 125 psi at 350 degrees F (861.8 kPa at 51.7 degrees C).
 - b. Liquids: Up to 150 psi at 150 degrees F (1,034 kPa at 65.6 degrees C).

F. Accessories: Provide blowdown vent/drain and outlet ball valve.

2.07 SUCTION DIFFUSERS

- A. Fitting: Angle pattern, cast-iron body, threaded for 2 inch (50 mm) and smaller, flanged for 2-1/2 inch (65 mm, DN) and larger, rated for 175 psi (1200 kPa) working pressure, with inlet vanes, cylinder strainer with 3/16 inch (5 mm) diameter openings, disposable 5/32 inch (4 mm) mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.
- B. Class 125:
 1. Horizontally or vertically mounted angle-pattern fitting with integral-cast vanes, fine particle mesh screen and magnetic drain plugs for particle removal without disassembly.
 2. Maximum Operating Service: 175 psi (1,200 kPa) and 300 degrees F (148.9 degrees C).
 3. Sizes, Material, and Connection:
 - a. 2 inch (50 mm, DN) and Smaller: Cast iron body, threaded.
 - b. 2-1/2 to 12 inch (65 to 300 mm, DN): Ductile iron body, flanged.
- C. Class 150, Size 1-1/2 to 4 inch (40 to 100 mm, DN):
 1. Angle-pattern flanged carbon steel fitted with integral vanes, removable strainer, and magnetic drain plugs for particle removal without disassembly.
 2. Maximum Operating Service:
 - a. Class 150: 150 psi at 450 degrees F (1,034.2 kPa at 232.2 degrees C).
 - b. Class 250: 250 psi at 250 degrees F (1,723.7 kPa at 121.1 degrees C).
 - c. Class 300: 300 psi at 250 degrees F (2,068.4 kPa at 121.1 degrees C).

2.08 PUMP CONNECTORS

- A. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
 1. Maximum Operating Service: 150 psi (1030 kPa) at 120 degrees F (49 degrees C).
 2. Accommodate the Following:
 - a. Axial Deflection in Compression and Expansion: _____ inch (_____ mm).
 - b. Lateral Movement: _____ inch (_____ mm).
 - c. Angular Rotation: 15 degrees.
 - d. Force developed by 1.5 times specified maximum allowable operating pressure.
 3. End Connections: Same as specified for pipe jointing.
 4. Provide necessary accessories including, but not limited to, swivel joints.

2.09 PRESSURE-TEMPERATURE TEST PLUGS

- A. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F (93 degrees C).
- B. Application: Use extended length plugs to clear insulated piping.

2.10 BALANCING VALVES

- A. Size 2 inch (50 mm, DN) and Smaller:
 1. Provide ball or globe style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and female sweat, NPT threaded, press, or soldered connections.
 2. Metal construction materials consist of bronze or brass.
 3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.
- B. Size 2-1/2 inch (65 mm, DN) and Larger:

1. Provide ball, globe, or butterfly style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and flanged, grooved, or weld-end connections.
2. Valve body construction materials consist of cast iron or carbon steel.
3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, or EPDM.

2.11 AUTOMATIC FLOW CONTROL VALVES

- A. Construction:
 1. Brass, bronze, or iron body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
 2. Built-in lug-type outlet butterfly valve with 2-position handle.
- B. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi (13.7 kPa).
- C. Control Mechanism: Provide stainless steel or nickel-plated, brass piston or regulator cup, operating against stainless steel helical or wave formed spring or elastomeric diaphragm and polyphenylsulfone orifice plate.

2.12 FLOW METERS

- A. Orifice principle by-pass circuit with direct reading gauge, soldered or flanged piping connections for 125 psi (860 kPa) working pressure, with shut off valves, and drain and vent connections.
- B. Direct reading with insert pitot tube, threaded coupling, for 150 psi (1034 kPa) working pressure, maximum 240 degrees F (115 degrees C), 5 percent accuracy.
- C. Cast iron, wafer type, orifice insert flow meter for 250 psi (1720 kPa) working pressure, with read-out valves equipped with integral check valves with gasketed caps.

2.13 RELIEF VALVES

- A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.14 PRESSURE REDUCING VALVES

- A. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 23 2113.
- B. Materials of Construction:
 1. Valve Body: Constructed of bronze, cast iron, brass, or iron.
 2. Internal Components: Construct of stainless steel or brass and engineered plastics or composition material.
- C. Connections:
 1. NPT threaded: 1/2 inch (15 mm, DN) or 3/4inch (20 mm, DN).
 2. Soldered: 1/2 inch (15 mm, DN).
- D. Provide integral check valve and strainer.
- E. Maximum Inlet Pressure: 400 psi (2,758 kPa).
- F. Maximum Fluid Temperature: 180 degrees F (82 degrees C).
- G. Adjustable Pressure Range: From 10 to 45 psi (69 to 310.3 kPa), set to 25 psi (172 kPa).

2.15 PRESSURE INDEPENDENT VALVES

- A. Size 2 inch (50 mm, DN) and Smaller:
 1. Provide ball or globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.
 2. Metal construction materials consist of bronze or brass.
 3. Non-metal construction materials consist of Teflon or EPDM.

- B. Size 2-1/2 inch (65 mm, DN) and Larger:
 - 1. Provide ball, globe, or butterfly style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
 - 2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
 - 3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, or EPDM.

2.16 AUTOMATIC FLOW LIMITING VALVES

- A. Size 1/2 inch (15 mm, DN) to 14 inch (350 mm, DN):
 - 1. Provide ball or globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.
 - 2. Metal construction materials consist of bronze or brass.
 - 3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.
- B. Size 2-1/2 inch (65 mm, DN) to 24 inch (600 mm, DN):
 - 1. Provide ball, globe, or butterfly style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged or grooved connections.
 - 2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
 - 3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, or NORYL.

2.17 GLYCOL SYSTEM

- A. Pump System:
 - 1. Storage: 15 gal (56.7 L) polypropylene tank with bolt-removable hinged solid cover and enamel coated carbon steel tank-stand.
 - 2. Pump:
 - a. Thermally protected motor at 115 to 120 VAC, single phase rated for indoor service.
 - b. Maximum Service Operation: 100 psi (689 kPa) at 85 degrees F (29 degrees C).
 - 3. Mechanical Accessories: System isolation valves, strainer, and pressure gauges.
 - 4. Control Panel:
 - a. Fused single-point system connection rated at 115 to 120 VAC, single phase.
 - b. Interface: Hand switches with indicating lights for ON, FAULT, and LOW LEVEL.
 - c. Pressure Switch: Panel-mounted and prewired for 10 psi (69 kPa) cut-in and 40 psi (276 kPa) cut-out, adjustable.
 - d. Low Level Cut-Off Switch: Prewired to shut-down unit upon activation. Tank-side mounted.
 - 5. Pressure Relief Valve: System-mounted brass valve tubed from pump discharge side into tank with adjustable setpoint between 20 psi (138 kPa) and 150 psi (1,034 kPa).
- B. Glycol Solution:
 - 1. Water-based solution mix containing 40 percent propylene glycol by volume required for cooling or heating system operating temperature range.
 - 2. Cooling or heating System Operating Temperature Range: Between freezing and boiling points of 3 and 220 degrees F (minus 16.1 and 104.4 degrees C) at 14.7 psia (101.4 kPa).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Provide manual air vents at system high points and as indicated.
- C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

- D. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- E. Provide valved drain and hose connection on strainer blowdown connection.
- F. Provide pump suction fitting on suction side of base-mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
- G. Support pump fittings with floor-mounted pipe and flange supports.
- H. Provide radiator valves on water inlet to terminal heating units such as radiation, unit heaters, and fan coil units.
- I. Provide radiator balancing valves on water outlet from terminal heating units such as radiation, unit heaters, and fan coil units.
- J. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- K. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- L. Pipe relief valve outlet to nearest floor drain.
- M. Where one line vents several relief valves, make cross-sectional area equal to sum of individual vent areas.
- N. Clean and flush glycol system before adding glycol solution, see Section 23 2500.
- O. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.
- P. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill at 12 psi (80 kPa).
- Q. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Pressure system cold at 5 psi (35 kPa).

END OF SECTION

SECTION 23 2123 HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. In-line circulators.
- B. Vertical in-line pumps.

1.02 REFERENCE STANDARDS

- A. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Armstrong Fluid Technology, Inc
- B. Bell & Gossett, a Xylem Inc. brand
- C. Taco
- D. Grundfos

2.02 HVAC PUMPS - GENERAL

- A. Provide pumps that 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.
- B. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to Authority Having Jurisdiction as suitable for the purpose specified and indicated.

2.03 IN-LINE CIRCULATORS

- A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psi (860 kPa) maximum working pressure.
- B. Performance: As scheduled on drawings.

2.04 VERTICAL IN-LINE PUMPS

- A. Type: Vertical, single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 175 psi (1200 kPa) working pressure.
- B. Performance: As scheduled on drawings.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. In-line pumps shall be staggered at least 2 feet so one is not directly above another.
- C. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.

- D. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings.
- E. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.

END OF SECTION

**SECTION 23 2300
REFRIGERANT PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Check valves.
- G. Pressure regulators.
- H. Pressure relief valves.
- I. Filter-driers.
- J. Solenoid valves.
- K. Expansion valves.
- L. Receivers.
- M. Flexible connections.
- N. Engineered wall seals and insulation protection.
- O. Exterior penetration accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 08 3100 - Access Doors and Panels.
- C. Section 09 9123 - Interior Painting.
- D. Section 23 0716 - HVAC Equipment Insulation.
- E. Section 23 0719 - HVAC Piping Insulation.
- F. Section 23 0993 - Sequence of Operations for HVAC Controls.
- G. Section 23 5400 - Furnaces.
- H. Section 23 6100 - Refrigerant Compressors.
- I. Section 23 6213 - Packaged Air-Cooled Refrigerant Compressor and Condenser Units.
- J. Section 23 6313 - Air Cooled Refrigerant Condensers.
- K. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers; 2005.
- B. AHRI 710 - Performance Rating of Liquid-Line Driers; 2009.
- C. AHRI 730 (I-P) - Flow Capacity Rating of Suction Line Filters and Suction Line Filter Driers; 2013 (Reapproved 2014).
- D. AHRI 750 - Thermostatic Refrigerant Expansion Valves; 2007.
- E. AHRI 760 (I-P) - Performance Rating of Solenoid Valves for Use with Volatile Refrigerants; 2014.
- F. AHRI 761 (SI) - Performance Rating of Solenoid Valves for Use with Volatile Refrigerants; 2014.

- G. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2019, with All Amendments and Errata.
- H. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; 2024, with Addendum (2025).
- I. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2021.
- J. 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; 2021.
- K. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- L. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; 2018.
- M. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2022.
- N. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2020.
- O. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
- P. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 2024.
- Q. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- R. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2022).
- S. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- T. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.
- U. UL 429 - Electrically Operated Valves; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
- C. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
- D. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
- E. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- F. Test Reports: Indicate results of leak test, acid test.
- G. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
- H. Submit welders certification of compliance with ASME BPVC-IX.
- I. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.
- J. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.05 QUALITY ASSURANCE

- A. Contractor's Designer Qualifications: Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of documented experience.

1.06 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 SYSTEM DESCRIPTION

- A. Provisions for A2L and similar refrigerants: Comply with State and Local code ordinances, regulations and requirements. Provide and install necessary system components and coordinate required provisions to comply with Code requirements. Install tubing in rated enclosures where required and provide exterior vented pipe sleeves when necessary. Refer to ASHRAE Refrigeration Standards for additional requirements.
- B. 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.
- C. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.
- D. Liquid Indicators:
 - 1. Use line size liquid indicators in main liquid line leaving condenser.
 - 2. If receiver is provided, install in liquid line leaving receiver.
 - 3. Use line size on leaving side of liquid solenoid valves.
- E. Valves:
 - 1. Use service valves on suction and discharge of compressors.
 - 2. Use gauge taps at compressor inlet and outlet.
 - 3. Use gauge taps at hot gas bypass regulators, inlet and outlet.
 - 4. Use check valves on compressor discharge.
 - 5. Use check valves on condenser liquid lines on multiple condenser systems.
- F. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.
- G. Strainers:
 - 1. Use line size strainer upstream of each automatic valve.
 - 2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
 - 3. On steel piping systems, use strainer in suction line.
 - 4. Use shut-off valve on each side of strainer.
- H. Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.
- I. Filter-Driers:
 - 1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.
 - 2. Use a filter-drier on suction line just ahead of compressor.
 - 3. Use sealed filter-driers in lines smaller than 1/2 inch (13 mm) outside diameter.
 - 4. Use sealed filter-driers in low temperature systems.
 - 5. Use sealed filter-driers in systems utilizing hermetic compressors.
 - 6. Use replaceable core filter-driers in lines of 1/2 inch (13 mm) outside diameter or greater.
 - 7. Use replaceable core liquid-line filter-driers in systems utilizing receivers.

8. Use filter-driers for each solenoid valve.
- J. Solenoid Valves:
 1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.
 2. Use in liquid line of single or multiple evaporator systems.
 3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.
- K. Receivers: Refer to Drawings
 1. Sized to accommodate pump down charge.
 2. Use on systems with long piping runs.
- L. Flexible Connectors: Utilize at or near compressors.

2.02 REGULATORY REQUIREMENTS

- A. Comply with ASME B31.9 for installation of piping system.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- C. Welders Certification: In accordance with ASME BPVC-IX.
- D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

2.03 PIPING

- A. Copper Tube: ASTM B280, H58 hard drawn.
 1. Fittings: ASME B16.22 wrought copper.
 2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.
- B. Copper Tube up to 7/8 inch (22 mm): ASTM B280, annealed.
 1. Fittings: ASME B16.26 cast copper.
 2. Joints: Flared.
- C. Pipe Supports and Anchors:
 1. Provide hangers and supports that comply with MSS SP-58.
 - a. 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 Inch (13 to 38 mm): Malleable iron adjustable swivel, split ring.
 3. Hangers for Pipe Sizes 2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.
 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 5. Wall Support for Pipe Sizes 4 Inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.
 6. Vertical Support: Steel riser clamp.
 7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 8. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 9. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 10. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
 - a. Bases: High density, UV tolerant, polypropylene or reinforced PVC.
 - b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.

- e. Height: Provide minimum clearance of 6 inches (150 mm) under pipe to top of roofing.
- f. Manufacturers:
 - 1) PHP Systems/Design; _____: www.phpsd.com/#sle.
 - 2) Portals Plus; Pedestal Plus: www.portalsplus.com/#sle.

2.04 MOISTURE AND LIQUID INDICATORS

- A. Manufacturers:
 - 1. Henry Technologies
 - 2. Parker Hannifin/Refrigeration and Air Conditioning
 - 3. Sporlan, a Division of Parker Hannifin
- B. Indicators: Single port type, UL listed, with copper or brass body, flared or brazed ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F (93 degrees C) and maximum working pressure of 500 psi (3450 kPa).

2.05 VALVES

- A. Manufacturers:
 - 1. Hansen Technologies Corporation
 - 2. Henry Technologies; _____: www.henrytech.com/#sle.
 - 3. Flomatic Valves
- B. Diaphragm Packless Valves:
 - 1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, soldered or flared ends, with positive backseating; for maximum working pressure of 500 psi (3450 kPa) and maximum temperature of 275 degrees F (135 degrees C).
- C. Packed Angle Valves:
 - 1. Forged brass, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, soldered or flared ends; for maximum working pressure of 500 psi (3450 kPa) and maximum temperature of 275 degrees F (135 degrees C).
- D. Ball Valves:
 - 1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi (3450 kPa) and maximum temperature of 300 degrees F (149 degrees C).
- E. Service Valves:
 - 1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or soldered ends, for maximum pressure of 500 psi (3450 kPa).

2.06 STRAINERS

- A. Manufacturers:
 - 1. Hansen Technologies Corporation; _____
 - 2. Parker Hannifin/Refrigeration and Air Conditioning
 - 3. Sporlan, a Division of Parker Hannifin
- B. Straight Line or Angle Line Type:
 - 1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi (2960 kPa).

2.07 CHECK VALVES

- A. Manufacturers:
 - 1. Hansen Technologies Corporation

2. Parker Hannifin/Refrigeration and Air Conditioning
 3. Sporlan, a Division of Parker Hannifin
- B. Globe Type:
1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F (149 degrees C) and maximum working pressure of 425 psi (2930 kPa).
- C. Straight Through Type:
1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi (3450 kPa) and maximum temperature of 200 degrees F (93 degrees C).

2.08 PRESSURE REGULATORS

- A. Manufacturers:
1. Hansen Technologies Corporation
 2. Parker Hannifin/Refrigeration and Air Conditioning
 3. Sporlan, a Division of Parker Hannifin
- B. Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 80 psi (0 to 550 kPa) range, for maximum working pressure of 450 psi (3100 kPa).

2.09 PRESSURE RELIEF VALVES

- A. Manufacturers:
1. Hansen Technologies Corporation
 2. Henry Technologies
 3. Sherwood Valve/Harsco Corporation
- B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 235 psi (1620 kPa).

2.10 FILTER-DRIERS

- A. Manufacturers:
1. Flow Controls Division of Emerson Electric
 2. Parker Hannifin/Refrigeration and Air Conditioning; _____
 3. Sporlan, a Division of Parker Hannifin
- B. Performance: (Refer to Drawings)
- C. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.
- D. Construction: UL listed.
1. Replaceable Core Type: Steel shell with removable cap.
 2. Connections: threaded.

2.11 SOLENOID VALVES

- A. Manufacturers:
1. Flow Controls Division of Emerson Electric
 2. Parker Hannifin/Refrigeration and Air Conditioning
 3. Sporlan, a Division of Parker Hannifin
- B. Valve: AHRI 760 (I-P) (AHRI 761 (SI)), pilot operated, copper, or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, soldered, or threaded ends; for maximum working pressure of 500 psi (3450 kPa).

- C. Coil Assembly: UL 429 UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.
- D. Electrical Characteristics: 120 volts, single phase, 60 Hz.

2.12 EXPANSION VALVES

- A. Manufacturers:
 - 1. Flow Controls Division of Emerson Electric
 - 2. Parker Hannifin/Refrigeration and Air Conditioning
 - 3. Sporlan, a Division of Parker Hannifin; _____
- B. Angle or Straight Through Type: AHRI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with nonreplaceable capillary tube and remote sensing bulb and remote bulb well.
- C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F (6 degrees C) superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.13 RECEIVERS

- A. Manufacturers:
 - 1. Henry Technologies
 - 2. Parker Hannifin/Refrigeration and Air Conditioning
 - 3. Sherwood Valve/Harsco Corporation
- B. Internal Diameter 6 inch (150 mm) and Smaller:
 - 1. AHRI 495, UL listed, steel, brazed; 400 psi (2760 kPa) maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.
- C. Internal Diameter Over 6 inch (150 mm):
 - 1. AHRI 495, welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; 400 psi (2760 kPa) with tappings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

2.14 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Circuit Hydraulics, Ltd
 - 2. Flexicraft Industries
 - 3. Penflex
- B. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 12 inches (230 mm) long with copper tube ends; for maximum working pressure of 500 psi (3450 kPa).

2.15 ENGINEERED WALL SEALS AND INSULATION PROTECTION

- A. Manufacturers:
 - 1. Airex Manufacturing, Inc
- B. 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 (190.5 mm wide by 254 mm high).
 - a. Elastomeric Sleeve Diameter: 1-11/16 inch (43 mm).
 - 2. Wall Outlet Size, Siding and Compact Applications: 6-7/8 inch wide by 3-7/8 inch high (175 mm wide by 99 mm high).
 - a. Elastomeric Sleeve Diameter: 1-11/16 inch (43 mm).
 - 3. Outlet Cover Color: Gray.
 - 4. Water Penetration: Comply with ASTM E331.

5. Air Leakage: Comply with ASTM E283.
6. Air Permeance: Comply with ASTM E2178.
- C. Insulation Protection System: Mechanical line insulation and PVC 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 25/450: Comply with ASTM E84.
 6. Adhesive free.

2.16 EXTERIOR PENETRATION ACCESSORIES

- 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.
 1. Manufacturers:
 - a. Quickflash Weatherproofing Products, Inc

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.

3.02 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Pipe Hangers and Supports:
 1. Install in accordance with ASME B31.5.
 2. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
 3. Place hangers within 12 inches (300 mm) of each horizontal elbow.
 4. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 6. Provide copper plated hangers and supports for copper piping.
- G. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- H. Provide clearance for installation of insulation and access to valves and fittings.
- I. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 08 3100.
- J. Flood piping system with nitrogen when brazing.
- K. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.

- L. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. See Section 09 9123.
- M. Insulate piping and equipment.
- N. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- O. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
- P. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- Q. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- R. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- S. Fully charge completed system with refrigerant after testing.
- T. Provide electrical connection to solenoid valves. See Section 26 0583.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Test refrigeration system in accordance with ASME B31.5.
- C. Pressure test system with dry nitrogen to 200 psi (1380 kPa). Perform final tests at 27 inches (92 kPa) vacuum and 200 psi (1380 kPa) using halide torch. Test to no leakage.

3.04 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch (13 mm), 5/8 inch (16 mm), and 7/8 inch (22 mm) OD: Maximum span, 5 feet (1500 mm); minimum rod size, 1/4 inch (6.3 mm).
 - 2. 1-1/8 inch (29 mm) OD: Maximum span, 6 feet (1800 mm); minimum rod size, 1/4 inch (6.3 mm).
 - 3. 1-3/8 inch (35 mm) OD: Maximum span, 7 feet (2100 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 4. 1-5/8 inch (41 mm) OD: Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 5. 2-1/8 inch (54 mm) OD: Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 6. 2-5/8 inch (67 mm) OD: Maximum span, 9 feet (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 7. 3-1/8 inch (79 mm) OD: Maximum span, 10 feet (3.0 m); minimum rod size, 3/8 inch (9.5 mm).
 - 8. 3-5/8 inch (92 mm) OD: Maximum span, 11 feet (3.4 m); minimum rod size, 1/2 inch (12.7 mm).
 - 9. 4-1/8 inch (92 mm) OD: Maximum span, 12 feet (3.6 m); minimum rod size, 1/2 inch (12.7 mm).

END OF SECTION

**SECTION 23 2500
HVAC WATER TREATMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. By-pass (pot) feeder.
- B. Solution metering pump.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- D. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. AmSolv-Amrep, Inc; _____: www.amsolv.com/#sle.
- B. GE Water & Process Technologies; _____: www.gewater.com/#sle.
- C. Nalco, an Ecolab Company; _____: www.nalco.com/#sle.
- D. Axiom
- E. Alternate manufacturer approved by Engineer of Record.

2.02 BY-PASS (POT) FEEDER

- A. ___ gal (___ L) quick opening cap for working pressure of 175 psi (1200 kPa).
- B. See plans for additional information.

PART 3 EXECUTION

3.01 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.
- C. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.03 CLOSED SYSTEM TREATMENT

- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. Provide 3/4 inch (19 mm) water coupon rack around circulating pumps with space for 4 test specimens.

3.04 CLOSEOUT ACTIVITIES

- A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.
 - 1. Have operation and maintenance data prepared and available for review during training.
 - 2. Conduct training using actual equipment after treated system has been put into full operation.

END OF SECTION

**SECTION 23 3100
HVAC DUCTS AND CASINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal ducts.
- B. Flexible ducts.
- C. Nonmetal ducts.
- D. Air plenums and casings
- E. Ducts for kitchen exhaust applications.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 11 4000 - Foodservice Equipment: Kitchen range hoods.
- C. Section 23 0713 - Duct Insulation: External insulation and duct liner.
- D. Section 23 3300 - Air Duct Accessories.

1.03 REFERENCE STANDARDS

- A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2020.
- D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
- E. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
- G. ASTM E2336 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems; 2020.
- H. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2015.
- I. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2015.
- J. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2015.
- K. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2016.
- L. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
- M. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.
- N. NFPA 91 - Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids; 2026.
- O. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.
- P. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- Q. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines; 2001.

- R. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; 2012.
- S. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.
- T. UL 1978 - Grease Ducts; Current Edition, Including All Revisions.
- U. UL 2221 - Tests of Fire Resistive Grease Duct Enclosure Assemblies; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Product Data: Provide data for duct materials.
- B. Shop Drawings: Provide coordinated ductwork shop drawings that clearly indicate duct sizes, configurations, and routing in plan and elevation views, including all transitions, offsets, and fittings. Label each duct system and identify construction materials and insulation types per specification, including internal linings where applicable. Show all mechanical equipment and duct-mounted accessories with locations and required access. Include connections to air devices, terminal units, and equipment with tag numbers matching the contract documents. Account for coordination with structure, piping, electrical, and fire protection systems, and ensure drawings reflect conflict resolution and adequate installation clearances. Penetrations, fire-rated assemblies, and shaft coordination must be clearly shown.
- C. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate per appropriate seal class, following SMACNA (LEAK).
- D. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.05 QUALITY ASSURANCE

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

1.06 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide UL Class 1 ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.
- B. Provide metal duct unless otherwise indicated.
- C. Duct Shape and Material in accordance with Allowed Static Pressure Range:
 - 1. Round: Plus or minus 2 in-wc (500 Pa) of galvanized steel.
 - 2. Rectangular: Plus or minus 1 in-wc (250 Pa) of galvanized steel.
 - 3. Flat Oval: Plus 2 in-wc (500 Pa) of galvanized steel.
- D. Duct Sealing and Leakage in accordance with Static Pressure Class:
 - 1. Duct Pressure Class and Material for Common Mechanical Ventilation Applications:
 - a. Supply Air: 1 in-wc (250 Pa) pressure class, galvanized steel.
 - b. Outside Air Intake: 1 in-wc (250 Pa) pressure class, galvanized steel.
 - c. Return and Relief Air: 1 in-wc (250 Pa) pressure class, galvanized steel.
 - d. General Exhaust Air: 1 in-wc (250 Pa) pressure class, galvanized steel.
- E. Duct Fabrication Requirements:

1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings. Minimum thickness shall be 26 gauge.
2. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
3. Construct tee's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
4. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
5. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
6. 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.

2.02 METAL DUCTS

- A. Material Requirements:
 1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
 2. Aluminum: ASTM B209/B209M, aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.
 3. Stainless Steel: ASTM A666, Type 304.
- B. Flat-Oval Metal Ducts:
 1. Flat-Oval Single Wall Duct: Machine made from a round spiral lock seam duct.
 - a. Fittings: Manufacture at least two gauges heavier metal than the duct.
 - b. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- C. Round Metal Ducts:
 1. Round Single Wall Duct: Round lock seam duct with galvanized steel outer wall.
 2. Round Connection System: Interlocking duct connection system per SMACNA (DCS).
- D. Round Spiral Duct:
 1. Round spiral lock seam duct with galvanized steel outer wall.
- E. Connectors, Fittings, Sealants, and Miscellaneous:
 1. Fittings: Manufacture with solid inner wall of perforated galvanized steel.
 2. Transverse Duct Connection System: SMACNA "E" rated rigid class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
 3. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - a. 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.
 - b. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
 - c. For Use with Flexible Ducts: UL labeled.
 4. Gasket Tape:
 - a. Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle ring connections.
 5. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
 6. Hanger Fasteners: Attach hangers to structure using appropriate fasteners as follows:
 - a. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.

- b. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - c. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - d. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 - e. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
- F. Flexible Ducts: UL 181, Class 1, polyethylene film, mechanically fastened and rolled using galvanized steel to form a spiral helix.
- 1. Pressure Rating: 10 in-wc (2.50 kPa) positive and 5 in-wc (1.25 kPa) negative.
 - 2. Maximum Velocity: 4000 fpm (20.3 m/sec).
 - 3. Temperature Range: Minus 20 degrees F to 250 degrees F (Minus 28 degrees C to 121 degrees C).

2.03 FLEXIBLE DUCTS

- A. Flexible Air Ducts:
- 1. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
 - 2. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 - 3. Pressure Rating: From 10 in-wc (2.5 kPa) to 1 in-wc (250 Pa) negative.
 - 4. Temperature Range: Minus 20 to 210 degrees F (Minus 28 to 99 degrees C).

2.04 AIR PLENUMS AND CASINGS

- A. Fabricate in accordance with SMACNA (DCS) for indicated operating pressures indicated.
- B. Minimum Fabrication Requirements:
- 1. Fabricate acoustic plenum or casing with reinforcing turned inward.
 - 2. Provide 16 gauge, 0.059 inch (1.52 mm) sheet steel back facing and 22 gauge, 0.029 inch (0.76 mm) perforated sheet steel front facing with 3/32 inch (2.4 mm) diameter holes on 5/32 inch (4 mm) centers.
 - 3. Construct panels 3 inches (75 mm) thick packed with 4.5 pcf (72 kg/cu m) minimum glass fiber insulation media, on inverted channels of 16 gauge, 0.059 inch (1.52 mm) sheet steel.
 - 4. Mount floor mounted plenum or casings on 4 inch (100 mm) high concrete curbs. At floor, rivet panels on 8 inch (200 mm) centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18 gauge, 0.052 inch (1.31 mm) expanded metal mesh supported at 12 inch (300 mm) centers, turned up 12 inches (300 mm) at sides with sheet metal shields.
- C. Access Doors:
- 1. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
 - 2. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles.
 - 3. Provide clear wire glass observation ports, minimum 6 by 6 inch (150 by 150 mm) size.

2.05 DUCTS FOR KITCHEN EXHAUST APPLICATIONS

- A. Provide ductwork, fittings, and appurtenances per NFPA 96, SMACNA (KVS), UL 1978, and UL 2221 requirements and guidelines.
- B. Class 1 duct for air with gas and grease particle exhaust at an air velocity of 1,500 to 2,500 fpm (7.6 to 12.7 m/s).
- C. Where ducts are not self-draining back to equipment, provide low point drain pocket with the copper drain pipe to a sanitary sewer.
- D. Designed, fabricated, and installed to be liquid tight preventing exhaust leakage into the building.
- E. Kitchen Hood and Grease Exhaust Duct:
- 1. Fabricate in accordance with ductwork manufacturer's instructions, SMACNA (DCS), SMACNA (KVS), and NFPA 96.

2. Single-Wall, Premanufactured Kitchen Exhaust Duct:
 - a. UL labeled to UL 1978.
 3. Double-Wall, Premanufactured, Noncombustible Kitchen Exhaust Ducts:
 - a. Comply with ASTM E2336.
- F. Cooking Hood and Grease Exhaust Duct:
1. Duct Size: 1 in-wc (250 Pa) pressure class, stainless steel.
 2. Liquid-tight with continuous external weld for seams and joints.
 3. Where ducts are not self draining back to equipment, provide low point drain pocket with copper drain pipe to sanitary sewer.
 4. Tested and UL listed for use with commercial cooking equipment in accordance with NFPA 96.
 5. Certified for zero clearance to combustible material per UL 2221 with a 2 hour rating.
 6. Access Doors:
 - a. Provide for duct cleaning inside the horizontal duct at drain pockets, every 20 feet (6 m), and each change of direction.
 - b. Use the same material and thickness as duct with gaskets and sealants rated 1,500 degrees F (815 degrees C) for grease-tight construction.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install products following the manufacturer's instructions.
- C. Comply with safety standards NFPA 90A and NFPA 90B.
- D. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.
- E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- F. Flexible Ducts: Connect to metal ducts with adhesive.
- G. Kitchen Range Hoods: Install when provided by Section 11 4000 then fit-out with respective ductwork and accessories to interconnect exhaust system.
- H. Kitchen Hood Exhaust: Provide residue traps at the base of vertical risers with provisions for the cleanout.
- I. Duct sizes indicated are inside precise dimensions, unless noted otherwise. For lined ducts, maintain sizes inside lining.
- J. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- K. Use crimp joints with or without bead for joining round duct sizes 8 inch (200 mm) and smaller with a crimp in the direction of airflow.
- L. Use double nuts and lock washers on threaded rod supports.
- M. Connect terminal units to supply ducts directly or with one foot (300 mm) maximum length of flexible duct. Do not use a flexible duct to change direction.
- N. Connect diffusers or light troffer boots to low-pressure ducts directly or with 5 feet (1.5 m) maximum length of flexible duct held in place with strap or clamp.
- O. At exterior wall louvers, seal duct to louver frame and install blank-out panels.
- P. Fire Partitions: Provide firestopping sealing.
- Q. Duct Insulation: Provide duct insulation in compliance with Section 23 0713.

END OF SECTION

**SECTION 23 3300
AIR DUCT ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Backdraft dampers - metal.
- B. Combination fire and smoke dampers.
- C. Duct access doors.
- D. Duct test holes.
- E. Fire dampers.
- F. Flexible duct connectors.
- G. Smoke dampers.
- H. Volume control dampers.

1.02 RELATED REQUIREMENTS

- A. Section 23 3100 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
- B. NFPA 92 - Standard for Smoke Control Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- E. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.
- F. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.
- G. UL 555C - Standard for Safety Ceiling Dampers; Current Edition, Including All Revisions.
- H. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.
- I. UL 1978 - Grease Ducts; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, and duct test holes. Include electrical characteristics and connection requirements.
- B. Manufacturer's Installation Instructions: Provide instructions for fire dampers and combination fire and smoke dampers.
- C. Project Record Drawings: Record actual locations of access doors and test holes.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Fusible Links: Two of each type and size.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

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. Nailor Industries, Inc
 - 2. Ruskin Company
 - 3. Greenheck
 - 4. Pottorff
- B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch (150 mm) 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 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:
 - 1. Nailor Industries, Inc
 - 2. NCA, a brand of Metal Industries Inc
 - 3. Pottorff
 - 4. Ruskin Company
 - 5. Greenheck
- B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- C. Provide factory sleeve and collar for each damper.
- D. Multiple Blade Dampers: Fabricate with 16 gauge, 0.0598 inch (1.52 mm) galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 by 1/2 inch (3.2 by 12.7 mm) plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch (12.7 mm) actuator shaft.
- E. Operators: UL listed and labeled spring return electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.
- F. Normally Closed Smoke Responsive Fire Dampers: Curtain type, opening by gravity upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure.
- G. Electro Thermal Link: Fusible link melting at 165 degrees F (74 degrees C); 120 volts, single phase, 60 Hz; UL listed and labeled.

2.03 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. Ductmate Industries, Inc, a DMI Company
 - 2. Nailor Industries, Inc
 - 3. Ruskin Company
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Access doors with sheet metal screw fasteners are not acceptable.

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.

2.05 FIRE DAMPERS

- A. Manufacturers:
 - 1. Nailor Industries, Inc
 - 2. NCA, a brand of Metal Industries Inc
 - 3. Pottorff

4. Ruskin Company
 5. Greenheck
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
 - C. Ceiling (Radiation) Dampers: Galvanized steel, 22 gauge, 0.0299 inch (0.76 mm) frame and 16 gauge, 0.0598 inch (1.52 mm) flap, two layers 0.125 inch (3.2 mm) ceramic fiber on top side and one layer on bottom side for round flaps, with locking clip.
 1. Rated for three hour service in compliance with UL 555C.
 - D. Horizontal Dampers: Galvanized steel, 22 gauge, 0.0299 inch (0.76 mm) frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.
 - E. 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 1.0 inch (250 Pa) pressure class ducts up to 12 inches (300 mm) in height.
 - F. Multiple Blade Dampers: 16 gauge, 0.0598 inch (1.52 mm) galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch (3.2 by 12.7 mm) plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
 - G. Fusible Links: UL 33, separate at 160 degrees F (71 degrees C) with adjustable link straps for combination fire/balancing dampers.

2.06 FLEXIBLE DUCT CONNECTORS

- A. Manufacturers:
 1. Ductmate Industries, Inc, a DMI Company
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Flexible Duct Connections: Fabric crimped into metal edging strip.
 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz/sq yd (1.0 kg/sq m).
- D. Maximum Installed Length: 14 inch (356 mm).

2.07 SMOKE DAMPERS

- A. Manufacturers:
 1. Nailor Industries, Inc
 2. NCA, a brand of Metal Industries Inc
 3. Ruskin Company
 4. Greenheck
- B. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.
- C. Dampers: UL Class 1 airfoil blade type smoke damper, normally open automatically operated by electric actuator.
- D. Electro Thermal Link: Fusible link melting at 165 degrees F (74 degrees C); 120 volts, single phase, 60 Hz; UL listed and labeled.

2.08 VOLUME CONTROL DAMPERS

- A. Manufacturers:
 1. Nailor Industries, Inc
 2. Ruskin Company
 3. Greenheck
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Single Blade Dampers:
 1. Fabricate for duct sizes up to 6 by 30 inch (150 by 760 mm).
 2. Blade: 24 gauge, 0.0239 inch (0.61 mm), minimum.

- D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 by 72 inch (200 by 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
 - 1. Blade: 18 gauge, 0.0478 inch (1.21 mm), minimum.
- E. End Bearings: Except in round ducts 12 inches (300 mm) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

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 3100 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 filters, coils, fans, 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 (200 by 200 mm) size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch (100 by 100 mm) 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. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- G. Demonstrate re-setting of fire dampers to Owner's representative.
- H. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
- J. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- K. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION

**SECTION 23 3700
AIR OUTLETS AND INLETS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Rectangular ceiling diffusers.
- B. Registers/grilles:
 - 1. Ceiling-mounted, egg crate exhaust and return register/grilles.
- C. Louvers:
- D. Roof hoods.

1.02 REFERENCE STANDARDS

- A. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.
- B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. 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.
- C. Project Record Documents: Record actual locations of air outlets and inlets.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Price Industries: www.price-hvac.com/#sle.
- B. Titus, a brand of Air Distribution Technologies: www.titus-hvac.com/#sle.

2.02 RECTANGULAR CEILING DIFFUSERS

- A. Type: Provide rectangular and square formed ceiling diffusers constructed to maintain 360 degree discharge air pattern with sectorizing baffles where indicated.
- B. Frame: Provide surface mount, snap-in, inverted T-bar, and spline type.
- C. Fabrication: Steel with baked enamel finish.
- D. Color: As selected by Architect from manufacturer's standard range.

2.03 CEILING SLOT DIFFUSERS

- A. Type: See plans and equipment schedules for details. Provide with adjustable vanes for left, right, or vertical discharge.
- B. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting and gasket, mitered end border.
- C. Plenum: Integral, galvanized steel.

2.04 CEILING EGG CRATE EXHAUST AND RETURN GRILLES

- A. Type: Egg crate style face consisting of 1/2 by 1/2 by 1/2 inch (13 by 13 by 13 mm) grid core.
- B. Fabrication: Grid core consists of aluminum with mill aluminum finish.

2.05 VAV DIFFUSERS

- A. General:
 - 1. Factory-assembled, AHRI 880 (I-P) rated, variable air volume control terminal with damper/actuator assemblies, temperature sensors, duct collars, and all required features.
 - 2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits.
 - 3. Provide square and linear diffusers as indicated on drawings.

4. Each VAV diffuser to have a temperature adjustment scale with indicators that range from 70 degrees F to 78 degrees F (21.1 degrees C to 25.6 C).
 5. Room temperature settings for heating and cooling to be separately adjustable.
 6. Each VAV diffuser will be capable of adjusting minimum airflow from 0 to 30 percent.
 7. Each VAV diffuser to be self-contained and self-powered.
- B. Construction:
1. Minimum 24 gauge, 0.0239 inch (0.61 mm) galvanized steel.
 2. Air Inlet Collars: Provide round, suitable for standard flexible duct sizes.
- C. Damper Assembly:
1. Provide room temperature sensing, thermal actuators to control the cone-shaped diffusion damper.
 2. Incorporate low leak damper blades for tight airflow shutoff.
- D. Controls:
1. Room Sensor:
 - a. Wall-mounted, compatible with temperature controls specified.
 - b. Provide with temperature set-point adjustment.

2.06 WALL SUPPLY REGISTERS/GRILLES

- A. Type: Streamlined and individually adjustable blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing with spring or other device to set blades, vertical face, double deflection.
- B. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting and gasket.
- C. Fabrication: Steel with 20 gauge, 0.0359 inch (0.91 mm) minimum frames and 22 gauge, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gauge, 0.0359 inch (0.91 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.
- D. Color: To be selected by Architect from manufacturer's standard range.

2.07 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing, with spring or other device to set blades, vertical face.
- B. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting.
- C. Fabrication: Steel frames and blades, with factory baked enamel finish.

2.08 LOUVERS

- A. Type: 4 inch (100 mm) deep frame with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch (13 mm) square mesh screen over intake or exhaust end.
- B. Fabrication: 16 gauge, 0.0598 inch (1.52 mm) thick galvanized steel thick galvanized steel welded assembly, with factory prime coat finish.
- C. Color: To be selected by Architect from manufacturer's standard range.
- D. Mounting: Furnish with interior flat flange for installation.

2.09 GOOSENECKS

- A. Fabricate in accordance with of minimum 18 gauge, 0.0598 inch (1.21 mm) galvanized steel.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.

- C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- D. Install diffusers to ductwork with air tight connection.
- E. 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.

SECTION 23 5216 CONDENSING BOILERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Manufactured units.
- B. Boiler construction.
- C. Boiler trim.
- D. Fuel burning system.
- E. Factory installed controls.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete.
- B. Section 23 0913 - Instrumentation and Control Devices for HVAC.
- C. Section 23 2114 - Hydronic Specialties.
- D. Section 23 2123 - Hydronic Pumps.
- E. Section 23 2500 - HVAC Water Treatment.

1.03 REFERENCE STANDARDS

- A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); Current Edition.
- B. ANSI Z21.13 - American National Standard for Gas-Fired Low-Pressure Steam and Hot Water Boilers; 2022.
- C. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2025).
- E. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; 2021.
- F. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI); Current Edition.
- G. NFPA 54 - National Fuel Gas Code; 2021.
- H. SCAQMD 1146.1 - Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters; 1990, with Amendment (2018).

1.04 SUBMITTALS

- A. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections. Provide all applicable certifications verifying compliance with the standards and codes referenced herein.
- B. Shop Drawings: Indicate equipment locations, dimensions, weights, locations and sizes of field connections, and required clearances. Indicate mounting and anchorage details.
- C. Manufacturer's Installation Instructions: Indicate assembly, support details, connection requirements, and include start up instructions.
- D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.
- E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Contractor specializing in installing the type of packaged units specified in this section, with a minimum documented experience of 5 years.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. The entire boiler/burner package shall be warranted by the boiler manufacturer.
 - 1. Heat exchanger: Minimum 10 year manufacturer's warranty.
 - 2. Burner: Minimum 12 month manufacturer's warranty.
 - 3. Parts: Minimum 12 months from the date of start-up or 18 months from the date of manufacture, whichever occurs first.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Natural Gas, Propane, or Combination Natural Gas/Propane for Indoor Applications:
 - 1. Lochinvar
 - 2. Aerco
 - 3. Laars

2.02 MANUFACTURED UNITS

- A. Factory assembled, factory fire-tested, self-contained, readily transported unit ready for automatic operation except for connection of water, fuel, electrical, and vent services.
- B. Unit: Metal membrane wall, water or fire tube, condensing boiler on integral structural steel frame base with integral fuel burning system, firing controls, boiler trim, insulation, and removable jacket, suitable for indoor application.
- C. Electrical: Single point connection. Wiring shall be numbered and color coded to match wiring diagram. Provide each motor with overcurrent protection. Refer to contract drawings for electrical requirements.

2.03 BOILER CONSTRUCTION

- A. Comply with the minimum requirements of ASME BPVC-IV and ANSI Z21.13 for construction of boilers.
- B. Assembly to bear the ASME "H" stamp and comply with the efficiency requirements of the latest edition of ASHRAE Std 90.1 I-P.
- C. Required Directory Listings:
 - 1. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.
 - 2. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI); current edition at www.nationalboard.org.
- D. Heat Exchanger: Type 316L stainless steel.
- E. Provide adequate tappings, observation ports, removable panels, and access doors for entry, cleaning, and inspection.
- F. Insulate casing with insulation material, protected and covered by heavy-gauge metal jacket.
- G. Factory apply boiler base and other components, that are subject to corrosion, with durable, acrylic, powder coated, painted, or weather-proofed finish.
- H. Boiler shall be provided with a drain and means to flush and clean the heat exchanger.

- I. The boiler shall be suitable for operating safely at reduced or near-zero flow rates as certified by the manufacturer, or incorporate controls that detect low/no flow and cycle the burner off to prevent overheating or damage.

2.04 BOILER TRIM

- A. ASME rated pressure relief valve.
- B. Flow switch.
- C. Electronic Low Water Cut-off: Complete with test light and manual reset button to automatically prevent firing operation whenever boiler water falls below safe level.
- D. Temperature and pressure gauge.
- E. Pressure Switches:
 - 1. High gas pressure.
 - 2. Low gas pressure.
 - 3. Air pressure.
- F. Manual reset high limit.
- G. Condensate neutralizer kit: Provide PH neutralizer for condensate neutralization on all condensing boilers. Factory-fabricated and assembled condensate neutralizing capsule tank assembly of corrosion-resistant material with threaded or flanged inlet and outlet pipe connections. Include initial charge of neutralizing agent. Axiom Industries, Neutra-Safe, or approved equal, rated for boiler capacity.
- H. Drain valve: Minimum 3/4" hose-end gate valve.
- I. Integral modulating controller.
- J. Boiler Pump: See project mechanical schedules.
 - 1. Where pump is provided by boiler manufacturer, pump shall be factory supplied and sized for field installation to ensure minimum, continuous circulation through boiler.
 - 2. Where pump is not provided by boiler manufacturer, provide pump in accordance with boiler manufacturer's recommendations and project mechanical schedules.

2.05 FUEL BURNING SYSTEM

- A. Provide forced draft automatic burner, integral to boiler, designed to burn natural gas, and maintain fuel-air ratios automatically. Burners and controls to conform to ASME/CSD-1.
 - 1. Blower Design: Variable speed blower fan, statically and dynamically balanced to supply combustion air; direct connected to motor.
 - 2. Forced Draft Design: Mixes combustion air and gas to achieve minimum combustion and thermal efficiency as listed on project mechanical schedules.
 - 3. Combustion Air Filter: Protects fuel burning system from debris.
- B. Gas Train: Factory-assembled and certified gas train meeting UL/CSA requirements. Gas train shall include redundant safety shutoff valves, electronic gas-air ratio control, and all required interlocks and safeties to comply with NFPA 54 and local codes.
- C. Emission of Oxides of Nitrogen Requirements: Comply with SCAQMD 1146.1 for natural gas fired system, as applicable.
- D. Intakes: Combustion air intake capable of accepting free mechanical room air or direct outside air through a sealed intake pipe. Provide complete system in accordance with manufacturer's requirements including but not limited to: intake pipe, vent terminal with screen, inlet air coupling, sealant.
- E. Venting: Provide complete system in accordance with manufacturer's requirements, including but not limited to: vent pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap, sealant. Use manufacturer approved materials only.
- F. Turndown: Minimum boiler turndown to be no less than 10:1, or as listed on project mechanical schedule.

- G. High Altitude Configuration: When project site elevation exceeds 2,500 feet above sea level, provide boilers factory-rated and properly configured for safe operation at project elevation. Include all manufacturer-recommended adjustments, high-altitude kits, or settings required for project elevation.

2.06 FACTORY INSTALLED CONTROLS

- A. General: Boiler mounted enclosure to include fusing, step-down control transformer and boiler controls.
- B. Display: Boiler controls shall feature a standard, factory installed graphic LCD screen display with navigation dial or touchscreen interface.
- C. Option for internal or external (0-10) VDC control.
- D. Temperature Controls:
 - 1. Automatic reset type to control fuel burning system on-off and firing rate to maintain temperature.
 - 2. Manual reset type to control fuel burning system to prevent boiler water temperature from exceeding safe system water temperature.
 - 3. Low-fire start time delay relay.
- E. Electronic PI setpoint/modulation control system.
- F. Microprocessor-based, fuel/air mixing controls.
- G. BAS, SCADA, or other Integrated Automation: ASHRAE Std 135 BACnet IP or MSTP. Factory installed interface to enable building automation system to monitor, control, and display boiler status and alarms to be provided when applicable; refer to mechanical drawings and schedules.
 - 1. External Point Mapping: Provide mapping table for each parameter included in the local visual interface with software-toggle flag to allow reduced mapping of available points.
 - 2. At a minimum, BAS interface shall be able to receive hardwired 0-10 VDC input signals to control setpoint and enable/disable boiler.
 - 3. All monitoring and control features, which are available at the local control panel, shall also be available at the remote operator workstation through the BAS.
- H. Cascade control: Where cascading boiler controls are specified by the project documents, the boiler shall have an integral cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of system boilers without utilization of an external controller. The cascade controller shall be factory installed, and at a minimum shall include lead/lag control, efficiency optimization, and lead boiler rotation.
- I. Outdoor air reset: Boiler shall come standard with outdoor air reset control which calculates the setpoint using a field installed outdoor air sensor and an adjustable reset curve.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Boiler locations indicated on drawings are approximate. Determine exact locations before roughing-in piping and electrical connections. Install piping adjacent to boiler to allow for service and maintenance clearances.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Install in accordance with manufacturer's instructions.
- D. Install boiler and provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes. Connect gas piping full size to boiler gas-train inlet with union.
- E. Install boiler on concrete housekeeping base, sized minimum of 4 inches (100 mm) larger than boiler base in accordance with Section 03 3000.
- F. Coordinate factory installed controls with DDC system specified in other mechanical sections, and sequence of operations.

- G. Coordinate provisions for water treatment in accordance with Section 23 2500 and drawings.
- H. Install piping from relief valves and terminate with a minimum 1 inch gap above nearest floor drain or approved termination location.
- I. Pipe cooled condensate produced by the combustion process from the boiler condensate connection and/or flue stack to neutralizer prior to discharging into nearest floor drain. All piping to be PVC and installed per manufacturer's diagrams and instructions. Install piping with a minimum of 2 percent downward slope in required direction of flow. Piping shall be at least full size of condensate connection. Neutralizer to be secured to floor or wall out of normal walking path.
- J. Connect to supply and return water piping. Connect supply and return water piping with shutoff valve and union at each connection. Arrange piping for easy removal of boilers.
- K. Install flue venting kit and combustion air duct, where applicable. Comply with all boiler manufacturer's installation instructions. Connections shall be
- L. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and DDC system specified in other mechanical sections. Install control wiring to field-mounted electrical devices.
- M. Assemble and install boiler trim not installed at factory.
- N. Install primary boiler pump in accordance with Section 23 21 23.
- O. Install piping in accordance with Section 23 21 14 and 26 05 83.
- P. Install electrical in accordance with Division 26.
- Q. Flush and clean boilers in accordance with manufacturer's start-up instructions.
- R. Provide shutoff switches (emergency stops) at exit doors meeting requirements of ASME CSD-1.
- S. High Altitude Verification: Verify combustion setup per manufacturer requirements if site elevation exceeds 2,500 feet.
- T. Tests Inspections:
 - 1. Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to conduct performance testing.
 - 2. Perform installation and startup checks according to manufacturer's written instructions.
 - 3. Perform hydrostatic leak test. Repair leaks and retest until no leaks exist.
 - 4. Perform operational test. Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion as needed.
 - 5. Test and adjust controls and safeties. Check and adjust initial operating set points and high-limit and low-limit safety set points.
 - 6. Performance tests: Boilers shall comply with performance requirements as indicated, as determined by field performance tests. Document test results and submit to architect.

3.02 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals for closeout submittals.
- B. Demonstrate proper operation of equipment to Owner's designated representative.
- C. Training: Train Owner's personnel on operation and maintenance of system.

END OF SECTION

**SECTION 23 6423
SCROLL WATER CHILLERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air-cooled scroll water chillers.

1.02 RELATED REQUIREMENTS

- A. Section 28 44 00 - Refrigeration Detection and Controls.
- B. Section 03 3000 - Cast-in-Place Concrete: Concrete housekeeping pads.
- C. Section 23 0548 - Vibration and Seismic Controls for HVAC.
- D. Section 23 0553 - Identification for HVAC Piping and Equipment.
- E. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
- F. Section 23 0800 - Commissioning of HVAC.
- G. Section 23 0923 - Direct-Digital Control System for HVAC.
- H. Section 23 0993 - Sequence of Operations for HVAC Controls.
- I. Section 23 2113 - Hydronic Piping.
- J. Section 23 2114 - Hydronic Specialties.
- K. Section 25 3519 - Integrated Automation Control Valves.
- L. Section 26 0583 - Wiring Connections.

1.03 REFERENCE STANDARDS

- A. AHRI 550/590 (I-P) - Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle; 2020, with Addendum (2022).
- B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2019, with All Amendments and Errata.
- C. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2025).
- D. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2021.
- E. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2019.
- F. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- G. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate physical size, weight and location of major pieces of equipment to be installed. Notify Architect of any major deviations from the equipment originally specified prior to ordering equipment.

1.05 SUBMITTALS

- A. Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.
- B. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.
- C. Manufacturer's Performance Data: Indicate energy input versus cooling load output from 0 to 100 percent of full load at specified and minimum condenser water temperature for water-cooled chillers and at specified and minimum outdoor air temperature for air-cooled chillers.
- D. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.

- E. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
- F. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories; include trouble-shooting guide.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Refrigerant: One container.
 - 2. Extra Lubricating Oil: One container.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Contractor specializing in installing the products specified in this section with minimum Five years of documented experience.
- B. When required, provide certification of inspection in compliance with the requirements of Authority Having Jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's written installation instructions for rigging, unloading, transporting, and storing units. Provide protective covering over vulnerable components until installation.
- B. Deliver units to the job site completely assembled and charged with refrigerant and oil by manufacturer.

1.08 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer's Warranty: Provide minimum one year parts and labor on entire unit, minimum three year extended warranty on compressor (parts only).

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. York / Johnson Controls
- B. Daikin
- C. Trane
- D. Carrier
- E. Substitutions: .
 - 1. The chilled water system has been designed based on specific capacities and characteristics of equipment specified in this section and other sections.
 - 2. When substitution of a different manufacturer or model number is desired, submit sufficient information to demonstrate to Engineer that the substitute will have the same or better performance as that specified AND that the related equipment in the system will perform acceptably with the substitute.
 - 3. If the related equipment must be modified to perform acceptably with the substitute, the entity proposing the substitution is responsible for all additional costs due to re-design and provision of different related equipment.

2.02 SCROLL-WATER CHILLER PERFORMANCE REQUIREMENTS

- A. Packaged Air-Cooled Chiller:
 - 1. The chiller shall be specified and installed in accordance with this specification and perform at the specified conditions as noted in equipment schedules on the design documents.
 - 2. Chiller shall be able to start and operate in ambient conditions from 30°F to 125°F.

3. Refrigerant Type: Match refrigerant type noted in equipment schedules. Alternatives shall only be refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) no greater than that allowed by federal code.
4. Energy Efficiency: Meets applicable efficiency requirements in Table 110.2-D of the California Title 24, Part 6 Energy Efficiency Standards.
5. Acoustics: Manufacturer must provide both sound power and sound pressure data in decibels per AHRI 370 at full load.

2.03 AIR-COOLED, SCROLL WATER CHILLER

- A. Factory assembled and tested chiller consisting of compressor(s), compressor motor(s), evaporator, condenser, enclosure, refrigeration circuits(s) and specialties, interconnecting piping, starters, and microprocessor-based controls.
 1. Rating: AHRI 550/590 (I-P).
 2. Safety: UL 1995 or replace and ASHRAE Std 15.
 3. Construction and Testing: ASME BPVC-VIII-1 as applicable for construction type.
 4. Enclosures:
 - a. Frame: Heavy-gauge steel with hot-dipped galvanized finish.
 - b. Steel Cabinets: Factory apply baked on enamel or baked on powder paint finish.
 - c. Perform 1000-hour minimum salt spray test in accordance with ASTM B117.
- B. Hermetic Scroll Compressor:
 1. Unit: Fully hermetic type with multiple, direct drive compressors with discharge and suction service valves and crankcase heaters.
 2. Vibration Control: Factory installed internal isolators or field installed external isolators.
 3. Oil Lubrication System: Initial oil charge, oil sump, heater, oil level, and sight glass.
 4. Capacity Reduction System: Provide compressor staging and/or variable-speed control capable of modulating capacity to less than or equal to 10% of full load without activation of hot gas bypass.
 5. Motor: Suction gas-cooled, with thermal or current overload protection.
 6. Options: Factory-installed individual compressor sound attenuator blankets.
- C. Evaporator:
 1. Brazed plate type.
 - a. Plate Material: 316 stainless steel.
 - b. Working Pressure Rating, Refrigerant Side: 430 psi (2965 kPa) minimum.
 - c. Working Pressure Rating, Water Side: 150 psi (1034 kPa) minimum.
 - d. End Connections: Provide with flanged or grooved connections.
 - e. Cold Surface Insulation.
 - 1) Insulation is factory installed on evaporator, connections, and suction piping.
 - 2) 0.75 inches (20 mm) minimum thick, UV-rated, closed cell insulation with a maximum K-factor of 0.28.
 - f. Provide factory installed vents and water drain connections on evaporator.
 - g. Evaporator shall be supplied with a factory-installed strainer.
 - h. Freeze Protection for Outdoor Locations: Provide thermostatically controlled electric heater to protect from freezing at ambient temperatures down to minus 20 degrees F (minus 28.9 degrees C).
 - i. Proof of flow (flow switch) shall be provided by the equipment manufacturer, installed and wired at the factory of origin.
- D. Air-Cooled Condenser:
 1. Finned-Tube Type:
 - a. Mechanically bond aluminum fins to copper tubing and protect with corrosion resistant materials or coatings.
 - b. Clean, dehydrate and test.
 - c. Leak Test: 650 psi (4482 kPa) minimum.
 2. Fans and Motors:

- a. Low Sound Fans: Dynamically and statically balanced propeller, shrouded-axial, or airfoil type fans of reinforced polymer or glass fiber reinforced composite corrosion resistant construction equipped with sealed, permanently lubricated ball bearings.
 - b. Discharge Fan Guards: Corrosion resistant, heavy gauge, steel wire.
 - c. Discharge Direction: Vertical.
 - d. Motors: Direct drive, totally enclosed for outdoor use with current overload protection. Variable speed drives where noted on equipment schedules.
 - e. Fans shall be low sound option.
- E. Refrigerant Circuits:
- 1. Provide multiple independent refrigeration circuits with one or multiple compressor(s) per circuit.
 - 2. Provide liquid line shut-off valve, filter-drier, expansion valve, refrigerant relief device, and discharge service isolation valve for each independent circuit.
- F. Controls Package:
- 1. Unit Controls: Factory-supplied DDC:
 - a. General: Automatic start, stop, operating, and protection sequences across the range of scheduled conditions and transients.
 - b. Control-panel mounted with required input-output expansions, power supply, fused disconnect, hand switches, knobs, and accessories required to control chiller unit to sequence of operations to meet intended use with listed performance.
 - c. Factory configured to interface prewired sensors, switches, and safeties with allowance to add up to four chiller valves and flow sensors.
 - d. Graphic-based touchscreen to include unit operation controls and user filter based interface for faults, alarms, performance, unit diagnostics, and data recording up to 12 months.
 - e. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.
 - f. External Point Mapping: Provide mapping table for each parameter included in the local visual interface with software-toggle flag to allow reduced mapping of available points.
 - g. Isolation Valves: Field-installed, 2-position, butterfly type with position tracking; see Section 25 3519.
 - 2. Prewire, assemble, factory mount, and test operating and safety control system consisting of a digital display or gauges, on-auto-off switch, motor starters, disconnect switches, power and control wiring. Provide controls, monitoring, programmable setpoints, alarms, and BAS as defined in the list below. The following list is the minimum; refer to the Sequence of Operations for additional requirements.
 - a. Automatic Adjustable Operating Controls:
 - 1) Temperature of chilled water leaving chiller.
 - 2) Chiller system capacity control based on setpoints and system load.
 - 3) Compressor short-cycling prevention.
 - 4) Lead/lag for multiple compressors.
 - 5) Automatic reset on power source failure.
 - 6) Load limiting.
 - b. Normal Operation Monitoring and Open Coverless Displays:
 - 1) Hours of operation.
 - 2) Suction and discharge refrigerant pressures.
 - 3) Automatic diagnostics.
 - 4) Number of starts.
 - 5) On/off compressor status.
 - 6) Entering and leaving chilled water temperatures.
 - 7) Status of operation.
 - 8) Oil pressure.

- c. Setpoints:
 - 1) Leaving chilled water temperature.
 - 2) Date/time.
- d. Automatic Chiller Shut-Down Safety Controls and Alarm:
 - 1) Automatic Reset:
 - (a) Chilled water flow interlock.
 - (b) Voltage protection; over and under.
 - (c) Phase reversal protection.
 - 2) Manual Reset:
 - (a) Evaporator low pressure.
 - (b) High motor winding temperature.
 - (c) Low chilled water temperature.
 - (d) Low chilled water flow.
 - (e) High condenser refrigerant discharge pressure.
 - (f) Motor current overload and phase loss.
 - (g) Low oil flow.
 - 3) Remote Alarm: Activate remote, audible bell upon safety shutdown of chiller.
- e. Points for Remote Monitoring and Control:
 - 1) Minimum Data Transmission to BAS:
 - (a) All system operating conditions.
 - (b) Capacity control information.
 - (c) Safety shutdown conditions.
 - (d) Circulating pump status
 - 2) Minimum Operating Commands from BAS:
 - (a) Remote unit start/stop.
 - (b) Remote chilled water setpoint reset.
- G. Electrical:
 - 1. Unit shall have a single point power connection.
 - 2. Unit shall have a a factory-installed and factory-wired control power transformer to provide unit control power.
 - 3. Compliance: NEMA EN 10250.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide protective covering over vulnerable components until installation. Fit nozzles and open ends with plastic enclosures.
- B. Examine rough-in of piping systems to verify actual locations of connections before equipment installation. Examine installation area for suitable conditions and compliance with requirements for installation tolerances. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Install in accordance with manufacturer's instructions. Install units level and firmly anchored with manufacturer's recommended clearances maintained.
- D. Loose components: Install electrical components, devices, and accessories that are not factory mounted, per manufacturer instructions.
- E. Align chiller package on steel or concrete foundations. Where concrete foundations are used; foundation shall be minimum 6 inches thick and 6 inches wider than equipment base on all sides.
- F. Install units on vibration isolators.
- G. Connect to electrical service.

- H. Connect to chilled water piping. Install piping adjacent to the machine to allow service and maintenance. Drawings indicate general arrangement of piping, fittings, and specialties. The following list is the minimum; refer to the drawings for additional requirements.
 - 1. Inlet: Provide thermometer, strainer, flow switch, flexible pipe connection, pressure gauge, and shutoff isolation valve.
 - 2. Outlet: Provide thermometer, flexible pipe connection, pressure gauge, and shutoff valve.
- I. Arrange piping for easy dismantling to permit tube cleaning and removal.
- J. Coordinate controls interface between unit controller(s) and BAS.

3.02 MANUFACTURER'S FIELD SERVICES

- A. Perform factory startup of the chiller by factory trained and authorized servicing technicians confirming equipment has been correctly installed prior to equipment becoming operational and covered under the manufacturer's warranty.
- B. Complete installation and startup checks according to manufacturer's written instructions.
- C. Supply initial charge of refrigerant and oil if not completely factory charged.
- D. Demonstrate system operations and verify specified performance.

3.03 CLOSEOUT ACTIVITIES

- A. Demonstrate proper operation of equipment to Owner's designated representative.
- B. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Briefly describe function, operation, and maintenance of each component.
- C. Training: Train Owner'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.

END OF SECTION

**SECTION 23 7433
DEDICATED OUTDOOR AIR UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Indoor-mounted DOAS.

1.02 RELATED REQUIREMENTS

- A. Section 23 0513 - Common Motor Requirements for HVAC Equipment.
- B. Section 23 0548 - Vibration and Seismic Controls for HVAC.
- C. Section 23 0934 - Variable-Frequency Motor Controllers for HVAC.
- D. Section 23 3300 - Air Duct Accessories: Flexible duct connections.
- E. Section 25 1500 - Integrated Automation Software: BAS, BMS, or SCADA.

1.03 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2023.
- B. AHRI 270 (SI/I-P) - Sound Performance Rating of Outdoor Unitary Equipment; 2025.
- C. ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units; 2022.
- D. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
- G. UL (DIR) - Online Certifications Directory; Current Edition.
- H. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - 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. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
- D. Operation And Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- E. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturers warranty for compressor/condenser unit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Aeon
- B. Greenheck.
- C. Valent.

2.02 PERFORMANCE REQUIREMENTS (REFER TO DRAWING SCHEDULES)

2.03 INDOOR-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. See drawing schedules for performance requirements of unit sections.
- D. Supply Fan Section
- E. Return-Exhaust Fan Section
- F. Hot Water Heating Section
- G. Chilled Water Cooling Section:
- H. Energy Recovery Section: Enthalpy Energy Recovery Wheel
 - 1. Total Heat Effectiveness: 55 percent.
 - 2. Latent Heat Effectiveness: 50 percent.
 - 3. Sensible Heat Effectiveness: 65 percent.
- I. Electrical: single point to factory-mounted fused disconnect switch internally wired into motors and compressors, and other powered components including system safeties.

2.04 INDOOR-MOUNTED DOAS

- A. Packaged Unit:
 - 1. Casing and Components:
 - a. Fabrication: AHRI 210/240 and UL 207 construction, ASHRAE Std 23 tested.
 - b. 18 gauge, 0.0478 inch (1.21 mm) steel panels reinforced with structural angles and channels to ensure rigidity.
 - c. Provide bolted access panels to access each sections from either side of unit.
 - d. Provide hinged door with lockable handle for serviceable sections.
 - e. Drain Pan: Galvanized steel with corrosion-resistant coating.
 - 2. Performance Ratings: ASHRAE Std 90.1, EER and COP as applicable.
 - 3. Regulatory Requirements: AHRI 270 (SI/I-P) rated, NFPA 70, and UL (DIR) listed.
 - 4. Insulation: Minimum 1 inch (13 mm) thick acoustic duct liner for lining cabinet interior.
 - 5. External Surface Finish: Heat resistant baked enamel.
 - 6. Suspended Installations: Service platforms complete with handrails and access ladder.
- B. Filter Section:
 - 1. Prefilter: Removable, metal frame fitted 2 inches (50 mm) thick disposable glass fiber.
 - 2. Filter: Removable, 4 inches (100 mm) thick MERV-13 and in accordance with the Local AHJ.
- C. Heating Section:*******SELECT*******
 - 1. Hot Water Coil:
 - a. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.
- D. Cooling Section:*******SELECT*******
 - 1. Chilled Water:
 - a. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.
- E. Energy Recovery Section: Provide wheel recovery device fully coordinated with return, exhaust, or return-exhaust fan section.
- F. Fan Section: *******SELECT*******
 - 1. Provide direct or plenum mounted variable-speed fan motors.
 - 2. Coordinate fan sequencing for units with return, exhaust, or return-exhaust fan sections.
 - 3. Provide preinstalled neutral wire protection when required to support specified fan type.

4. Motor to include thermal overload protection, quick disconnect plug, and permanently lubricated bearings.
 5. Variable Speed Control: Configure controller to maintain adjustable flow setpoint for modulating or speed-switched units.
 6. Fan Turndown: Design control features to allow fan speed reduction to adjustable 50 percent of its capacity when the zone set point temperature is satisfied or when unit runs in fan-only mode.
- G. Unit Controls:
1. DDC:
 - a. Tested to monitor and handle sequencing functions and other operational modes using field-mounted thermostat and other sensors.
 - b. Coordination and Sequencing:
 - 1) Internal Devices: Include compressors, blower, sensors, switches, valves, safeties, other components.
 - 2) Field-Installed Devices: Solenoid valves, thermostat, EWT sensors, LWT sensors, internal and remote contacts, and other devices required for operation.
 - 3) Safeties: At minimum include anti-short-cycle compressor protection, condensate overflow, refrigerant high pressure, refrigerant low pressure, loss-of-charge, refrigerant freeze protection, and freezestat.
 2. Thermostat: *******SELECT*******
 - a. Field mounted and wired, tied into prewired control-interface terminals.
 - b. Night Setback: Energize system when space temperature is below the 50 degrees F (10 degrees C) setpoint, adjustable.
 3. Local Control Panel: Interface to include on-off-auto switch, summer-winter switch, heat-off-cool switch, indicating lights for supply fan, pilot operation, burner operation, lockout indication, and clogged filter indication.
- H. Electrical: single point to factory-mounted disconnect switch internally wired into motors and compressors, and other powered components including system safeties.
- I. Furnish dedicated outdoor air unit and associated components and accessories produced by a single manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide unit- or duct-mounted smoke detectors and other NFPA 90A provisions.
- C. Install unit on vibration isolator pad or roof curb; see Section 23 0548.
- D. Provide flexible duct connections on inlet and outlet from unit; see Section 23 3300.
- E. Connect drain pan outlet to nearest building drain system piping.
- F. Adjusting: Use plenum static pressure readings against manufacturer calibration chart to adjust primary airflow as other measuring methods will not work.
- G. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s).

3.02 MAINTENANCE

- A. Provide service and maintenance of units for one year from Date of Substantial Completion.

END OF SECTION

SECTION 23 8126.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air-source heat pumps.
- B. Forced air furnaces.
- C. Air cooled condensing units.
- D. Indoor air handling (fan and coil) units for ducted systems.
- E. Indoor air handling (fan and coil) units for ductless systems.
- F. Controls.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Mounting pad for outdoor unit.
- B. Section 22 1005 - Plumbing Piping:
- C. Section 23 23 00 - Refrigerant Piping
- D. Section 23 1123 - Facility Natural-Gas Piping.
- E. Section 23 3100 - HVAC Ducts and Casings.
- F. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.03 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2023.
- B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; 2004.
- C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2019, with All Amendments and Errata.
- D. ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units; 2022.
- E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
- F. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.
- G. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances; 2024.
- H. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections. Indicate refrigerant pipe sizing.
- 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 Owner's name and registered with manufacturer.

- G. Project Record Documents: Record actual locations of components and connections.

1.05 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Daikin
- B. LG
- C. Samsung
- D. Mitsubishi

2.02 SYSTEM DESIGN

- A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed. Refer to equipment schedules for unit types.
 - 1. 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 Equipment Schedules for additional requirements.
- C. Electrical Characteristics: See equipment schedules
 - 1. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Division 26.

2.03 INDOOR DUCTLESS SYSTEMS (REFER TO DRAWING SCHEDULE)

- A. Ductless Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
- B. Supply Fan: Variable or multi-speed ECM fan with automatic airflow adjustment
- C. Air Filters: Manufacturer's permanent, cleanable filters.
- D. 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.
- E. Furnish with a wall mounting plate / bracket.

2.04 OUTDOOR UNITS (REFER TO DRAWING SCHEDULE)

- A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
 - 1. Comply with AHRI 210/240.
 - 2. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) no greater than that allowed by federal code.
 - 3. Cabinet: Galvanized steel with baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access.
 - 4. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL 207.
- B. Compressor: Hermetic, AHRI 520 resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high-pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.
- C. Air Cooled Coil: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.

1. Condenser Fans: Direct-drive propeller type statically and dynamically balanced with built-in thermal overload protection.
- D. Heat Pump Components (Where Applicable): Reversing valve and low temperature air cut-off.
- E. Accessories: Filter drier, high-pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line), disconnect switch, liquid line sight glass and moisture indicator, shut-off valves on suction and liquid piping.
 1. Provide thermostatic expansion valves.
 2. Refrigerant Line Sets: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized and sealed; factory-insulated with flared fittings at both ends.
 3. Refer to Section 23 23 00 for refrigerant piping.
 4. Low ambient wind baffle kits: See equipment schedules.
- F. Operating Controls:
 1. Control by room thermostat to maintain room temperature setting.
 2. Thermostat: 7-day programmable electronic space thermostat with automatic changeover, setback capability, and BACnet interface. System selector switch (heat-off-cool) and fan control switch (auto-on).
 3. Low Ambient Kit: Provide refrigerant pressure switch to cycle condenser fan on when condenser refrigerant pressure is above 285 psig (1965 kPa) and off when pressure drops below 140 psig (965 kPa) for operation to 0 degrees F (-18 degrees C).
- G. Piping: Provide extended piping units where specified on drawings. Contractor to verify refrigerant pipe routing, per shop drawings, does not exceed unit's maximum piping length capacity.

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. Connect indoor ducted units to supply and return ductwork with flexible connections.
- C. Install condensate piping with trap and route from drain pan to nearest floor drain or other approved condensate disposal location.
- D. Install all components furnished loose for field mounting.
- E. Secure outdoor units to concrete or stands; reference project drawings for additional details.
- F. Install in accordance with NFPA 90A and NFPA 90B.
- G. Provide vent connections in accordance with NFPA 211.
- H. Install refrigeration piping from outdoor unit(s) to indoor unit(s) in accordance with ASHRAE Std 15. Install refrigerant specialties furnished with unit.
- I. Evacuate refrigerant piping and install initial charge of refrigerant.
- J. Install control wiring between indoor unit(s), outdoor unit(s), and field installed accessories.
- K. Install connection to electrical power wiring in accordance with Division 26 and NFPA 70.
- L. Complete installation and startup checks according to manufacturer's written instructions.
- M. Demonstrate operation to owner's representative.

- N. Vacuum clean coils and inside of cabinet, and install new filters in units at substantial completion.
- O. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 26 00 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Electrical materials and installation instruction common to most electrical systems and components including but not limited to: equipment, raceways, fittings, sleeve/seals, sleeves, wires & connectors, conductors, demolition, equipment installation requirements common to equipment sections, painting and finishing, concrete bases, supports and anchorages, general coordination, electrical wiring and device coordination.

1.2 DEFINITIONS

- A. Following is a list of abbreviations generally used in Division 26.
1. AHJ – Authority Having Jurisdiction.
 2. ETL – Electric Testing Laboratories.
 3. NEC – National Electric Code.
 4. NEMA – National Electrical Manufacturers Association.
 5. NFPA – National Fire Protection Association.
 6. OSHA – Occupational Safety and Health Administration.
 7. UL – Underwriters Laboratories Inc.
- B. Terms used on the drawings or in the specifications shall have the following meanings:
1. Approved Equal: An Item suggested by the Contractor that is allowed by the Engineer to replace an item listed in the Specifications or Drawings. The burden of proof of equality is the responsibility of the Contractor.
 2. Furnish: Supply and deliver, ready for installation, assembly or intended use, all materials, labor, equipment, testing apparatus, controls, tests, accessories, and all other items customarily required for the proper and complete application for the particular work referred to.
 3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at the project site as required to complete all items of work as required for the intended use/operation including all testing, certification, commissioning, and other requirements for final turnover to the Owner.
 4. Provide: "Furnish" and "Install".
 5. Owner Furnished, Contractor Installed: The Owner will furnish at his cost and the Contractor shall receive, protect, store and install in the performance of the Work.
 6. Finished Spaces: Spaces other than electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
 7. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
 8. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include installations above ceilings, in shafts, trenches, partitions, or other enclosures.
 9. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations embedded in or below masonry or concrete construction, earthwork/trenches, within unheated shelters, crawl spaces or enclosures.

10. Wiring: All wires, raceways, fittings, conductors, connectors, tape, junction and outlet boxes, connectors, splices, and all other items necessary and/or required in connection with such work.
11. Raceway: All raceways, conduit, fittings, hangers, supports, sleeves, etc.

1.3 GENERAL REQUIREMENTS

- A. Examine the Drawings, specifications and other Contract Documents relating to the Work and the work of all trades and become fully informed as to the extent and character of work required. Coordinate all work with that of others to ensure proper and complete installation of all materials, equipment and supports. It is the intent of the drawings, specifications and related contract Documents to provide a complete working installation of all systems and equipment called for, in proper operating condition, finished, tested and ready for its intended use (hereinafter "Design Intent"). Provide all items not specifically shown on the drawings, called for in the specifications or related Contract Documents, but required to conform to the labor, material and equipment to achieve the Design Intent all and scaffolding, access provisions, tools, appliances, consumables, fees, permits and licenses, debris removal/disposal, supervision and labor, including required start-up, check-out and training to provide complete and fully operable systems in full compliance with the Contract Documents.
- B. Before submitting a bid and prior to the start of work, Contractor shall examine all conditions relating to the Work, including that associated with the work of other trades upon which Contractor's work may rely or otherwise depend, to achieve the Design Intent, in accordance with the best trade practices, workmanship and highest quality product installation, taking into account the sequence of the work, delivery, storage and hoisting requirements, requirements for access, testing and temporary services and all other site limitations and project complexities. Report to the Architect/Engineer any conditions which might prevent installation of materials and/or equipment in the manner intended by the Contract Documents or contrary to applicable codes, standards or regulations.
- C. No consideration or allowance will be granted for any alleged misunderstanding of materials, equipment or components to be furnished or work to be done; it being agreed that tender of proposal carries with it agreement to items, terms and conditions required by the Contract Documents.
- D. Site Visit – Visit the site and verify the exact conditions relating to the work and obtain such information as may be necessary to present a complete and comprehensive bid. No allowance will be made for any extra expense due to Contractor's failure to make such a visit and reasonably verify all actual/existing conditions. In the event of a conflict between existing conditions and the requirements of the Contract Documents, perform the necessary work to conform to Design Intent. The Owner or his representative will be the sole individual to interpret the intent of the Drawings in the event of a conflict between (1) existing conditions and those shown on the drawings, or (2) quality of existing material and quality of material indicated on the drawings or in the specifications. Wherever a conflict such as this occurs, the higher standard shall prevail.

1.4 SPECIAL REQUIREMENTS

- A. All seismic construction, restraints, bracing, mounts and hanging systems shall be in full compliance with the requirements of all Authorities Having Jurisdiction (AHJ's), pre-approval, certification and engineering (including certified engineering calculations and stamps). Contractor shall be solely responsible for obtaining and complying with all requirements of the AHJ.

1.5 SUBMITTALS

- A. Reference Division 1 for submittal requirements.
- B. Submittal Schedule – Provide a detailed submittal schedule including all requirements of this Division and its subdivisions to the Architect and Engineer within thirty (30) days of contract award.
 - 1. Contractor shall submit for the Engineer's approval a Submittal Schedule for the performance of the work that is consistent with the requirements of the project schedule. The Submittal Schedule shall allow reasonable time for the Architect and other consultants review as specified in Division 1 Submittal Procedures. If the time for Architects/Engineers review is not otherwise specified, the review period (from date of receipt) shall be fifteen (15) business days. Once approved by the Architect/Engineer, submittal dates and time limits established by the Submittal Schedule shall not, except for reasonable cause, be changed or exceeded by the Contractor.
 - 2. For each submittal required by the Contract Documents the schedule shall include: specification section number, subsection/paragraph identification number, item description (as stated in the applicable specification section, subsection or other Contract Document) and the scheduled delivery date to the Architect/Engineer.
 - 3. Contractor shall be responsible to the Architect/Engineer and/or Owner for all costs, expenses and impact to the project schedule resulting from any deviation to the approved Submittal Schedule, including but not limited to; payment for required overtime, out-of-house resources/consultants or other higher cost resources of the Architect/Engineer as may be required to perform out of sequence, stacked, critical, delayed, unscheduled or multiple reviews of required submittals necessitated by rejection of a prior submittal, (cumulatively and hereinafter, "Additional Review Costs")
- C. General
 - 1. Review is for general conformance with the Contract Documents and is not intended to otherwise approve or verify dimensions, quantities, or to coordinate the Work shown on shop drawings on or between Contractor and the work of other trades or Sections. Contractor is solely responsible for quantities, dimensions, means and methods. Dimensions shall be confirmed and correlated by Contractor at the jobsite prior to the start of the Work (procurement, fabrication, construction or other commencement activities). Contractor's failure to fully verify conditions at the jobsite prior to commencement of the work shall not relieve Contractor of its obligations under the Contract Documents and Contractor shall be responsible for all damages caused by or related to its failure to comply with the requirements of this provision.
 - 2. Submittal review shall be performed to show compliance with the design intent. Contractor shall specifically note any deviations from the Contract Documents and explain the reason and nature of the deviation. Such deviations will be reviewed or rejected on the submittal. Deviations not so identified shall not relieve the Contractor from the requirements of the Contract Documents.
 - 3. Resubmittals will be reviewed for compliance with comment(s) made on the original submittal only. Architect/Engineer shall not be responsible for changes made upon resubmittal that are not clearly identified (highlighted), and respond directly to the initial rejection. Resubmittals should not be packaged with non-related first time submittals, all resubmittals must be marked with the resubmittal number and date and must otherwise comply with all submittal requirements.
 - 4. Submit shop drawings, commissioning plan(s) and checklists, penetration locations, supplemental data, etc. as may be requires by the Contract Documents for all materials, equipment and other components of the work included is all Sections of thei Division and other provisions of the Contract Documents in accordance with the requirements of this Division and Division 1.
 - 5. All submittals must be reviewed by Contractor, and bear Contractors review stamp and signoff for Conformity to the Contract Documents, prior to the submission of any required

submittal to Architect/Engineer. Submittals that fail to meet this requirement will be considered incomplete, will not be reviewed by Architect/Engineer and will be returned to Contractor, without review and/or rejected and resubmittal will be required. Contractor shall be solely responsible for any and all Additional Review Costs and/or other project costs or schedule impact.

6. Forward all submittals to Architect/Engineer in a coherent, organized fashion, complete and packaged as required herein, Architect/Engineer may reject submittals that fail to comply with this or any other provision of the Contract Documents and Contractor shall be solely responsible for any and all Additional Review Costs and/or other project costs or schedule impact.
7. Subject to other provisions of the Contract Documents and in the absence of a more stringent requirement, Architect/Engineer will review a submittal not more than two (2) times. Contractor shall be solely responsible for any and all Additional Review Costs and/or other project costs or schedule impact.
8. Identify each submittal item by reference to Specification Section paragraph in which item is specified, or drawing/detail number, as applicable. In addition, for equipment submittals, include identification numbers appearing on the equipment schedule.
9. Identify each item by manufacturer, brand, trade name, number, size, rating, or whatever other data is necessary to properly identify and check materials and equipment. Words "as specified" are not sufficient identification.
10. Organize submittals in same sequence as they appear in specification sections, articles or paragraphs.
11. All materials and equipment submittals shall have a summary sheet at the front complete with catalog numbers. Where materials or equipment pertain to more than one building,, submittals shall clearly indicate at which locations the materials or equipment is to be installed.
12. Submittals shall show physical arrangement, construction details, finishes, materials used in fabrications, provisions for piping and/or conduit entrance, access requirements for installation and maintenance, physical size and dimension, electrical characteristics and requirements, foundation/curbs and all permanent and temporary support details as well as all information relating to weight, including but not limited to live and dead weights.

D. Catalog Cuts & Submittal Literature

Catalog cuts, submittal literature and published material may be included to supplement scale drawings.

1. Prepare submittals electronically in accordance with the following and Division 1
2. Submittal literature, drawings and diagrams shall be specifically applicable to this project and shall not contain extraneous material or optional choices. Clearly mark literature to indicate the proposed item. Substitutions: Comply with Division 1 Product Substitution Procedures.

E. Shop Drawings:

1. Shop drawings shall include all significant Division systems, equipment and components, including but not limited to all terminal devices, connections and elevations. Include all related specialty rooms (i.e. electrical, data/technology). Drawings shall be at a minimum scale of 1/4" per 1'-0" and shall be fully coordinated with the work of other trades and/or Sections.
2. Identify congested areas and clearly indicate solutions to space problems, developed in conjunction with the work of other trades and/or Sections. Identification of space problems without proposed solutions is not acceptable and is grounds for rejection. For such areas indicate, superimposed, the work of all trades and/or Sections involved and:
 - a. Clearly identify each area of congestion and deviations from the Contract Documents, and:

- b. Proposed solution(s), clearly documented and signed-off by all other trades and/or Sections involved.
- F. Anchorage and Supports: Submit details and calculations for support and anchors that are not specifically detailed on the drawings. All calculations must meet 2018 IBC.
 - 1. Provide details and calculations for electrical equipment per IBC 2018:
 - a. Having an operating weight over 400 pounds or more and mounted directly to the floor.
 - b. Having an operating weight over 20 pounds and suspended from the roof, floor, or wall or supported by vibration isolation devices.
 - 2. Where pre-approved bracing systems will be employed, submit:
 - a. System component brochure describing components used and detailed installation instructions.
 - b. Loads to be transmitted to the structure at anchor points.
 - 3. Where anchorage, support, and bracing are not detailed on the drawings, and pre-approved systems are not used, submit details and calculations of proposed systems.
 - a. Anchorage and Supports
 - 1) Where equipment substitutions change the weight, size, configuration, or other aspects of systems and equipment that will affect the performance of anchorages and/or supports, submit calculations for proposed anchors and supports, and install them as shown in these calculations.
 - 2) Where substitutions will have no effect on anchors and supports detailed on Contract Documents, submit information on sizes, weights, center of gravity and other relevant information to demonstrate this fact.
- G. Shop Fabrication Drawings: Drawings are for the Contractor's use and shall be its responsibility. Do not submit shop fabrication documents unless specifically requested.
- H. Testing and Balancing: Coordinate Shop Drawings to include any additional components for proper system testing and balancing.
- I. Certificates: Submit final inspection certificates signed by governing authorities.
- J. Operating and Maintenance Instructions and Manuals.
 - 1. Instructions on major items, including but not limited to: switchgear, generators, pumps, air compressors, water heaters, water softeners, specialty units, fans, air handlers, AC units and temperature controls, shall be by representative of manufacturer of respective equipment.
 - 2. Submit as identified below and as directed in Division 1.
 - a. Names, addresses and phone numbers of contractors and subcontractors. Alphabetical list of all system components, with the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year of operation.
 - b. Complete operating and maintenance instructions and parts lists of all equipment and component parts. Data sheets to show complete internal wiring, and electrical ratings and characteristics, catalog data on component parts whether furnished by equipment manufacturer or others, names, addresses and telephone numbers of source of supply for parts subject to wear or failure, and description of operating, test, adjustment, and maintenance procedures.
 - 1) Where data sheets included in manual cover equipment, options, or other features not part of equipment actually furnished, line out these references or otherwise clearly mark so remaining text, diagrams, drawings, schedules, and similar information shall apply specifically to equipment furnished.
 - c. Operating Instructions should include, but not be limited to:
 - 1) Normal starting, operational and shutdown procedures, including emergency procedures for each type of equipment/system.

- 2) Equipment wiring diagrams.
 - 3) All other items as may be specified/required by this Section and the Contract Documents.
 - d. Maintenance Instructions
 - 1) All items as may be specified/required by this Section and the Contract Documents.
 - e. Manufacturers Data (each piece of equipment)
 - 1) Installation instructions
 - 2) Drawings & specifications
 - 3) Parts List, including recommended stock and long lead parts/components.
 - 4) Wiring and riser diagrams.
 - 5) Warranties and guarantees for all equipment, materials and components, including repair, replacement and labor from both Contractor and manufacturer as required by the Contract Documents.
 - 6) Certificates of Installation – manufacturer's certification of supervision during equipment installation and start-up procedures.
 - 7) Instruction certificates – certificates of compliance with Sections specific training and instruction programs.
 - 8) All other items as may be specified/required by this Section and the Contract Documents.
- K. Record Documents.
- 1. Maintain one (1) complete set of blueline prints and specifications at the job site exclusively for recording deviations from the drawings which are necessary because of job conditions, request for information and/or approved change orders. Record locations and depths of buried and concealed conduits or other systems components from fixed, easily identifiable objects, such as building walls or other fixed physical objects. Where conduits are concealed in walls or other fixed physical objects, indicate distances from building corners or other building features not likely to be disturbed by fixture alterations. Drawings, specifications (as-builts) and approved submittals.
 - 2. Where the project use a BIM model the contractor shall keep the model updated in a similar fashion, maintaining the current project record as described in (a), above and submit, an addition to all other requirements of this Section and other provisions of the Contract Documents a complete and accurate BIM model for the project.
 - 3. Prior to Substantial Completion, obtain from the Architect a complete set of electronic CADD drawings. Record all revisions to these drawings to indicate as-built conditions. Indicate all changes, including RFI's, on this set of documents. Submit one set of blueprints of these revised drawings for review. Make necessary changes and deliver to Architect one set of reproducibles and one electronic copy, including and BIM model, upon Final Completion and Acceptance. Refer to Division 1 for additional requirements.
 - 4. Provide full size copies of record one-line diagrams, in metal frames with glass front. Obtain Record prints from Owner's Representative at Contractor's cost and have prints framed by a firm normally engaged in this work. Locate diagrams as directed.
 - 5. All test reports, certifications, and inspection reports.
 - 6. AHJ/Specialty AHJ Approvals (i.e. Fire Marshal and/or Fire Department system approvals).
 - 7. Substantial and Final inspection certificate signed by governing authorities.
 - 8. All other items as may be specified/required by this Section and/or other provisions of the Contract Documents.

1.6 EQUIPMENT DEVIATIONS & SUBSTITUTIONS

- A. See Division 1 for requirements and procedures related to Deviations and Substitutions. Unless specified elsewhere in the Contract Documents, a minimum of two (2) weeks shall be allowed for

evaluation. The burden of all systems re-engineering/design, testing, suitability and constructability is solely placed upon the Contractor for all deviations from the basis of design as reflected in the Contract Documents.

- B. No substitutions will be allowed and/or considered unless the description of a product includes the phrase "approved equal" and then only upon a determination as to equivalency and impact upon the project budget, schedule and the work of others, including any redesign of the project or its system components by the Architect, Engineer or other trades. The final determination as to sufficiency or acceptance of any such substitution and/or deviation properly requested and submitted by Contractor will lie solely with the Architect/Engineer. Contractor may not implement substitutions that have not been approved by Architect/Engineer.
- C. Where the contractor proposes to use an item of equipment other than that specified or detailed on the drawings which requires any redesign of any portion of the project, including but not limited to the mechanical, electrical, plumbing, structure, or architectural design or any of their respective subcomponents. Contractor shall be responsible to the Architect/Engineer and/or Owner for all costs, expenses and impact to the project budget and/or schedule resulting from any required investigation, analysis or redesign, including but not limited to; payment for required overtime, out-of-house resources/consultants or other higher cost resources of the Architect/Engineer, Owner or AHJ as may be required to perform the investigation, analysis or redesign (cumulatively and hereinafter, "Deviation Review Costs")
- D. If approved by Architect/Engineer, all such redesign, including all new drawings and detailing required, will be prepared by the Architect/Engineer and their sub-consultants for Change Order documentation for approval by Owner and the Authority Having Jurisdiction will be paid by the Contractor as part of the Deviation Review Costs.
- E. Where such approved deviation requires a different quantity and arrangement of equipment, wiring, conduit, supports, foundations, pads, curbs, or equipment from that specified or indicated on the drawings or other Contract Documents, Contractor shall be responsible for all such costs, including the work of other trades and shall be solely responsible to furnish and install any such ductwork, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and conduit, and any other additional equipment required by the system at no additional cost or schedule impact to the project (cumulatively and hereinafter "Deviation Construction Costs").

1.7 COORDINATION

- A. Drawings and corresponding electronic media are diagrammatic and indicate the general arrangement of systems and work included in the Work. Consult the drawings, details and other electronic media for locations of fixtures and equipment; where same are not definitely located, obtain this information from the Architect/Engineer.
- B. The drawings and related electronic media have been made to scale with the best knowledge of conditions, dimensions and space requirements available at the time of design and shall be followed as closely as possible during performance of the Work and coordination with the work of others. The foregoing however shall not relieve Contractor from its responsibility to verify all conditions. Dimensions and space requirements prior to commencement of the Work and to immediately report any errors or discrepancies to the Architect/Engineer.
- C. Check drawings and related electronic media of other trades to verify spaces and conditions in which work will be performed prior to commencement of the work.

- D. If directed by the Architect/Engineer or required for proper installation, execution and coordination of the work, the Contractor shall, without extra charge, make reasonable modifications in the layout as needed.
- E. Take all dimensions from Architectural and Structural Drawings, certified equipment drawings and from the actual field measurements before fabricating work. All conflicts shall immediately be reported to the Architect/Engineer. Contractor is solely responsible for conflicts known or which reasonably should have been know but not reported or resolved before commencement of the work.
- F. Equipment furnished shall fit in allocated space with due provision for manufacturer's recommended access and proper maintenance requirements. Verify and coordinate space requirements with all trades and equipment which comprise the Work.
- G. Prior to construction, coordinate the Work with that of other trades and building components. Prepare coordination drawings (or other specified electronic media) for all major trades, utilities and other primary systems routing in conjunction with the contract documents to maximize the pre-installation planning and coordination of trades, utilities and systems and minimize the requirement to manage field coordination through the RFI's, ASI's or other similar processes.
- H. Coordinate connection of systems with interior/exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- I. Before starting work, carefully examine the site and all Contract Documents. Become thoroughly familiar with new and existing conditions governing work on this project. Verify indicated elevations, building measurements, rough-in dimensions and equipment locations before proceeding with any of the work.
- J. Drawings shall be accurately scaled to 1/8 inch – 1 foot or larger using the same version of AutoCAD or other electronic media as used by Architect/Engineer. Drawings shall include all addenda and Change Order items.
- K. Contractor shall be solely responsible for coordination and shall bear the cost of its failure to coordinate installation or of failure to advise Architect/Engineer of installation conflicts.
- L. Sequence, coordinate, and integrate installations of systems materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to building enclosure.

1.8 ELECTRICAL WIRING AND COORDINATION

- A. In general, power wiring will be provided under DIVISION 26 – ELECTRICAL, and control wiring will be provided under DIVISION 23 – HVAC, unless otherwise specified.
- B. The following schedule summarizes the division or work and material responsibilities.

ITEM	FURNISHED UNDER	SET IN PLACE OR MOUNTED UNDER	WIRED AND CONNECTED UNDER
Equipment motors	MD 1	MD 1	ED 2

Resistance heaters	MD	MD	ED
Fire protection controls, including remote switches, flow switches	MD	MD	ED
Motor controls where specified as an integral package	MD	MD	ED
Motor controllers	ED 4	ED 4	ED
Resistance type heater controllers	MD	ED 4	ED
Magnetic contactors and magnetic starters with overload trip assembly	ED 4	ED 4	ED
Integral control transformers	MD	ED 4	ED
Cover-mounted control devices	MD	ED 4	ED
Disconnect switches fused and unfused	ED 4	ED 4	ED
Thermal or thermal-magnetic circuit breakers	ED 4	ED 4	ED
Fuses	ED 4	ED 4	ED
Duct smoke detectors	ED	MD	ED 3
Smoke and fire/smoke dampers (with and without end switches)	MD	MD	ED 3
Control power source for temperature and equipment control panels	ED	ED	ED
Electric temperature control relays and miscellaneous devices	MD	MD 5	MD 5
Level and float switches	MD	MD 5	MD 5
Pipe mounted control devices such as flow switches, flow sensors, valves, and wells.	MD	MD 5	MD 5
Thermostats and space sensors.	MD	MD 5	MD 5
Duct mounted control devices such as temperature, humidity, flow and pressure sensors.	MD	MD 5	MD 5
Damper actuators.	MD	MD 5	MD 5
Control dampers.	MD	MD	--
Variable frequency drives (vfd) specified to be mounted on or in the mechanical equipment.	MD	MD	ED
VFD specified to be mounted separately from the mechanical equipment	MD	ED	ED

C. Notes: (1) MD: Mechanical Divisions 21, 22, 23. (2) ED: Electrical Division 26. (3) Fire Alarm related and power wiring provided under Division 28; Control-related wiring and relays provided under

Division 21, 22, 23. (4) If furnished as part of factory equipment under Division 21, 22, 23, wiring and connections only by Electrical Division 26. (5) If any control devices carry the Full Load Current to any motor, they shall be furnished under Division 21, 22, 23, but shall be set in place and connected under Division 26.

1.9 ACCESSIBILITY

- A. Contractor is responsible for verifying that equipment and devices will fit within the space shown on the drawings. Contractor shall locate all equipment which must be serviced, operated or maintained, if fully accessible positions.
- B. Minor deviations from the drawings may be made to allow for better accessibility, but changes of magnitude or which involve extra cost shall not be made without approval from the Architect/Engineer.

1.10 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum 5 years documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with a minimum of 5 years documented experience. Company personnel shall be approved by manufacturer for all product installations and required training.
- C. Conform to all applicable standards, codes and regulation and industry best practice requirements.
- D. All materials and equipment shall be new, shall bear manufacturer's name, and shall conform to the grade, quality and standards specified herein. Type, capacity and application shall be suitable and capable of satisfactory operation for the purpose intended. All equipment and components shall include UL label and/or marking on equipment body/device including manufacturer's name, pressure rating(s), electrical classification(s), limits and ratings as applicable to individual components for the purpose specified and intended.
- E. Equipment Selection: All items of a given type shall be the product of the same manufacturer. Equipment of greater or larger power, dimensions, capacities, and ratings may be considered provided such proposed equipment is approved in writing by Architect/Engineer and connecting electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. See Deviations & Substitutions for requirements. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings of efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.
- F. Listing and labeling: Provide motors that are listed and labeled. Terms "listed and labeled": as defined by UL, NEC, Article 100 or other applicable recognized agency as specified in the Contract Documents.
- G. Cutting & Patching: Unless otherwise required by the Contract Documents, Contractor shall be responsible for all cutting, fitting and patching required to complete the Work, or to make portions of the Work and existing conditions fit together properly, and all such areas shall be restored to the conditions existing prior to the cutting, fitting and patching unless otherwise provided in the Contract Documents.

- H. Contractor shall promptly correct any portion of the Work that is defective or not in accordance with the Contract Documents or rejected by the Architect/Engineer or Owner. Contractor shall be responsible for, and pay for all costs arising out of, any additional testing and inspections, demolition, uncovering and replacement and additional design and consulting services required to properly correct any portion of the Work.
- I. Contractor shall comply will comply with the Contract Documents and all Laws, standards and handling criteria regarding hazardous substances, wastes and materials, including asbestos-containing materials, lead-based paints, petroleum (or any constituent thereof), mold, radon, and polychlorinated biphenyl (PCB), ("Hazardous Materials") in performing the Work. Unless required by the Contract Documents, no Hazardous Materials shall be brought onto the Project.
- J. Lead Free Requirements: Contractor shall endeavor to use lead free products and where required by law, ordinance, regulation or standard all materials products and practices shall comply with limitations and requirements as to the allowable limits and/or percentages of lead. Lead free products must be certified by and independent 3rd party.
 - 1. This provision shall apply to any and all similarly regulated materials, products and practices that may be considered hazardous or are otherwise regulated by applicable law, ordinance regulation or standard in the project local.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. All materials and equipment shall be adequately covered and protected against dirt, water, chemical or mechanical damage, and theft. At completion, all work, equipment and materials shall be cleaned, and damage repaired by Contractor. Damaged equipment will be replaced by the contractor if Owner does not accept repairs done to the equipment. Such replacement shall be scheduled to minimize building system interruption of occupied or scheduled for occupancy.
- B. Material delivered at the site shall not be left exposed to the weather or left unattended. Deliver pipes, tubes and conduit with factory-applied end-caps. Contractor shall be responsible to maintain end-caps or provide temporary end caps on all open-ended piping, tubes and conduit through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
- C. Protect stored material from moisture and dirt. Protect plastic pipes and materials from sunlight and support to prevent sagging and bending.
- D. Elevate stored materials above grade. When stored inside, to not exceed structural capacity of the floor.
- E. Provide protective coatings to materials to prevent damage and/or infiltration of moisture and dirt on all materials and equipment including but not limited to cast iron and steel valves.
- F. Contractor shall check the openings in the building and the size of the doors, passages, and openings through which equipment is to be admitted. Wherever necessary, he shall provide the equipment in sections or knocked down in order to admit the equipment through these openings.
- G. Contractor shall provide all rigging, erection and hoisting equipment as required to handle or place equipment and piping in position. This rigging and hoisting equipment shall only be attached and placed on the structure in locations as approved by Architect/Engineer at the site.

1.12 PERMITS, FEES & UTILITIES

- A. Obtain and pay for all necessary permits, fees and utilities and inspections required to perform the Work.
- B. Coordinate work with local regulatory entities, utility companies and others as required to fully comply with the requirements of this section and the Contract Documents, including those for both temporary and permanent services.
- C. Permits, fees and utility expenses to be paid by Owner, if any, shall only where specifically required by the Contract Documents, and then only to the extent so specified.

1.13 DOCUMENT OWNERSHIP

- A. The Drawings and Specifications, combined with the calculations, field data, notes, and reports, are the intellectual and real property of the Architect and/or Engineer. This covers all forms of written and recorded or electronic media. The reuse of these documents without specific permission of the Engineer is prohibited. The Drawings may be employed by the Owner and Contractor for the express use of constructing, commissioning and operating the facility only upon proper execution of the Agreement for Use of Electronic Files & Data.

1.14 GUARANTEE AND WARRANTY

- A. Contractor warrants to Owner that the materials and equipment provided under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise. Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects. Work, materials and equipment not conforming to these requirements, including substitutions not properly approved by Change Order, shall be considered defective. This warranty excludes remedy for damage caused by improper or insufficient maintenance, improper operation or normal wear, tear and usage. Contractor shall assign to Owner, or otherwise assure the Owner has the full benefit of, all warranties and guarantees of manufacturer, subcontractors, sub-subcontractors and suppliers, and Contractor shall perform the Work in a manner that does not adversely affect or invalidate any available warranties or guarantees.
- B. Contractor shall warrant and guarantee all work against faulty material or workmanship for a period of one (1) year from the date of final completion and written acceptance by the Owner, unless specified more stringently elsewhere in the Contract Documents.
- C. If the project is occupied or the systems placed in operation in several phases at the request of the Owner, the guarantee of each system or piece of equipment used shall begin on the date each system or piece of equipment was placed in satisfactory operation, tested, commissioned and accepted, in writing, by the Owner. The use of building equipment for temporary service and testing or phases of work completed prior to the projects final completion and acceptance by the Owner does not constitute the commencement of the warranty period.
- D. If a defect or deficiency in the Work is discovered within the one (1) year Warranty & Guarantee period or within such longer period as may be prescribed by the Laws or by any specific guarantee, and Owner elects to have Contractor correct such defect or deficiency, Owner shall notify Contractor of such defect or deficiency in writing. This period of correction relates only to the specific obligation to correct defects and deficiencies and in no way otherwise limits the Contractor's responsibility for Work that is not in accordance with the Contract Documents, If

Contractor fails to timely correct defects or deficiencies in the Work, Owner may, at its sole option, correct them and charge contractor for all cost therefore.

- E. See Division 1 – Closeout Submittals for additional warranty requirements.
- F. Specific exclusions, if any, from this one (1) year warrantee and guarantee period are listed in the individual specification sections.

1.15 LIMITATIONS OF LIABILITY

To the extent any of the following provisions are not more stringently included in the Contract Document the following Limitations of Liability shall apply:

- A. Architect/Engineer is not responsible for Contractor's means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, and is not responsible for Contractor's failure to perform or furnish the work in accordance with the Contract Documents.
- B. In the event that Architect/Engineer's employees or sub-consultants make comments or issue warnings about safety issues, such comments and warnings shall be considered to have been offered by a Good Samaritan and shall not impose any obligation or responsibility.
- C. Engineer will not be responsible for the acts or omissions of Owner, Contractor, any subcontractor, any supplier, or of any other person or organization performing or furnishing any of the portions of the work
- D. Contractor understands and acknowledges that Engineer is not authorized to order extra work or issue Change Orders to the work, however in the event and to the degree that Engineer may offer advice, suggestions, and opinions Contractor shall not rely on such advice, suggestions, and opinions unless directed in writing by Owner or its designated representative, and shall, in no event, make any claim against the Engineer for any such advice, suggestions, and opinions.
- E. To the fullest extent permitted by law, Contractor shall indemnify and hold harmless Architect, Engineer, and their joint ventures, officers, directors, partners, employees and agents from and against any and all claims, costs, losses and damages (including but not limited to all fees and charge of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs) caused in whole or in part by the negligent acts or omissions of Contractor, Contractor's officers, directors, partners, employees, agents; or contractor's subcontractors or material men in the performance of Work. Contractor shall direct its insurer to list Architect, Engineer, and their joint ventures, as Additional Insureds on general liability insurance policies covering this project. Prior to commencing work, Contractor shall submit copies of its certificate of insurance to both Architect and Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
 - 2. Manufacturer: Unless otherwise specified, company specializing in manufacturing specified products for at least 3 years.

2.2 MATERIALS AND EQUIPMENT

- A. The device numbers noted in this specification are generally those of a specific manufacturer and represent the minimum quality required as the basis of design for this project. Subject to the Substitutions and other provisions of the Contract Documents, Contractor may submit equivalent devices from the other manufacturers listed in the section.
- B. Materials and equipment used in carrying out these specifications shall be new and have UL listing, or listing by other recognized testing laboratory when such listings are available.
- C. All material shall bear manufacturer's name, model number, electrical characteristics and other identification and shall be the standard product of manufacturer regularly engaged in production of similar material.
- D. Construction of equipment shall be as follows:
 - 1. All prefabricated equipment shall be designed and constructed in such a manner that all parts of said equipment and the equipment as a whole, including attachments, will resist the forces (including seismic where applicable) to which they may be subjected.
 - 2. Unless otherwise specified or required, design criteria shall be no less than 1.5g for lateral forces and 0.6g for vertical forces.
 - 3. Provisions for support and anchorage of equipment shall be an integral part of each item and shall include the fastening means and all necessary internal and external bracing, brackets and connections.
- E. Specifications for many items are or may be described on the drawings, including but not limited to wiring devices, lighting fixtures, control devices, etc. are or may be described on the drawings. Contractor shall promptly advise Architect of any conflicts or discrepancies.
- F. Except for conduit, conduit fittings, outlet boxes, wire and cable (600V and below only), all items of equipment or material shall be the product of one manufacturer throughout.
- G. The documents contain specifications regarding equipment design, including BIL levels, AIC ratings, and series ratings. In all cases provide equipment sufficient for the use intended. Do not provide materials whose ratings fall below those included in the Documents.

PART 3 - EXECUTION

3.1 UTILITY SERVICE(S)

- A. Contractor shall be responsible for verifying and coordinating the work with local utility companies providing service to the facility and/or site and coordination with the work of others. This shall include, but not be limited to:
 - 1. Confirmation of schedule and service routing and sequence of the work to be performed by each utility, contractor, subcontractor or others to ensure that the work can be performed without impact to the project schedule and with minimum interruption to services.
 - 2. Verification of utility services point of entry to the facility, including applicable invert elevations, proper placement of sleeves and/or penetrations and sealant thereof.
 - 3. Establishing utility point of contact, documenting the local utility company representatives:
 - a. Company:
 - b. Contact Person:
 - c. Contact Telephone Number:
 - d. Provide required connections for each incoming utility service.

3.2 ELECTRICAL SYSTEMS

- A. Visit site and observe conditions under which work must be performed.
- B. Before starting work, carefully examine Architectural, Civil, Landscape, Structural, Plumbing, Heating, Ventilating and Air Conditioning drawings to become thoroughly familiar with conditions governing work on this project. Verify elevations, measurements, rough-in requirements of equipment and its installation location before proceeding with the work. Install equipment with access as required by the NEC.
- C. Circuit "tags" on the Electrical Drawings in the form of arrows are used to indicate home runs of raceways to electrical distribution points. These tags show the circuits in each home run and the panel designation. Do not combine circuits other than those shown or allowed on the Drawings. Show the actual circuit numbers on the finished record drawing, and on the panel directory card. Provide an insulated grounding conductor sized in accordance with NEC in every power circuit.
- D. The general directions and location of homeruns are indicated on Drawings and are to be extended to panels as though routes were completely shown. Items which are installed other than as shown on Drawings and without receiving prior written approval will be ordered removed and installed as shown without additional cost to Owner.
- E. The Drawings do not indicate the exact number of wires in each conduit for the branch circuit wiring. Provide the correct quantity of wires as indicated by: the circuit numbers indicated, wiring diagrams, and by applicable requirements of the NEC.
- F. Electrical Drawings are diagrammatic and shall not be scaled for exact sizes. Adjust location of conduits, panels, equipment, pull boxes and fixtures to accommodate the work and to prevent interferences.
 - 1. Lines which pitch have right-of-way over those that do not. Lines whose elevation cannot be changed have right-of-way over lines whose elevations can.

2. Make offsets, transitions, and changes in direction in raceways as required to maintain proper headroom pitch of sloping lines.
- G. Wire and cable routing shown on the Drawings is approximate. Route wire and cable as required to meet Project Conditions.
- H. When wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.
- I. The Drawings are diagrammatic. They do not show every offset, bend, conduit body, elbow or junction box that may be required to install work in the space provided and avoid conflicts. Follow the Drawings as closely as is practical and install additional bends, offsets and elbows where needed by local job site conditions. Provide necessary junction boxes to meet code regulations for the allowed number of conduit bends.
- J. Establish sizes and locations of the various concrete bases required. Coordinate and provide all necessary anchor bolts together with templates for holding these bolts in position.
- K. Provide supports, blocking, hangers, and auxiliary structural members required for support of work.
- L. Furnish and set all sleeves for passage of raceways through structural, masonry, and concrete walls, floors, and elsewhere for proper protection of the raceways.
- M. Establish size, location, and count of cast-in conduits or conduits to be concealed underneath the foundations. Coordinate with steel reinforcing.
- N. The architectural drawings govern the locations and elevations of all electrical equipment, devices and fixtures. Resolve conflicts with the Architect prior to rough-in.
- O. Verify that the physical dimension of each item of electrical equipment will fit the available space. Coordinate electrical equipment space requirements with the allotted space provisions, and access routes through the construction area.
- P. Coordinate rough-in and wiring requirements for all mechanical, kitchen and other equipment with equipment supplier and installer. Make installation in accordance with rough-in and wiring diagrams provided by equipment supplier and installer.
- Q. Coordinate all aspects of the electrical, telephone and other utility services with the appropriate serving utility company.
- R. Coordinate underground work with other contractors working on the site. Common trenches may be used with other trades. In such areas, maintain clearances as required by codes and ordinances.
- S. Coordinate underground work with foundation plans and work.
- T. The location of utilities indicated on the plans is taken from existing public records. The exact location and elevation of public utilities must be determined by the Contractor. The Contractor shall ascertain whether any additional facilities other than those shown on the Drawings may be present.
- U. Call to the attention of the Architect any error, conflict or discrepancy in Plans and/or Specifications. Do not proceed with any questionable items of work until clarification of same has

been made. Supplementary Details and Plans may be supplied as required and they will become a part of the Contract Documents.

3.3 EQUIPMENT INSTALLATION

- A. Follow manufacturer's instructions.
- B. Where the product has no manufacturer's instructions, follow these specifications. Where neither the manufacturer nor these specifications contain such instructions, install in accordance with the standards listed above. No allowance of any kind will be made for negligence on part of Contractor to foresee means of bringing in or installing equipment into position.
 - 1. Verify all dimensions by field measurements.
 - 2. Install systems, materials, and equipment to provide the maximum headroom possible.
 - 3. Install systems, materials, and equipment to comply with approved submittal data, including coordination drawings
 - 4. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
 - 5. Fit surface panels, devices and outlets with neat, appropriate trims, plates or covers, without over-hanging edges, protruding corners or raw edges, to leave a finished appearance.
 - 6. Extend maintenance and access components (i.e., grease fittings, service panels, and similar items) to accessible locations.
 - 7. Install equipment to allow right of way for piping installed at required slope.
- C. Locations:
 - 1. Verify all locations with actual field conditions, architectural, structural, electrical, plumbing, heating and ventilating plans to avert possible installation conflicts.
 - 2. Architect reserves the right to make minor changes prior to installation without cost to Owner.
 - 3. Coordinate work with that of other trades to assure symmetrical placing of fixtures, sprinkler heads and other exposed components with respect to ceiling tile, grilles, etc. See Architectural reflected ceiling plan for exact location of light fixtures and other equipment.
 - 4. Any work which is incorrectly installed without prior verification without required coordination will be ordered removed and relocated and any changes or damage resulting to other work shall be repaired and/or replaced at no cost to the Owner.
 - 5. In general, locate all finished devices or other exposed finished devices as indicated on or by symbols on drawings. Where devices or other exposed finished components occur in face, decks or base millwork, walls, ceilings or other finished surfaces carefully coordinate with details and arrangements of same.
 - 6. All mounting heights shown on drawings are from finish floor to centerline unless otherwise indicated or required by code. Mounting heights at non-typical locations shown with (+) sign and height required noted adjacent to such device. Devices located in concrete block, brick or tile walls are to be adjusted in height to coordinate with modular joints of the materials. Verify requirements with Architect prior to installation.
 - 7. Wiring Requirements: Install wiring complete to every outlet with all devices shown and/or required. All wiring to be in raceways and concealed throughout finished areas unless specifically noted otherwise. For the purpose of electrical specifications, all areas, with the exception of boiler rooms, mechanical rooms and mechanical spaces, are to be considered as finished areas.
- D. Equipment Connections
 - 1. Coordinate the work with that of other trades to ensure all required connections are provided to ensure proper installation and operation.

2. Provide complete electrical connections for all items of equipment requiring such connections, including incidental wiring, materials, devices and labor necessary for a finished working installation.
3. Verify the location and method for connecting to each item of equipment prior to roughing-in. Check voltage and phase of each item of equipment before connection.
4. Make motor connections for the proper direction of rotation.

3.4 NOISE CONTROL

- A. Provide insulation, isolators and other sound attenuation requirements as specified by Contract Documents.
- B. Back to back or straight through boxes are not permitted unless specifically noted on the drawings.
- C. Contactors, transformers, starters and similar noise producing devices shall not be placed on walls which are common to occupied spaces unless specifically called for on the drawings. Where equipment is mounted on wall common to occupied spaces, provide shock mounting or noise isolators to effectively prevent transmission to occupied spaces.
- D. Contactors, starters, transformers and like equipment found noticeably noisier than similar equipment of same type are to be removed and replaced as directed by Architect at no cost to owner.
- E. Route raceways along corridors or other noncritical noise space to minimize penetrations through sound rated walls. Seal raceway penetrations through sound rated walls.

3.5 FIRE WALL PENETRATIONS

- A. Perform necessary fire rated wall sealing for the work in accordance with Division 7 - Fire and Smoke Protection.
- B. Provide necessary wall material to maintain fire wall rating where flush mounted equipment or components installed.
- C. Where systems or components penetrate floors, ceilings, ducts, chases and fire walls, provide fire stopping to maintain integrity of the fire assembly. Fire stopping method shall be approved by the authority having jurisdiction.
- D. Where electrical boxes with total area exceeding 16 square inches are located in fire resistive walls, fire stopping shall be provided to maintain integrity of the fire assembly.
- E. Where electrical boxes are installed on opposite sides of a rated wall, horizontal separation between the boxes shall be a minimum of 24-inches. Horizontal separation of these boxes may be less than 24-inches if a UL approved protective material is utilized.
 4. Electrical boxes shall not be installed back to back in rated walls.
 - a. The aggregate surface area of the boxes shall not exceed 100 sq in per 100 sq ft of wall surface.

3.6 EQUIPMENT SUPPORT

- A. General
 - 1. Provide a system of supporting devices and hangers for support and bracing of piping, conduit and equipment as required by code or as provided under this Division as indicated on plans and as described herein.
 - 2. Do not install supporting devices so as to obstruct access to equipment.
 - 3. Floor-mounted equipment shall not be held in place solely by its own dead weight. Include floor anchor fastening in all cases.
 - 4. Do not support ductwork, piping, conduits, conductors, or equipment from other piping, conduits, ceiling grids, equipment, ductwork, or ceiling supports. In all cases, provide independent supports for such components and equipment.
- B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to code (including seismic codes where applicable).
 - 1. Construct concrete bases and form equipment anchorages as detailed in the structural drawings.
 - 2. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use concrete and reinforcement as specified in Division 3 Sections and the Structural Drawings.
- C. Metal Supports & Anchorages
 - 1. Refer to local codes, practices and standards for installation and material requirements and limitations relating to the use of metal supports and anchorages (including applicable seismic requirements).
 - 2. Refer to Division 5 Section "Metal Fabrications" for structural steel.
 - 3. Field Welding: Comply with AWS D1.1.
- D. Wood Supports & Anchorages
 - 1. Refer to local codes, practices and standards for installation and material requirements and limitations relating to the use of wood supports and anchorages (i.e. fire retardant materials).
 - 2. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor materials and equipment.
 - 3. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
 - 4. Attach to substrates as required to support applied loads.
- E. Grouting
 - 1. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.
 - 2. Clean surfaces that will come into contact with grout.
 - 3. Provide forms as required for placement of grout.
 - 4. Avoid air entrapment during placement of grout.
 - 5. Place grout, completely filling equipment bases.
 - 6. Place grout on concrete bases and provide smooth bearing surface for equipment.
 - 7. Place grout around anchors.
 - 8. Cure placed grout.

3.7 PAINTING

- A. Painting of systems, equipment, and components is specified in Division 9. Unless and to the extent that painting is not specified elsewhere in the Contract Documents, all exposed materials in finished areas and on exterior walls shall be painted to match surrounding surfaces.
- B. Contractor shall be responsible for and shall coordinate the timing of painting with the work of other trades and to minimize the requirements for damage and touchup to the work.
- C. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 CUTTING, PATCHING AND CORE DRILLING

- A. General
 - 1. Refer to Divisions 1, 3 and other related provision of the Contract Documents, including Structural Drawings and Specifications for requirements relating to cutting, patching and core drilling of walls, floors and other surfaces.
 - 2. Do not cut or break any steel or wood framing, concrete, masonry, or partitions, etc., without permission from the Architect or as shown on the Drawings.
 - 3. Subject to the provisions of this Section and other portions of the Contract Documents cut, channel, chase and drill floors, walls, partitions and ceilings as necessary for the proper installation, support and anchorage of piping, ductwork, raceway, boxes, and other equipment.
 - 4. Repair any damage to the building, piping, equipment, or finish.
 - 5. Perform repairs with materials matching the original, and install in accordance with appropriate sections of the Contract Documents.
 - 6. Where trenching is done through existing paving, walks, curbs, etc. Contractor is responsible for patching and repairs to original condition.
 - 7. In new work, patch and refinish all finished surfaces damaged by this contractor to match adjacent surface.
 - 8. Where new work is installed in the existing building, patch and refinish surfaces damaged to match existing. Refinishing to be as directed by the Architect.
 - 9. All related refinishing to be as directed by the Architect.
- B. All cutting, patching and/or core drilling of structural systems that are do not appear on or that deviate in any way from the Structural Drawings must be preapproved by the Structural Engineer and Contractor shall provide all data, calculations and/or other requirements as maybe required by the Structural Engineer, prior to commencement of the work, including but not limited to:
 - 1. X-Ray of structural systems to show the actual location of reinforcement.
 - 2. Size and dimensions of penetrating ductwork, piping or conduit including placement within desired opening and required clearances, means of fastening and/or support including all anchoring systems and fasteners.
 - 3. As a general rule, subject to adjustment by Structural Engineer, penetrating ductwork, piping or conduit shall pass through the center of all structural openings, avoiding structural members by minimums specified on the Structural Drawings.
- C. Core Drilling Layouts
 - 1. Unless otherwise specified in the Contract Documents Contractor shall provide to the Structural Engineer a complete floor by floor core drilling layout for all required floor core penetrations in advance of the work for Structural Engineer's review and approval. Core drilling layouts shall include size, dimension and specific locations of core drilling for all trades. Contractor shall not be permitted to conduct independent coring without providing such layout to Structural Engineer.

3.9 EXCAVATION, BACKFILL & WATERPROOFING

- A. Refer to Divisions 1, 2, and other related provisions of the Contract Documents, including but not limited to Sitework and Structural Drawings and related specifications for requirements relating to excavation, backfill and waterproofing for each trade.
- B. Do necessary trenching and excavating for installation of underground piping, raceways and equipment. Use necessary precautions not to affect the bearing value of soil under and near footings. Excavate trenches with proper pitch six inches deeper than required by line grade and prefill to line grade with pea gravel. Where trenching occurs through existing paving, walks, curbs, etc., patch and repair to original conditions. Compact backfill with vibratory or roller compaction equipment in nine inch layers to 90 percent density. Dispose of excess excavated material as directed. Backfill under floor slabs and under hard surfaced yard areas (i.e. walks, drives, parking areas) to be crushed rock unless otherwise indicated, compacted in nine inch layers. Backfill material and compaction to comply with Site Work Section of these Specifications.
- C. Provide and maintain ample means and devices with which to promptly remove and dispose of water entering the excavation during the time it is being prepared for the piping, raceways or equipment laying, during the laying of materials or equipment and until the backfill has been completed.
- D. Avoid, if possible, penetrations of waterproof membranes. Where such penetration is required, perform it prior to waterproofing and in accordance with Architectural details. Where penetrations are not detailed or must be conducted through waterproof membranes, provide a detail of the penetrations for approval of the Architect.

3.10 SAFETY & PROTECTION

- A. The Contract Documents do not include, or is Architect/Engineer responsible for the design of construction details or instructions relating to Contractor's safety or protective measures or precautions or as it pertains to its means, methods, techniques, sequences or procedures required for to perform the work.
- B. Provide necessary shoring, railing, barricades, protective devices, temporary systems/supports, safety instructions and procedures to perform the work safely and to comply with the Safety Requirements of the governing authorities.
- C. Unless otherwise specifically detailed and included, the Contract Documents represent the finished state of all systems and components related to the work and it is Contractor's sole responsibility to provide the necessary means, methods, equipment and protection of the work and those performing the work during construction. Neither Architect/Engineer nor any of their respective subconsultants shall be responsible or liable for Contractor's failure to adequately protect the work or those performing the work during construction.

3.11 FUTURE PROVISIONS TO BE INCLUDED IN THE WORK

- A. The following provisions shall be provided for and included in the work:
 - 1. Provide pull line in each empty conduit provided for future installation of wiring.
 - 2. At all systems such as fire alarm, where future stations are to be fed from adjacent outlets or terminal cabinets, all conductors required for complete installation of additional units are to be provided to nearest outlet or terminal cabinet as required. In general, all wiring installed so it will not be necessary to remove existing conductors and re-pull additional

wiring to install additional units. All spare conductors properly labeled and terminated in outlet boxes or at terminals in terminal cabinets.

3.12 CLEANING

A. General

1. At all times keep the premises free from accumulation of waste materials or rubbish caused by the employees or the work. At the completion of the work, remove all superfluous materials, equipment and debris related to or resulting from the work.
2. All systems, equipment and component including but not limited to all panels, compartments, points of access, surface areas, panels, whether concealed or not shall be free from debris, filings, clippings, dirt, dust and debris and in a new condition. Touch up paint where necessary.
3. Where existing systems are expanded and/or remodeled, clean the new installation prior to making final connection to the existing systems.

3.13 COOPERATION WITH OTHER TRADES

- #### **A.**
- Contractor shall cooperate with and coordinate the work with that of all other trades in the performance of the work, including but not limited to; delivery of equipment and materials, furnishing material and location requirements of sleeves, bucks, chases, supports, mountings, backings, inserts, anchor bolts, cast-in-place box-out or steel embeds, routings, sequencing, locations, finished devices, etc., for proper installation of its work. Contractor shall be responsible for any and all removal, replacement or repairs to its work or the work of others for its failure to fully comply with this provision.

3.14 OPERATION AND INSTRUCTION

- #### **A.**
- Upon completion of the work and prior to final acceptance, Contractor shall operate the equipment for a period as required to fully instruct the Owner and its authorized representatives in all details of operation, adjustment and maintenance. Absent more stringent requirements found elsewhere in the Contract Documents, Contractor shall, at a minimum:
1. Schedule with Owner and its designated representatives a single time and location for a 1-day instruction class and submit 3 copies of certificate, signed by Owner's representatives, attesting to the Owner's authorized representatives having been so instructed. All arrangements shall be made through Architect and Owner's Representative.
 2. Thoroughly review and instruct Owner and its designated representatives on all aspects of systems and facilities operations and maintenance utilizing the Instructions and Manuals submitted under the provisions of this Section. Any required instructions from manufacturer's representatives shall be given during this period.
 3. This requirement is in addition to any "Operation Test" specified in the Contract Documents.

END OF SECTION 26 00 00

SECTION 26 05 09 EQUIPMENT WIRING

PART 1 – GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Equipment connections, whether furnished by Owner or other Divisions of the Contract.
 - 2. Equipment grounding.

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements (if available) apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements (if available).

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements (if available).
- B. In addition:
 - 1. Verify mechanical and utilization equipment electrical characteristics with Drawings and equipment submittals prior to ordering equipment. Submit confirmation of this verification as a part of, or addendum to, the electrical product submittals.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements (if available) apply to this Section.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements (if available).

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Materials and Equipment for Equipment Wiring: As specified in individual Sections.

2.2 GENERAL

- A. Unless otherwise noted, the following voltage and phase characteristics apply to motors:
 - 1. 3/4 HP and Under: 120 volt, 1 phase.
 - 2. 1 HP and Over: 208 volt, 3 phase.
 - 3. 1 HP and Over: 480 volt, 3 phase.

- B. Safety Switches: Provide as required by NEC and as specified in Section 26 28 16, Enclosed Switches and Circuit Breakers.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Prior to submittal of product data for electrical distribution equipment, obtain and examine product data and shop drawings for equipment furnished by the Owner and by other trades on the project. Update the schedule of equipment electrical connections accordingly, noting proper ratings for overcurrent devices, fuses, safety disconnect switches, conduit and wiring, and the like. As a minimum, this requirement applies to equipment furnished by Owner and equipment furnished under the following divisions of work under this contract:
 - 1. Division 10, Specialties
 - 2. Division 11, Equipment
 - 3. Division 21, Fire Suppression
 - 4. Division 22, Plumbing
 - 5. Division 23, HVAC, Heating, Ventilating and Air Conditioning
 - 6. Division 27, Communications
 - 7. Division 28, Electronic Safety and Security

3.2 INSTALLATION

- A. Do not install unrelated electrical equipment or wiring on mechanical equipment without prior approval of Engineer.
- B. Provide moisture tight equipment wiring and switches in ducts or plenums used for environmental air.
- C. Connect motor and appliance/utilization equipment complete from panel to motor/equipment as required by code.
- D. Install motor starters and controllers for equipment furnished by others.
- E. Appliance/Utilization Equipment:
 - 1. Provide appropriate cable and cord cap for final connection unless equipment is provided with same. Provide receptacle configured to receive cord cap.
 - 2. Verify special purpose outlet NEMA configuration and ampere rating with equipment supplier prior to ordering wiring devices and coverplates.
- F. Door Hardware:
 - 1. Provide dedicated circuit from nearest 208/120V emergency panelboard for door hardware power supplies. Provide complete control connections for door hardware locking mechanisms to building security system.
 - 2. Coordinate with Division 08, Openings and Drawing requirements.

3.3 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Division 01, General Requirements.

3.4 SYSTEMS STARTUP

- A. Provide field representative to prepare and start equipment.
 - 1. Test and correct for proper rotation of polyphase motors.
- B. Adjust for proper operation within manufacturer's published tolerances.
- C. Demonstrate proper operation of equipment to Owner's designated representative.

END OF SECTION 26 0509

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
- B. Related Requirements:
 - 1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
 - 2. Section 271323 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.
 - 3. Section 271000 "Structured Cabling System" for twisted pair cabling used for data circuits.

1.3 DEFINITIONS

- A. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers:
 - 1. Belden Inc
 - 2. General Cable Tech
 - 3. Southwire Company
 - 4. Or approved equal
- C. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. RoHS compliant.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Conductor Insulation:
 - 1. Type NM: Comply with UL 83 and UL 719.
 - 2. Type RHW-2: Comply with UL 44.
 - 3. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
 - 4. Type THWN-2: Comply with UL 83.
 - 5. Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
 - 6. Type UF: Comply with UL 83 and UL 493.
 - 7. Type XHHW-2: Comply with UL 44.
- F. Shield:
 - 1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers:
 - 1. AFC Cable
 - 2. Hubbell Power Systems
 - 3. O-Z/Gedney
 - 4. Thomas & Betts Corp
 - 5. Or approved equal.
- C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 - 1. Material: Copper.
 - 2. Type: One hole with standard barrels.
 - 3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- D. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- E. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.
- F. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Not allowed.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- D. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- H. VFC Output Circuits: Type XHHW-2 in metal conduit.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.
 - 2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
 - 3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes grounding and bonding systems and equipment.
- B. Section includes grounding and bonding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Ground bonding common with lightning protection system.
 - 3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings.
 - 4. Grounding arrangements and connections for separately derived systems.
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:

- 1) Test wells.
 - 2) Ground rods.
 - 3) Grounding arrangements and connections for separately derived systems.
- b. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NFPA 70B.
- 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - 2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- 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. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

- A. Manufacturers:
1. ERICO
 2. Hubbell Incorporated
 3. ILSCO
 4. O-Z/Gedney
 5. Or approved equal

2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.
 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- H. Conduit Hubs: Mechanical type, terminal with threaded hub.
- I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- J. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- K. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- L. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.
- M. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- N. Straps: Solid copper, copper lugs. Rated for 600 A.
- O. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal one-piece clamp.
- P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- Q. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with zinc-plated bolts.
 - a. Material: Tin-plated aluminum.
 - b. Listed for direct burial.
 - 2. U-bolt type with malleable-iron clamp and copper ground connector.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Zinc-coated steel, sectional type; 3/4 inch by 10 feet (19 mm by 3 m).
- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
 - 1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
 - 2. Backfill Material: Electrode manufacturer's recommended material.
- C. Ground Plates: 1/4 inch (6 mm) thick, hot-dip galvanized.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8AWG and smaller, and stranded conductors for No. 6AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches (600 mm) below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

- E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.6 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. Use exothermic welds for all below-grade connections.
 - 3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.
 - 1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
- I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column.
1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
 2. Bury ground ring not less than 24 inches (600 mm) from building's foundation.
- J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
- K. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet (6.0 m) long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.
- L. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.

E. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

F. Grounding system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.

I. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Steel slotted support systems.
 - 2. Aluminum slotted support systems.
 - 3. Nonmetallic slotted support systems.
 - 4. Conduit and cable support devices.
 - 5. Support for conductors in vertical conduit.
 - 6. Structural steel for fabricated supports and restraints.
 - 7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
 - 8. Fabricated metal equipment support assemblies.

1.3 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 the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
 - 2. Include rated capacities and furnished specialties and accessories.
- B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.
 - 1. Hangers. Include product data for components.
 - 2. Slotted support systems.
 - 3. Equipment supports.

4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Suspended ceiling components.
 2. Ductwork, piping, fittings, and supports.
 3. Structural members to which hangers and supports will be attached.
 4. Size and location of initial access modules for acoustical tile.
 5. Items penetrating finished ceiling, including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Projectors.
- B. Seismic Qualification Data: Certificates, for hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M.
 2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified.
 2. Component Importance Factor: 1.0.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.
1. Manufacturers:
 - a. Allied Tube & Conduit
 - b. B-Line
 - c. Haydon Corp.
 - d. Thomas & Betts Corp.
 - e. Or approved Equal
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Material for Channel, Fittings, and Accessories: Galvanized steel.
 4. Channel Width: Selected for applicable load criteria.
 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.
1. Manufacturers:
 - a. Cooper Industries
 - b. Haydon Corp.
 - c. Thomas & Betts
 - d. Or approved equal
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Channel Material: 6063-T5 aluminum alloy.
 4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 5. Channel Width: Selected for applicable load criteria.
 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least one surface.
1. Manufacturers:
 - a. Allied Tube & Conduit
 - b. B-Line
 - c. Haydon Corp
 - d. Or approved equal
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Channel Width: Selected for applicable load criteria.

4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
 5. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
 6. Rated Strength: Selected to suit applicable load criteria.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers:
 - 1) Hilti, Inc.
 - 2) ITW Ramset
 - 3) MKT Fastening
 - 4) Or approved equal
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers:
 - 1) B-line
 - 2) Hilti, Inc.
 - 3) ITW Ramset
 - 4) Or approved equal
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: Stainless-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA 101
 - 3. NECA 102.
 - 4. NECA 105.
 - 5. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, according to NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Comply with requirements in Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

**SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections (if available), apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Nonmetal wireways and auxiliary gutters.
 - 5. Boxes, enclosures, and cabinets.
 - 6. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Metal Conduit:
 - 1. Manufacturers:
 - a. AFC Cable Systems
 - b. Allied Tube & Conduit
 - c. Western Tube and Conduit
 - d. Or Approved Equal
 - 2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. GRC: Comply with ANSI C80.1 and UL 6.
 4. ARC: Comply with ANSI C80.5 and UL 6A.
 5. IMC: Comply with ANSI C80.6 and UL 1242.
 6. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit, IMC.
 - a. Comply with NEMA RN 1.
 - b. Coating Thickness: 0.040 inch (1 mm), minimum.
 7. EMT: Comply with ANSI C80.3 and UL 797.
 8. FMC: Comply with UL 1; zinc-coated steel or aluminum.
 9. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- B. Metal Fittings:
1. Manufacturers:
 - a. AFC Cable Systems
 - b. Allied Tube & Conduit
 - c. Western Tube and Conduit
 - d. Or Approved Equal
 2. Comply with NEMA FB 1 and UL 514B.
 3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 4. Fittings, General: Listed and labeled for type of conduit, location, and use.
 5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 6. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: clamp/bolt-on.
 7. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Nonmetallic Conduit:
1. Manufacturers:
 - a. AFC Cable Systems
 - b. Allied Tube & Conduit
 - c. Western Tube and Conduit
 - d. Or Approved Equal
 2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. Fiberglass:
 - a. Comply with NEMA TC 14.
 - b. Comply with UL 2515 for aboveground raceways.
 - c. Comply with UL 2420 for belowground raceways.
 4. ENT: Comply with NEMA TC 13 and UL 1653.
 5. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
 6. LFNC: Comply with UL 1660.

7. Rigid HDPE: Comply with UL 651A.
8. Continuous HDPE: Comply with UL 651A.
9. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
10. RTRC: Comply with UL 2515A and NEMA TC 14.

B. Nonmetallic Fittings:

1. Manufacturers:
 - a. AFC Cable Systems
 - b. CANTEX INC
 - c. Thomas & Betts Corp.
 - d. Or Approved Equal
2. Fittings, General: Listed and labeled for type of conduit, location, and use.
3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
 - a. Fittings for LFNC: Comply with UL 514B.
4. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

1. Manufacturers:
 - a. B-Line
 - b. Hoffman
 - c. Square D
 - d. Or Approved Equal
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R, Type 4X, unless otherwise indicated, and sized according to NFPA 70.
 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

1. Manufacturers:
 - a. Allied Moulded Products
 - b. Hoffman
 - c. Or Approved Equal
- B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

- D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

- 1. Manufacturers:
 - a. B-Line
 - b. Hoffman
 - c. Square D
 - d. Or Approved Equal
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
- K. Gangable boxes are allowed.
- L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 & Type 3R, Type 4 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- M. Cabinets:
 - 1. NEMA 250, Type & Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
 1. Manufacturers:
 - a. Armorcast Products Comp.
 - b. Oldcastle Enclosure
 - c. Quazite
 - d. Or Approved Equal
 2. Standard: Comply with SCTE 77.
 3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 6. Cover Legend: Molded lettering, "ELECTRIC."
 7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 8. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 1. Exposed Conduit: GRC.
 2. Concealed Conduit, Aboveground: EMT.
 3. Underground Conduit: RNC, Type EPC-40-PVC.
 4. Retain first option in first subparagraph below if raceway may be exposed to physical damage.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 6. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
 1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Loading dock.

- b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 - 6. Damp or Wet Locations: GRC.
 - 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 1/2-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
- 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - 3. EMT: Use clamp/bolt-on, steel fittings. Comply with NEMA FB 2.10.
 - 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- G. Install surface raceways only where indicated on Drawings.
- H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C) .

3.2 INSTALLATION

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Install no more than the equivalent of four 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

- I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- L. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from ENT to GRC before rising above floor.
- M. Stub-Ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- T. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- V. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a

blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

- W. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Conduit extending from interior to exterior of building.
 4. Conduit extending into pressurized duct and equipment.
 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 6. Where otherwise required by NFPA 70.
- X. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- Y. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.00078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Z. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches (915 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- AA. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

- BB. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- CC. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- DD. Locate boxes so that cover or plate will not span different building finishes.
- EE. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- GG. Set metal floor boxes level and flush with finished floor surface.
- HH. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
 - 1. Excavate trench bottom to provide firm and uniform support for conduit.
 - 2. Install backfill.
 - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
 - 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 - 5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- D. Install handholes with bottom below frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Color and legend requirements for raceways, conductors, and warning labels and signs.
 - 2. Labels.
 - 3. Bands and tubes.
 - 4. Tapes and stencils.
 - 5. Tags.
 - 6. Signs.
 - 7. Cable ties.
 - 8. Paint for identification.
 - 9. Fasteners for labels and signs.

1.3 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 electrical identification products.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder conductors.
 - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - 4. Color for Neutral: White
 - 5. Color for Equipment Grounds: Green
 - 6. Colors for Isolated Grounds: Green with white stripe.
- C. Raceways and Cables Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
- D. Warning Label Colors:
 - 1. Identify system voltage with black letters on an orange background.
- E. Warning labels and signs shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

- F. Equipment Identification Labels:
 - 1. Black letters on a white field.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
 - 1. Manufacturers:
 - a. Brady Corp.
 - b. Emedco
 - c. Panduit Corp.
 - d. Or Approved Equal
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
 - 1. Manufacturers:
 - a. Brady Corp.
 - b. HellermannTyton
 - c. Panduit Corp
 - d. Or Approved Equal
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- (0.08-mm-) thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
 - 1. Manufacturers:
 - a. Brady Corp.
 - b. Brother International
 - c. Emedco
 - d. Ideal Industries
 - e. Or approved Equal
 - 2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 - 3. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 4. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Manufacturers:
 - a. Brady Corp.
 - b. Brother International
 - c. Emedco
 - d. Ideal Industries
 - e. Or approved Equal
 - 2. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches (37 by 150 mm) for raceway and conductors.

- b. 3-1/2 by 5 inches (76 by 127 mm) for equipment.
- c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameters sized to suit diameters and that stay in place by gripping action.
 - 1. Manufacturers:
 - a. Brady Corp.
 - b. HellermannTyton
 - c. Panduit Corp
 - d. Or approved Equal
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F (93 deg C). Comply with UL 224.
 - 1. Manufacturers:
 - a. Brady Corp
 - b. Panduit Corp
 - c. Or approved Equal

2.5 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
 - 1. Manufacturers:
 - a. Carlton Industries
 - b. Champion America
 - c. HellmannTyton
 - d. Ideal Industries Inc
 - e. Or approved Equal
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide; compounded for outdoor use.
 - 1. Manufacturers:
 - a. Brady Corp
 - b. Carlton Industries
 - c. Marking Services
 - d. Or approved Equal
- C. Tape and Stencil: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers placed diagonally over orange background and are 12 inches (300 mm) wide. Stop stripes at legends.
 - 1. Manufacturers:
 - a. Brimar Industries
 - b. HellermannTyton
 - c. Marking Services, Inc
 - d. Or approved equal

- D. Floor Marking Tape: 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.
1. Manufacturers:
 - a. Carlton Industries
 - b. Seton Identification
 - c. Or approved equal
- E. Underground-Line Warning Tape:
1. Manufacturers:
 - a. Brady Corp.
 - b. Brimar Industries
 - c. Ideal Industries
 - d. Or approved equal
 2. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 3. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
- F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.6 CABLE TIES

- A. Manufacturers:
1. HellermannTyton
 2. Ideal Industries
 3. Panduit Corp
 4. Or approved Equal
- B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black, except where used for color-coding.
- C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black.
- D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D 638: 7000 psi (48.2 MPa).
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 5. Color: Black.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 1. Secure tight to surface of conductor, cable, or raceway.

- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- K. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
 - 3. "UPS."
- L. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- M. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- N. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
- P. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- Q. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- R. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- S. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
 - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- T. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

- U. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- V. Underground Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common exceeds 16 inches (400 mm) overall.
 - 2. Limit use of underground-line warning tape to direct-buried cables.
 - 3. Install underground-line warning tape for direct-buried cables and cables in raceways.
- W. Cable Ties: General purpose, for attaching tags, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30A and 120V to Ground: Identify with self-adhesive raceway labels.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
- E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.
- H. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

- I. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- K. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- L. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
 - 1. Apply to exterior of door, cover, or other access.
 - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.
- N. Arc Flash Warning Labeling: Self-adhesive labels.
- O. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.
- P. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer. Coordinate "Equipment Identification Labels" Paragraph below with electrical Sections. Delete items not in Project.
- Q. Equipment Identification Labels:
 - 1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
 - 2. Outdoor Equipment: Laminated acrylic or melamine sign.
 - 3. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear.
 - e. Switchboards.
 - f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - g. Emergency system boxes and enclosures.
 - h. Enclosed switches.
 - i. Enclosed circuit breakers.
 - j. Enclosed controllers.
 - k. Variable-speed controllers.
 - l. Push-button stations.

- m. Power-transfer equipment.
- n. Contactors.
- o. Remote-controlled switches, dimmer modules, and control devices.
- p. Power-generating units.
- q. Monitoring and control equipment.
- r. UPS equipment.

END OF SECTION 26 05 53

SECTION 26 09 25
DIGITAL LIGHTING CONTROLS

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Digital network lighting control system.
- B. Related Sections.
 - 1. Section [26276 — Wiring Devices]
 - 2. Section [265113 — Interior Lighting Fixtures, Lamps, and Ballasts:] LED and Fluorescent lighting ballasts controlled by lighting control system.
 - 3. Section [260923 — Lighting Control Devices:] Occupancy Sensors, Photocells and Digital Switches used in conjunction with lighting control system
- C. Contractor responsibilities:
 - 1. Coordinate, receive, mount, connect, and place into operation all equipment. Furnish all conduit, wire, connectors, hardware, and other incidental items necessary for the complete and properly functioning relay lighting control system as described herein and shown on the plans.

1.2 REFERENCES

- A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) C62.41-1991 — Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- B. ASTM International (ASTM)
 - 1. D4674 -02a Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Fluorescent Lighting and Window-Filtered Daylight.
- C. Canadian Standards Association (CSA)
 - 1. CSA C22.2 # 14 Industrial Control Equipment
 - 2. CSA C22.2 # 184 Solid-State Lighting Controls
- D. International Electrotechnical Commission
 - 1. (IEC) 801-2 Electrostatic Discharge Testing Standard.
 - 2. IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.
- E. International Organization for Standardization (ISO)
 - 1. 9001:2000 — Quality Management Systems.
- F. National Electrical Manufacturers Association (NEMA) WD1 (R2005) - General Color Requirements for Wiring Devices.
- G. Underwriters Laboratories, Inc. (UL) ():
 - 1. 508 (1999) - Standard for Industrial Control Equipment.
 - 2. 924 – Standard for Safety of Emergency Lighting and Power Equipment
- H. American Society of Heating, Refrigerating and Air-Conditioning (ASHRAE)
 - 1. ASHRAE 90.1
- I. California Energy Commission (CEC)
 - 1. Title 24
- J. International Energy Conservation Code (IECC)
 - 1. IECC

1.3 SUBMITTALS

- A. Submit under provisions of Section [01 33 00] and in accordance with Conditions of the Contract. Submittal Set shall include the following:
 - 1. Bill of Materials: Complete list of all parts needed to fully install selected system components.
 - 2. System One-Line Diagram
 - 3. Device detail drawings providing wiring details and dimensional data.
 - 4. Product Data Sheets

1.4 CLOSEOUT SUBMITTALS

- A. To be provided within two weeks following system turn-on.
 - 1. Warranty documents specified herein.
 - 2. Three sets of operation and maintenance manuals.
 - 3. Two complete sets of as-built drawings

1.5 QUALITY ASSURANCE

- A. Manufacturer Requirements
 - 1. Continuously engaged in the manufacture of architectural lighting controls and relays for no less than ten years.
 - 2. Provide factory-direct technical support hotline 24 hours per day, 7 days per week.
 - 3. Maintain a quality system that is registered to the ISO 9001:2000 Quality Standard.
- B. Lighting control system components:
 - 1. Listed by UL specifically for the required loads, or certified by recognized independent testing organizations that test to UL standards.
 - a. UL508
 - b. UL916 listing not acceptable.
 - c. UL924
 - 2. Comply with ASHRAE 90.1
 - 3. Comply with Title 24, Part 6
 - 4. Comply with IECC
- C. Installer Qualifications
 - 1. Experienced in performing the work of this section
 - 2. Has specialized in installation of work similar to that required for this project.
- D. Source Limitations
 - 1. To assure compatibility, obtain all system components from a single source with complete responsibility for all lighting controls and accessories specified in this Section and elsewhere in Division 26 Section 09 "Lighting Controls." The use of subcontracted component assemblers is not acceptable.

1.6 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. LED Drivers
 - 1. Supply ballasts that are compatible with the network lighting control system.
 - 2. Accept 0 – 10V dimming control.
- B. Fluorescent Ballasts
 - 1. Supply ballasts that are compatible with the network lighting control system.
 - 2. Accept 0 – 10V dimming control.
- C. All conduit, wire, connectors, hardware, and other incidental items necessary for the complete and properly functioning network lighting control system as described herein and shown on the plans.

1.7 DELIVERY, STORAGE & HANDLING

- A. General: Comply with Division 1 Product Requirements Sections.
- B. Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
- C. Delivery
 - 1. Deliver materials in manufacturer's original, unopened, undamaged packages with intact identification labels.
 - 2. Deliver to other trades in a timely manner.
- D. Storage and Protection: Store materials away from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.8 PROJECT CONDITIONS

- A. Do not install equipment until the following conditions can be maintained in spaces to receive equipment:
 - 1. Ambient temperature: 0° to 50° C (32° to 122° F).
 - 2. Relative humidity: Maximum 90 percent, non-condensing.
 - 3. Lighting control system must be protected from dust during installation.

1.9 WARRANTY

- A. Manufacturer's Warranty
 - 1. Warrant all equipment free of defects in materials and workmanship.
 - 2. Warranty Period
 - a. Warrant all system components for 25 months from date of shipment, or two years from date of turn-on, whichever occurs first.
 - b. Make extended warranties available.
 - 3. Warrant relay modules for a period of 10 years.
 - a. Provide replacement modules at no cost to Owner.
 - 4. Owner's Rights: Manufacturer's warranty is in addition to, not a limitation of, other rights the Owner may have under contract documents.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Acceptable Manufacturer: Leviton Manufacturing Co. Inc. — System: Leviton GreenMAX DRC
- B. Basis of design product: Leviton Manufacturing Co. Inc. GreenMAX DRC or subject to compliance and prior approval with specified requirements of this section, one of the following:
 - 1. Leviton Manufacturing Co. Inc. GreenMAX DRC
 - 2. nLight or ILC
- C. Substitutions: Permitted.
 - 1. Show all substitutions as an add or deduct from the base bid price
 - a. All substitutions subject to provisions of Division 1.
 - 2. Clearly delineate all proposed substitutions as such and submit in writing for approval by the design professional a minimum of 10 working days prior to the bid date.
 - a. Proposed substitutions must be made available to all bidders.
 - b. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
 - 3. Prior to rough-in, provide complete engineered shop drawings, including power wiring,

with deviations from the original design highlighted in an alternate color, to the engineer for review and approval.

4. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring.

2.2 DESCRIPTION

- A. Digital network lighting control system comprised of the following components:
 1. GreenMAX DRC Room Controller
 2. GreenMAX DRC App
 3. Remote load control Smart Packs
 4. Sapphire Touch Screen Room Controller
 5. Phase Control Dimmer
 6. Configurable relay cabinets
 7. Remote low voltage input cabinets
 8. Low voltage control devices
 - a. Including but not limited to digital switches, analog switches, occupancy sensors, and daylight sensors.
 9. Network Equipment:
 - a. Hubs, Switches, and Repeaters for connection of LumaCAN and Ethernet cabling.
 - b. Network Protocol Converters, (NPC), used for system integration as required by specific project plans.
 - c. Power Supplies

2.3 PERFORMANCE CRITERIA

- A. [Occupancy/Vacancy Sensing] [0-10V Dimming] [Daylight Harvesting] [Partial-ON] [Partial-OFF] [Demand Response] [Receptacle Control] [Manual Switching] to control lighting with the following hierarchy:
 1. Emergency: Highest priority, overrides all other inputs.
 2. Power failure: All RTC relays close upon loss of system power.
 3. Bypass Switches: Second priority, over-rides all other inputs except Emergency
- B. Room Controller Operation
 1. Programmable from WiFi network using the GreenMAX DRC App on an Android or iOS smart device
 2. Multi-location switching
 3. Occupancy/vacancy detection
 - a. Allow programming of each group with the following operational behaviors:
 - 1) Auto ON / Auto OFF
 - 2) Auto ON /Auto OFF with light hold off
 - 3) Manual ON / Auto OFF with light hold off
 - 4) Manual ON / Auto OFF
 - 5) Manual ON / Manual OFF
 - 6) Manual ON / Manual OFF with light hold off
 - 7) Set Light Hold (delay) Times from thirty (30) seconds to thirty (30) minutes
 4. Multi-zone Daylight Harvesting
 - a. No limit to number of Zones.
 - b. Closed loop daylight harvesting
 - c. Eight (8) independent pairs of rising and falling trigger point values per photocell input.
 - d. Delay times of thirty (30) seconds to thirty (30) minutes
 - e. ON/OFF behavior

- f. Auto ON with Manual Override
 - g. Blink Warn Sequence
 - 5. Assign fixtures to a Group
 - a. System shall have the ability to assign fixtures to Groups.
- C. Digital switches
 - 1. Assign each button to individual fixtures or Groups
 - a. Programmable behaviors to include
 - 1) Scene
 - 2) Toggle
 - 3) Room ON
 - 4) Room OFF
 - 5) Group Raise / Group Lower
 - 6) Raise
 - 7) Lower
 - 2. Program delay time within each area or zone
 - a. Thirty (30) seconds to thirty (30) minutes

2.4 NETWORK PROTOCOLS

- A. Lumina RF
 - 1. Mesh network topology
- B. WiFi
 - 1. Connection to GreenMAX DRC App for wireless commissioning, configuration, control, monitoring and provisioning
 - 2. Connection to building network
- C. LumaCAN
 - 1. Daisy chain topology
 - 2. Maximum branch length of 1600 feet
 - a. Devices located at branch ends must have their termination jumpers in the ON position.
- D. Ethernet
 - 1. Command Modules only
 - 2. Can be configured as a bridge between LumaCAN branches
 - 3. Can be used as an Internet connection
 - a. Remote firmware upgrades, monitoring and programming possible via Internet
 - 4. Ethernet switches can be used to extend system coverage area by linking Command Modules
- E. BACnet IP
 - 1. Read-only device description for Relay Cabinets
 - a. For use with Building Management System (BMS) software that does not support writing of device descriptions.
 - 2. Re-name groups and relays via the BMS network, if it supports this function
 - 3. Support all 16 BACnet priorities
 - a. Separate Priority Array for each relay
 - b. 1 is highest, 16 is lowest
 - c. Higher priority maintains control until a "relinquish" command is issued
 - d. Top three priority levels permanently assigned to Internal Main Bypass, Emergency Power and Internal Relay Bypass
 - e. Individual control of all other priorities
 - 4. Support 252 Analog / Binary Outputs
 - 5. Support 240 Analog / Binary Inputs

2.5 NETWORK CABLE

- A. LumaCAN: CAT6
- B. Ethernet: CAT5 or better
- C. BACnet IP: CAT5 or better
- D. Terminations: RJ45 connectors

2.6 GREENMAX DISTRIBUTED ROOM CONTROL (DRC) ROOM CONTROLLER

- A. Coordinates all the energy management functions in a room as part of the GreenMAX DRC system.
- B. Performance Criteria
 - 1. GreenMAX DRC Room Controller shall be capable of the following applications:
 - a. Single room controller for GreenMAX DRC systems, coordinating all the energy management functions in a room
 - 2. Line voltage models UL924 listed
 - 3. Provide 0-10V control and power relay rated
- C. Physical
 - 1. Available in low voltage and line voltage models
 - a. Low voltage model can be surface mounted or installed in a DIN rail enclosure
 - b. Line voltage model provided in NEMA 1 enclosure with nipple mounting can install into a knockout or act as cover for a 4" square box
 - c. UL2043 Plenum rated
 - 2. Environmental
 - a. Operating Temperature: 32° to 122° F (0° to 50° C)
 - b. Ambient Humidity 0% to 90% non-condensing
- D. Electrical
 - 1. Supported and listed loads
 - a. 120 – 277VAC, 16A LED Driver, Tungsten, Resistive, Electronic Ballast
 - b. 120 – 277VAC, 20A Ballast
 - c. 120VAC 1/2HP Motor, 277VAC 1HP Motor, 240VAC 1HP Motor
 - d. 120VAC, 20A General Purpose Plug Load Control.
 - 2. Input Voltage
 - a. Low Voltage: 18 – 24VDC
 - b. Line Voltage: 120 – 277VAC, 50/60Hz, 20A Max
 - c. Line Voltage: 347VAC, 60Hz, 20A Max.
 - 3. Control output
 - a. Class I or Class II 0-10V wiring. #18AWG stranded
 - b. 0-10V Sinking Control, 20A
 - 4. Network Connections via LumaCAN wiring using CAT6 cable with RJ45 connectors.
 - 5. Wireless Connections via Lumina RF and Intellect fixtures and WiFi to building networks
- E. Product Components
 - 1. Leviton GreenMAX DRC Room Controller, DIN Rail Form Factor, model #DRC00-0L0
 - 2. Leviton GreenMAX DRC Room Controller, 120-277VAC, model #DRC07-ED0
 - 3. Leviton GreenMAX DRC Room Controller, 347VAC, model #DRC00-030

2.7 GREENMAX DISTRIBUTED ROOM CONTROL (DRC) SMART PACKS

- A. Remotely mounted network addressable load control relays allowing for a distributed system architecture.
- B. Performance Criteria
 - 1. DRC Smart Packs shall be capable of the following applications:

- a. UL924 listed for use with Normal or Emergency loads
 - b. Standalone load control when used with a GreenMAX DRC or Sapphire Room Controller.
 - c. Remote relay when used with GreenMAX Lighting Control Panel
- 2. Provide 0-10V dimming or switching control for all listed and compatible load types.
- 3. Smart Pack relay shall be listed for use on Plug Load circuits.
- 4. DRC Smart Pack shall provide two-way communication and metering relay capability and allow data to be collected over BACnet via connected devices.
- C. Physical
 - 1. Smart Pack provided in NEMA 1 enclosure with nipple mounting for use with standard junction box.
 - a. UL2043 Plenum rated.
 - b. Paintable for exposed ceiling installations
 - 2. Environmental
 - a. Operating Temperature: 23° to 122° F (-5° to 50° C)
 - b. Ambient Humidity 0% to 90% non-condensing
- D. Electrical
 - 1. Supported and listed loads
 - a. 120 – 277VAC, 16A LED Driver, Tungsten, Resistive, Electronic Ballast
 - b. 120 – 277VAC, 20A Ballast
 - c. 120VAC 1/2HP Motor, 277VAC 1HP Motor, 240VAC 1HP Motor
 - d. 120VAC, 20A General Purpose Plug Load Control
 - 2. Input Voltage
 - a. 120 – 277VAC, 50/60Hz, 20A Max.
 - 3. Control output
 - a. Class I or Class II 0-10V wiring. #18AWG stranded
 - b. 0-10V Sinking control, 100mA
 - 4. Network Connections via LumaCAN wiring using CAT6 cable with RJ45 connectors.
- E. Product Components:
 - 1. Leviton DRC Smart Pack, model # DRD07-ED0

2.8 SAPPHIRE TOUCH SCREEN ROOM CONTROLLER

- A. Provide a fully customizable touch screen based user interface as a component of the GreenMAX DRC network lighting control system or as a standalone room control solution when used with GreenMAX DRC Smart Packs.
- B. Performance Criteria:
 - 1. 7" capacitive LCD Touch Screen providing the following configurable user interface components:
 - a. Tabs / Pages
 - b. Buttons
 - c. Sliders
 - 2. Integral 7-day scheduler:
 - a. Astronomical time clock
 - b. (2) Custom user defined holiday exception calendars
 - c. Special event calendar
 - 3. Two-way communication allows touch screen to update based on actual device status.
 - 4. Online / Offline configuration and screen design through PC tool.
 - 5. Controller shall provide password protected administration.
 - 6. Touch screen shall provide local low-voltage inputs for connection of occupancy and daylight sensors.

7. Touch screen shall allow software and configuration updates through front panel via USB memory stick.
- C. Physical:
 1. Touch screen shall be installed in a standard 4-gang box with a 4-gang raised device cover.
 2. LCP panel shall be 7" diagonal, 16.9 form factor, 800x480 WVGA: 130° x 110° viewing angle with LED backlight and 24-bit color.
 3. Environmental:
 - a. Operating Temperature: 14° to 122° F, (-5° to 50° C)
 - b. Ambient Humidity: 0% to 90% non-condensing
 4. Color change kits available in White, Black, and Light Almond.
- D. Electrical
 1. Controller operates on +12-24VDC, Class II SELV on the digital LumaCAN network using CAT6 cable with RJ45 connectors.
 2. Power Supply
 - a. Power supplied to Touch Screen via the LumaCAN network or separate power supply. Device draws 1750mA, 200mA standby current.
- E. Product Components
 1. Leviton Sapphire LCD Touch Screen Room Controller, model # TS007-XXX

2.9 GREENMAX DISTRIBUTED ROOM CONTROL (DRC) PHASE CONTROL DIMMER

- A. Incorporates switching and dimming of 2-wire phase control loads as part of a GreenMAX DRC system.
- B. Performance Criteria
 1. Provides 1-4 channels of forward or reverse phase control
 2. Shall provide amplify feature, allowing channels to be combined to increase output
- C. Physical
 1. DIN Rail mountable in Leviton DIN Rail Rack Mount Enclosures, series DINRK-XXX
 2. Environmental:
 - a. Operating Temperature: 32° to 140° F, (0° to 60° C)
 - b. Ambient Humidity: 0% to 90% non-condensing
- D. Electrical
 1. Input Voltage
 - a. 120 – 277VAC, 50/60Hz, 10A Max.
 2. Load Ratings
 - a. Supports LED, CFL, electronic ballast, magnetic ballast, cold cathode, transformer
 3. Network Connections via LumaCAN wiring using CAT6A cable with RJ45 connectors.
 4. Topology:
 - a. Daisy chain, 1600' max between repeaters
 - b. Home-run and networking length up to 10,000' can be achieved when using Leviton LumaCAN network repeaters, model # NPRPT
 - c. Maximum 110 nodes between repeaters
 - d. Maximum 250 nodes on a LumaCAN network
- E. Product Components
 1. Leviton GreenMAX DRC Phase Control Dimmer, model # DRDDP-A40

2.10 GREENMAX DISTRIBUTED ROOM CONTROL (DRC) DIGITAL OCCUPANCY SENSORS

- A. Provides digital occupancy/vacancy and daylight sensing as part of the GreenMAX DRC System
- B. Performance Criteria

1. Occupancy detection using PIR technology with a 450 sq. ft. field-of-view
 2. Light level detection up to 0 to 100 footcandles
 3. Configurable parameters for occupancy sensitivity, timeout, enable/disable and photocell range, enable/disable
- C. Physical
1. Sensor shall combine both a PIR occupancy/vacancy sensor with a daylight sensing photocell
 2. Sensor shall be recess mounted into a 2" diameter hole
 3. Environmental
 - a. Operating Temperature: 32° to 122° F, (0° to 50° C)
 - b. Ambient Humidity 0% to 90% non-condensing
- D. Electrical
1. LumaCAN powered, +12-24VDC, 40mA
- E. Product Components
1. Leviton GreenMAX DRC Occupancy Sensor and Photocell, model #OSR05-ICW

2.11 GREENMAX DISTRIBUTED ROOM CONTROL (DRC) DIGITAL SWITCHES

- A. Network addressable control stations providing local control of digital lighting control system as part of a GreenMAX DRC system.
- B. Performance Criteria:
1. Used as primary user interface
 2. Can be used for multi-location control
 3. Each button shall be individually programmed for on, off, on/off, dimmed raise/lower, scene on level, and other customizable scenes and settings using the GreenMAX DRC App
- C. Physical:
1. Available in One (1), two (2), four (4), or (8) button configurations.
 2. Available in the following colors
 - a. White
 - b. Ivory
 - c. Light Almond
 - d. Gray
 - e. Red
 - f. Black
 3. Custom Engraving
 - a. To be available for the following:
 - 1) Individual buttons
 - 2) Wallplates
 4. Digital switches shall mount into a standard depth wallbox.
 5. Environmental
 - a. Operating Temperature: 32° to 122° F, (0° to 50° C)
 - b. Ambient Humidity: 0% to 90% non-condensing
- D. Electrical:
1. Digital stations powered by LumaCAN network through CAT6 cable and RJ45 connectors.
- E. Product Components:
1. Leviton GreenMAX DRC Digital Switches, series DRKDN-CXW
 2. Leviton GreenMAX DRC Color Change Kit, series CKDNK-X0Y
 3. Leviton GreenMAX DRC Color Change Kit with Engraving, series CKDNK-XEY

2.12 GREENMAX RELAY CABINETS

- A. Digital Lighting Control panel consisting of Enclosure, Command Module, Relay Insert Panels, and Modular Relays capable of being field assembled without voiding UL listing.
- B. Performance Criteria
 - 1. Capacities
 - a. Eight (8), sixteen (16), thirty-two (32) or forty-eight (48) single- or dual-pole relays.
 - b. Optional Factory Installed Low Voltage Input cards
 - 1) Eight (8) or sixteen (16) inputs
 - 2. Command Module
 - a. Field-installable and/or replaceable self-contained units with Emergency input.
 - 1) Integral overload and short circuit protection provide separate overload protection for system processor and connected LumaCAN devices including Low Voltage Input Card.
 - b. Supplies power to all electronics in the Relay Cabinet
 - c. Supplies power to digital switches and Handheld Display Unit via LumaCAN
 - d. Can supply +24VDC to other low-voltage inputs
 - e. Can contain an optional Low Voltage Input (+24VDC) card suitable for termination of eight (8) or sixteen (16) low voltage inputs.
 - f. Emergency Signal Input
 - 1) Input for a hardwired emergency override signal
 - 2) Requires external contacts
 - 3) Activates Emergency status when a signal of +24VDC is present
 - 4) Releases Emergency status when signal falls to zero (0VDC).
 - g. Controls all relays as assigned by the user regardless of processor operation.
 - h. Provides +24VDC to external contacts
 - i. Low Voltage Input Card Option allows user to configure inputs as:
 - 1) 0 to 10VDC analog
 - 2) +24VDC switched
 - 3) Contact closure.
 - j. +24VDC power supply
 - 1) 70W (2.9 amperes) capacity
 - 2) Input devices can use external power supplies
 - k. Compatible with the following devices
 - 1) Occupancy sensors
 - 2) Photocells
 - 3) GE switches
 - 4) External Contacts
 - 5) Multi-button low voltage switches
 - 6) ON/OFF dedicated button low voltage switches
 - 3. Handheld Display Unit used for system configuration and monitoring.
 - a. Current Operating Status
 - b. Errors
 - c. Current Time
 - d. Alarms
 - e. Astronomical Time Clock settings
 - f. Monitor Menus
 - g. Control Menus
 - h. Configuration Menus
 - i. Remote Manual operation of all system relays
 - j. Inspection of both digital and low voltage inputs
 - 1) State
 - 2) Status
 - 3) Current value

- k. Schedule monitoring and adjustment
 - l. Temporary override of schedule on a day-by-day basis
- C. Physical
 - 1. Material
 - a. Steel
 - 2. Finishes
 - a. Leviton Standard Green.
 - 3. Removable locking hinged door.
 - a. Removing the door from its hinges shall not defeat the locking mechanism.
 - b. Able to be delivered empty of electronics
 - 4. Relay Insert Panel
 - a. Allow relays modules to be installed, removed and relocated without internal rewiring or mounting screws
- D. Electrical
 - 1. Grounding point provided in left wire-way
 - 2. Relays shall be rated to switch voltages from 24 to 277VAC and +24VDC.
 - 3. Short Circuit Current Rating (SCCR) of the assembled cabinet, regardless of its specific configuration, to be 25,000 Amperes at 277VAC.
 - 4. Command Module requires single-phase power supply, 120 / 277VAC.
- E. Product Components:
 - 1. GreenMAX enclosure with lockable hinged door.
 - 2. Command Module.
 - 3. Relay Insert Panels
 - 4. Modular Relays, type per panel schedule

2.13 GREENMAX REMOTE LOW VOLTAGE INPUT CABINETS

- A. Remotely mounted network node providing additional Network power and local connection point for low voltage control devices.
- B. Performance Criteria:
 - 1. Fully functional as independent LumaCAN network nodes
 - a. Can be connect to network at any location: direct dedicated connection to a Relay Cabinet is not required
 - b. Eight (8) or sixteen (16) Low Voltage inputs
 - c. Provides power to LumaCAN digital devices
 - d. Provides a connection point for the HDU
- C. Physical:
 - 1. Surface mount enclosure
 - a. #16 US gage Steel
 - 2. Finishes
 - a. Leviton Standard Green.
 - 3. Removable locking hinged door.
 - a. Removing the door from its hinges shall not defeat the locking mechanism
- D. Electrical
 - 1. Integrated power supply
 - a. Supply 100 – 277VAC
 - b. Rated output at 70W of +24VDC power via LumaCAN
 - c. Connected devices can be self-powered.
- E. Product Components
 - 1. GreenMAX Remote Low Voltage Input Cabinet, Model #:
 - a. RLV08-110 with (8) low voltage inputs
 - b. RLV16-110 with (16) low voltage inputs

2.14 GREENMAX DIGITAL SWITCHES

- A. Network addressable control stations providing local control of digital lighting control system.
- B. Performance Criteria:
- C. Physical:
 - 1. Button Stations available in One (1), two (2), four (4), or (8) button configurations.
 - 2. Key station available in single-operator stainless steel configuration.
 - 3. Button stations available in the following colors
 - a. White
 - b. Ivory
 - c. Light Almond
 - d. Gray
 - 4. Custom Engraving
 - a. To be available for the following:
 - 1) Individual buttons
 - 2) Station wallplates
 - b. Engraved characters to be of a contrasting color as shown on drawings
- D. Electrical:
 - 1. Digital stations powered by LumaCAN network through CAT6 cable and RJ45 connectors.
 - 2. RJ45 connections available on each device:
 - a. LumaCAN input
 - b. LumaCAN throughput
 - c. Hand Held Display Unit access to entire network
- E. Product Components:
 - 1. GreenMAX Digital Switches, series RLVSW-XXX

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Coordinate, receive, mount, connect, [and place into operation] all equipment.
- B. Install equipment in accordance with manufacturer's installation instructions.
- C. Provide complete installation of system in accordance with Contract Documents.
- D. Maintain performance criteria stated by the manufacturer without defects, damage, or failure.
- E. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.
- F. Ensure that daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted and fixture-mounted daylight sensors shall not have direct view of luminaries.
- G. Furnish all conduit, wire, connectors, hardware, and other incidental items necessary for a properly functioning lighting control and relay system as described herein and shown on the plans. The Electrical Contractor shall maintain performance criteria stated by the manufacturer without defects, damage, or failure.
- H. Compliance: Contractor shall comply with manufacturer's product data, including shop drawings, technical bulletins, product catalog installation instructions, and product carton instructions for installation.
- I. Circuit Testing: The contractor shall test that all branch load circuits are operational before connecting loads to system load terminals, and then de-energize all circuits before installation.
- J. Application of Power: Power shall not be applied to the relay system during construction and prior to turn-on unless specifically authorized by written instructions from the manufacturer.
- K. [Programming: Program [low-voltage] [and] [digital switch] functionality remotely from the GreenMAX DRC App.]
 - 1. Terminate and test all network cable assemblies. Each field installed RJ45 connection

must be tested prior to system interconnection. A test report must be furnished to factory-certified service engineer prior to scheduling commissioning activity.

3.2 SITE VERIFICATION

- A. Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instructions.

3.3 FIELD MEASUREMENTS

- A. The electrical contractor shall be responsible for field measurements and coordinating the physical size of all equipment with the architectural requirements of the spaces into which they are to be installed.

3.4 INSPECTION

- A. Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

3.5 SITE PROTECTION

- A. Contractor shall protect installed product and finished surfaces from damage during all phases of installation including storage, preparation, testing, and cleanup.

3.6 COMMISSIONING

- A. Provide factory-certified field service engineer to ensure proper system installation and operation under following parameters:
 - 1. Certified by the equipment manufacturer on the system installed.
 - 2. Site visit activities:
 - a. Verify connection of power feeds and load circuits.
 - b. Verify connection of controls.
 - c. Verify system operation control by control, circuit by circuit.
 - d. Obtain sign-off on system functions.
 - e. Demonstrate system capabilities, operation and maintenance and educate Owner's representative on the foregoing.
 - 3. At least three site visits to accomplish the following tasks:
 - a. Prior to wiring
 - 1) Review and provide installer with instructions to correct any errors in the following areas:
 - a) Low voltage wiring requirements
 - b) Separation of high and low voltage wiring runs
 - c) Wire labeling
 - d) Load schedule information
 - e) Switching cabinet locations and installation
 - f) Physical locations and network addresses of controls
 - g) Ethernet connectivity
 - h) Computer-to-network connections
 - i) Load circuit wiring
 - j) Connections to other systems and equipment
 - k) Placement and adjustment of Occupancy Sensors
 - l) Placement and adjustment of Photocells
 - b. After system installation

- 1) Check and approve or provide correction instructions on the following:
 - a) Connections of power feeds and load circuits
 - b) Connections and locations of controls
 - c) Connections of low voltage inputs
 - d) Connections of the data network
 - 2) Turn on system control processor and upload any pre-programmed system configuration
 - 3) Verify cabinet address(es)
 - 4) Upload pre-programmed system configuration and information to switching and/or dimming cabinets
 - 5) Check load currents and remove bypass jumpers
 - 6) Verify that each system control is operating to specification
 - 7) Verify that each system circuit is operational according to specification
 - 8) Verify that manufacturers' interfacing equipment is operating to specification
 - 9) Verify that any computers and software supplied by the manufacturer are performing to specifications
 - 10) Verify that any remote WAN (Wide Area Network) connections are operating properly
 - 11) Have an owner's representative sign off on the above-listed system functions
- c. Before project completion and hand-off
- 1) Demonstrate system capabilities and functions to owner's representative
 - 2) Train owner's representative on the proper operation, adjustment, and maintenance of the system.
- B. Notification: Upon completion of the installation, the contractor shall notify the manufacturer that the system is ready for formal checkout. Notification shall be given in writing a minimum of 21 days prior to the time factory-trained personnel are required on site. Each field installed RJ45 connection must be tested prior to system interconnection. A test report must be furnished to manufacturer prior to scheduling commissioning activity. Manufacturer shall have the option to waive formal turn-on.
- C. Turn-On: Upon completion of all line, load and interconnection wiring, and after all fixtures are installed and lamped, Manufacturer's Rep or, if waived, Contractor shall completely check the installation prior to energizing the system. Each installed relay system shall be tested for proper ON/OFF operations, and proper LED illumination. Each installed control cabinet shall be tested verifying that each controlled load adjusts to the selected setting and that all switch LED's illuminate properly.
- D. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.

3.7 MAINTENANCE

- A. Enable the end user to order new equipment for system expansion, replacements, and spare parts.
- B. Make new replacement parts available for a minimum of ten years from the date of manufacture.
- C. Provide factory-direct technical support hotline 24 hours per day, 7 days per week.
- D. Offer renewable annual service contracts, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.

END OF SECTION 26 09 25

SECTION 26 24 13 SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections (if available), apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Service and distribution switchboards rated 600 V and less.
 - 2. Surge protection devices.
 - 3. Disconnecting and overcurrent protective devices.
 - 4. Accessory components and features.
 - 5. Identification.

1.3 ACTION SUBMITTALS

- A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
 - 1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 - 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
 - 6. Detail utility company's metering provisions with indication of approval by utility company.
 - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 8. Include schematic and wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for switchboards, overcurrent protective devices, accessories, and components, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.
 - 1. Include the following:
 - a. Routine maintenance requirements for switchboards and all installed components.
 - b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.

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. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 2. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
 - 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards.
- C. Handle and prepare switchboards for installation according to NECA 400.

1.9 FIELD CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- C. Unusual Service Conditions: NEMA PB 2, as follows:
 1. Ambient temperatures within limits specified.
 2. Altitude not exceeding 6600 feet (2000 m).
- D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
 2. Indicate method of providing temporary electric service.
 3. Do not proceed with interruption of electric service without Construction Manager's written permission.
 4. Comply with NFPA 70E.

1.10 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 SWITCHBOARDS

- A. MANUFACTURERS:
 - 1. EATON
 - 2. SIEMENS
 - 3. GE
 - 4. SQUARE D
 - 5. OR APPROVED EQUAL
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. 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.
- E. Comply with NEMA PB 2.
- F. Comply with NFPA 70.
- G. Comply with UL 891.
- H. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Panel mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- I. Nominal System Voltage: 208Y/120 V
- J. Main-Bus Continuous: See drawings.
- K. Indoor Enclosures: Steel, NEMA 250, Type 1.
- L. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- M. Outdoor Enclosures: Type 3R.
 - 1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
 - 2. Enclosure: Downward, rearward sloping roof for each section, with provisions for padlocking.
- N. Barriers: Between adjacent switchboard sections.
- O. Insulation and isolation for main and vertical buses of feeder sections.
- P. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

- Q. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- R. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- S. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- T. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
 - 2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity.
 - 3. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
 - 4. Copper feeder circuit-breaker line connections.
 - 5. Tin-plated aluminum feeder circuit-breaker line connections.
 - 6. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 - 7. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
 - 8. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 9. Disconnect Links:
 - a. Isolate neutral bus from incoming neutral conductors.
 - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
 - 10. Neutral Buses: 50 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
 - 11. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
 - 12. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- U. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- V. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

2.3 SURGE PROTECTION DEVICES

- A. MANUFACTURERS:
 - 1. Advanced Protection Tech.
 - 2. Eaton
 - 3. General Electric
 - 4. Siemens

5. Or Approved Equal
- B. SPDs: Comply with UL 1449, Type 1.
- C. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.
- D. Features and Accessories:
 1. Integral disconnect switch.
 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 3. Indicator light display for protection status.
 4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
 5. Surge counter.
- E. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- F. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
 1. Line to Neutral: 1200 V for 480Y/277 V
 2. Line to Ground: 1200 V for 480Y/277 V
 3. Line to Line: 2000 V for 480Y/277 V
- G. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:
 1. Line to Neutral: 700 V.
 2. Line to Ground: 700 V.
 3. Line to Line: 1000 V.
- H. SCCR: Equal or exceed 100 kA.
- I. Nominal Rating: 20 kA.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long and short time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
 6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
 7. Ground-Fault Equipment Protection (GFEPP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 8. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Ground-Fault Protection (for 1200A breakers and above unless noted): Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- B. Insulated-Case Circuit Breaker (ICCB): 80 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed circuit-breaker mounting.
 2. Two-step, stored-energy closing.
 3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Time adjustments for long- and short-time pickup.
 - c. Ground-fault pickup level, time delay, and I^2t response.
 4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 5. Remote trip indication and control.
 6. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
 7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 8. Control Voltage: 40-V dc.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- D. Fuses are specified in Section 262813 "Fuses."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NECA 400.
1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
 2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.

3. Protect from moisture, dust, dirt, and debris during storage and installation.
 4. Install temporary heating during storage per manufacturer's instructions.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
 - C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.
 - D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NECA 400.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness.
 1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches (50-mm) above concrete base after switchboard is anchored in place.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to switchboards.
 6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
- D. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices, surge protection devices, and instrumentation.
 1. Set field-adjustable switches and circuit-breaker trip ranges.
- G. Comply with NECA 1.

3.3 CONNECTIONS

- A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.
- B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

- C. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.
- D. Support and secure conductors within the switchboard according to NFPA 70.
- E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test ground-fault protection of equipment for service equipment per NFPA 70.
 - 2. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Switchboard will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies switchboards included. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 26 24 13

**SECTION 26 24 16
PANELBOARDS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
 - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 - 4. Detail bus configuration, current, and voltage ratings.

5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for series rating of installed devices.
7. Include evidence of NRTL listing for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Panelboard Schedules: For installation in panelboards.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 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. Keys: Two spares for each type of panelboard cabinet lock.
 2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

1.10 FIELD CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet (2000 m).
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect no fewer than five days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Architect's written permission.
 - 3. Comply with NFPA 70E.

1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 - 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
 - 1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARD REQUIREMENTS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

- C. 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.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.
- F. Enclosures: Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Height: 84 inches (2.13 m) maximum.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
 - 4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
 - 5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 7. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- G. Incoming Mains:
 - 1. Location: Convertible between top and bottom.
 - 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- H. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
 - 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
 - 5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
 7. Split Bus: Vertical buses divided into individual vertical sections.
- I. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Terminations shall allow use of 75 deg C rated conductors without derating.
 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 4. Main and Neutral Lugs: Compression type, with a lug on the neutral bar for each pole in the panelboard.
 5. Ground Lugs and Bus-Configured Terminators: Compression type, with a lug on the bar for each pole in the panelboard.
 6. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 7. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 8. Gutter-Tap Lugs: Compression type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
 9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- J. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- K. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: Twenty percent.
- L. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.
1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
 2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.
- M. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 POWER PANELBOARDS

- A. Manufacturers:
 - 1. Eaton
 - 2. Siemens
 - 3. Square D
 - 4. Or approved equal.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
- D. Mains: Circuit breaker
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.
- G. Branch Overcurrent Protective Devices: Fused switches.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers:
 - 1. Eaton
 - 2. Siemens
 - 3. Square D
 - 4. Or approved equal.
- B. Molded Case Circuit Breakers (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Shunt Trip: 24-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - i. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
 - j. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - k. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - l. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - m. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
 - n. Multipole units enclosed in a single housing with a single handle Device specified in "Handle Padlocking Device" Subparagraph below can be used as a safety disconnect device if it has fixed attachment and is configured to allow locking in the off position.
 - o. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - p. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.5 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
- D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NECA 407.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces.

Maintain required workspace clearances and required clearances for equipment access doors and panels.

- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NECA 407.
- D. Equipment Mounting:
 - 1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Attach panelboard to the vertical finished or structural surface behind the panelboard.
 - 3. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- G. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- H. Mount panelboard cabinet plumb and rigid without distortion of box.
- I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- J. Mount surface-mounted panelboards to steel slotted supports 5/8 inch (16 mm) in depth. Orient steel slotted supports vertically.
- K. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- M. Install filler plates in unused spaces.
- N. Stub four 1-inch (25 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (25 mm) empty conduits into raised floor space or below slab not on grade.
- O. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers optional tests. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- E. Panelboards will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include

notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
 - 1. Measure loads during period of normal facility operations.
 - 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
 - 4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

SECTION 26 27 26 WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Standard-grade receptacles, 125 V, 20 A.
 - 2. USB receptacles.
 - 3. GFCI receptacles, 125 V, 20 A.
 - 4. Twist-locking receptacles.
 - 5. Cord and plug sets.
 - 6. Toggle switches, 120/277 V, 20 A.
 - 7. Wall plates.

1.3 DEFINITIONS

- A. AFCI: Arc-fault circuit interrupter.
- B. BAS: Building automation system.
- C. EMI: Electromagnetic interference.
- D. GFCI: Ground-fault circuit interrupter.
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- F. RFI: Radio-frequency interference.
- G. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.7 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.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Comply with NFPA 70.
- C. RoHS compliant.
- D. Comply with NEMA WD 1.
- E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with requirements in this Section.
- F. Devices for Owner-Furnished Equipment:
 - 1. Receptacles: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.
- G. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
- H. Wall Plate Color: Stainless steel.
- I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

- A. Duplex Receptacles, 125 V, 20 A:
 - 1. Manufacturers:
 - a. Eaton
 - b. Leviton
 - c. Hubbell

- d. Or approved equal.
- 2. Description: Two pole, three wire, and self-grounding.
- 3. Configuration: NEMA WD 6, Configuration 5-20R.
- 4. Standards: Comply with UL 498 and FS W-C-596.

B. Weather-Resistant Duplex Receptacle, 125 V, 20 A:

- 1. Manufacturers:
 - a. Eaton
 - b. Leviton
 - c. Hubbell
 - d. Or approved equal.
- 2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
- 3. Configuration: NEMA WD 6, Configuration 5-20R.
- 4. Standards: Comply with UL 498.
- 5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

2.3 USB RECEPTACLES

A. USB Charging Receptacles:

- 1. Manufacturers:
 - a. Eaton
 - b. Leviton
 - c. Hubbell
 - d. Or approved equal.
- 2. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
- 3. USB Receptacles: Dual, USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
- 4. Standards: Comply with UL 1310 and USB 3.0 devices.

B. Tamper-Resistant Duplex and USB Charging Receptacles:

- 1. Manufacturers:
 - a. Eaton
 - b. Leviton
 - c. Hubbell
 - d. Or approved equal.
- 2. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap. Integral shutters that operate only when a plug is inserted in the line voltage receptacle.
- 3. Line Voltage Receptacles: Two pole, three wire, and self-grounding; NEMA WD 6, Configuration 5-20R.
- 4. USB Receptacles: Dual USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
- 5. Standards: Comply with UL 498, UL 1310, USB 3.0 devices, and FS W-C-596.
- 6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

2.4 GFCI RECEPTACLES, 125 V, 20 A

- 1. Manufacturers:
 - a. Eaton
 - b. Leviton

- c. Hubbell
 - d. Or approved equal.
- 2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
- 3. Configuration: NEMA WD 6, Configuration 5-20R.
- 4. Type: Non-feed through.
- 5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

2.5 TWIST-LOCKING RECEPTACLES

- A. Twist-Lock, Single Receptacles, 120 V, 20 A:
 - 1. Manufacturers:
 - a. Eaton
 - b. Leviton
 - c. Hubbell
 - d. Or approved equal.
 - 2. Configuration: NEMA WD 6, Configuration L5-20R.
 - 3. Standards: Comply with UL 498.
- B. Twist-Lock, Single Receptacles, 250 V, 20 A:
 - 1. Manufacturers:
 - a. Eaton
 - b. Leviton
 - c. Hubbell
 - d. Or approved equal.
 - 2. Configuration: NEMA WD 6, Configuration L6-20R.
 - 3. Standards: Comply with UL 498.
- C. Twist-Lock, Single Receptacles, 277 V, 20 A:
 - 1. Manufacturers:
 - a. Eaton
 - b. Leviton
 - c. Hubbell
 - d. Or approved equal.
 - 2. Configuration: NEMA WD 6, Configuration L7-20R.
 - 3. Standards: Comply with UL 498.

2.6 CORD AND PLUG SETS

- A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
- B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
- C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.7 TOGGLE SWITCHES, 120/277 V, 20 A

A. Single-Pole Switches, 120/277 V, 20 A:

1. Manufacturers:
 - a. Eaton
 - b. Leviton
 - c. Hubbell
 - d. Or approved equal.
2. Standards: Comply with UL 20 and FS W-S-896.

B. Lighted Single-Pole Switches, 120/277 V, 20 A:

1. Manufacturers:
 - a. Eaton
 - b. Leviton
 - c. Hubbell
 - d. Or approved equal.
2. Description: Handle illuminated when switch is on.
3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

C. Key-Operated, Single-Pole Switches, 120/277 V, 20 A:

1. Manufacturers:
 - a. Eaton
 - b. Leviton
 - c. Hubbell
 - d. Or approved equal.
2. Description: Factory-supplied key in lieu of switch handle.
3. Standards: Comply with UL 20 and FS W-S-896.

D. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches, 120/277 V, 20 A.

1. Manufacturers:
 - a. Eaton
 - b. Leviton
 - c. Hubbell
 - d. Or approved equal.
2. Description: For use with mechanically held lighting contactors.
3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

E. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches, 120/277 V, 20 A:

1. Manufacturers:
 - a. Eaton
 - b. Leviton
 - c. Hubbell
 - d. Or approved equal.
2. Description: For use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.8 WALL PLATES

- A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

- B. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.
- D. Antimicrobial Cover Plates:
 - 1. Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
 - 2. Tarnish resistant.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtail existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.

- B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Perform the following tests and inspections:
 - 1. In healthcare facilities, prepare reports that comply with NFPA 99.
 - 2. Test Instruments: Use instruments that comply with UL 1436.
 - 3. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- D. Tests for Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- E. Wiring device will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 26 27 26

**SECTION 26 28 13
FUSES**

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Control circuits.
 - b. Enclosed controllers.
 - c. Enclosed switches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in PDF format.
 - 5. Coordination charts and tables and related data.
 - 6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Ambient temperature adjustment information.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.

3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in PDF format.
4. Coordination charts and tables and related data.

1.5 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than 3 of each size and type.

1.6 FIELD CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C) apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
 1. Bussmann
 2. Littelfuse
 3. Or approved equal.
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
 1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC.
 2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC
 3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC
 4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC
 5. Type J: 600-V, zero- to 600-A rating, 200 kAIC
 6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC
 7. Type T: 600-V, zero- to 800-A rating, 200 kAIC
- B. 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.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.

- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Feeders: Class L, fast acting.
 - 2. Motor Branch Circuits: Class RK1, time delay.
 - 3. Large Motor Branch (601-4000 A): Class L, time delay.
 - 4. Power Electronics Circuits: Class J, high speed.
 - 5. Other Branch Circuits: Class RK1, time delay.
 - 6. Control Transformer Circuits: Class CC, time delay, control transformer duty.
 - 7. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Architect.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 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.

1.2 SUMMARY

- A. Section Includes:
1. Fusible switches.
 2. Nonfusible switches.
 3. Receptacle switches.
 4. Molded-case circuit breakers (MCCBs).
 5. Molded-case switches.
 6. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
1. Enclosure types and details for types other than NEMA 250, Type 1.
 2. Current and voltage ratings.
 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in [PDF] [and] <Insert calculation program format> electronic format.
- B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Data: Certificates, for enclosed switches and circuit breakers, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

1.7 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 2. Altitude: Not exceeding 6600 feet (2010 m).

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.2 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

2.3 FUSIBLE SWITCHES

- A. Manufacturers:
 - 1. ABB
 - 2. Eaton
 - 3. Siemens
 - 4. Or approved equal.
- B. Type HD, Heavy Duty:
 - 1. Single throw.
 - 2. Three pole.
 - 3. 600-V ac.
 - 4. 1200 A and smaller.
 - 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
 - 6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 NONFUSIBLE SWITCHES

A. Manufacturers:

1. ABB
2. Eaton
3. Siemens
4. Or approved equal.

B. Type GD, General Duty, Three Pole, Single Throw, 240-V ac, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Three Pole, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.5 RECEPTACLE SWITCHES

A. Manufacturers:

1. ABB
2. Eaton
3. Siemens

4. Or approved equal.
- B. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 240-V ac, 30 amperage A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
 - C. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: 600-V ac, 30 amperage A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
 - D. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.
 - E. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).
 - F. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 5. Lugs: Mechanical type, suitable for number, size, and conductor material.
 6. Service-Rated Switches: Labeled for use as service equipment.

2.6 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers:
 1. ABB
 2. Eaton
 3. Siemens
 4. Or approved equal.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. MCCBs shall be equipped with a device for locking in the isolated position.
- E. Lugs shall be suitable sized according to the 167 deg F (75 deg C) temperature rating in NFPA 70.

- F. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- G. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- H. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- I. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I-squared t response.
- J. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- K. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- L. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- M. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- N. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.7 MOLDED-CASE SWITCHES

- A. Manufacturers:
 - 1. ABB
 - 2. Eaton
 - 3. Siemens
 - 4. Or approved equal.

- B. Description: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- D. Features and Accessories:
 - 1. Standard frame sizes and number of poles.
 - 2. Lugs:
 - a. Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - b. Lugs shall be suitable sized according to the 167 deg F (75 deg C) temperature rating in NFPA 70.
 - 3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.8 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Architect's written permission.
 - 4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Other Wet or Damp, Indoor Locations: NEMA 250, [Type 4] <Insert type>.
 - 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

3.4 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

- E. Install fuses in fusible devices.
- F. Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 FIELD QUALITY CONTROL

- A. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
 - i. Verify correct phase barrier installation.
 - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
 - 2. Electrical Tests:
 - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

- b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

B. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and clearances.
- d. Verify that the unit is clean.
- e. Operate the circuit breaker to ensure smooth operation.
- f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
- h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole.

Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 4. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
1. Test procedures used.
 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION 26 28 16

SECTION 26 33 23
CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections (if available), apply to this Section.

1.2 SUMMARY

- A. Section includes the following central battery and power conversion equipment rated 600 V and less for emergency lighting:
 - 1. Uninterruptible (UPS-type) central battery equipment.

1.3 DEFINITIONS

- A. DDC: Direct digital control.
- B. IBC: International Building Code.
- C. Interruptible: As used in the Section Text, an off-line, passive-standby or line-interactive, inverter-only unit, with an intentional interruption of power to the load until an internal transfer switch picks up and transfers the load to the unit's inverter and internal battery source on loss of the "normal" source, and then retransfers to the "normal" source when it is restored. Transfer time can be "slow" (up to approximately 1 second) or "fast" (2-4 ms or 40-50 ms, depending on manufacturer).
- D. LED: Light-emitting diode.
- E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- F. NiCd: Nickel cadmium.
- G. OCPD: Overcurrent protective device.
- H. PC: Personal computer.
- I. PWM: Pulse-width modulated.
- J. TDD: Total demand (harmonic current) distortion (also listed as "THD" in catalog data by manufacturers).
- K. THD(V): Total harmonic voltage demand.
- L. Uninterruptible: As used in the Section Text, an on-line, double-conversion (rectifier/inverter) unit, with no interruption of power to the load on interruption and restoration of the "normal" source.
- M. UPS: Uninterruptible power supply.

- N. VRLA: Valve-regulated lead acid.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type and rating of central battery equipment unit.
 - 1. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, shipping splits, and furnished options, specialties, and accessories.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For central battery equipment to include in emergency, operation, and maintenance manuals.
 - 1. In addition include the following:
 - a. Manufacturer's written instructions for testing central battery equipment.
 - b. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - c. Manufacturer's written instructions for selecting and setting field-adjustable controls and status and alarm points

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in fully enclosed vehicles.
- B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).
 - 2. Altitude: Exceeding 400 feet.
- B. Interruption of Existing Electrical Distribution Systems: Do not interrupt electrical distribution systems within facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Architect no fewer than two days in advance of proposed interruption of electrical systems.
 - 2. Indicate method of providing temporary electrical service.
 - 3. Do not proceed with interruption of electrical systems without Architect's written permission.
 - 4. Comply with NFPA 70E.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for central battery equipment, including clearances between central battery equipment and adjacent surfaces and other items.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace central battery equipment that fails in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.
 - 1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:
 - a. Central Battery Equipment (excluding Batteries): One year.
 - b. Batteries:
 - 1) Full Warranty: One year.
 - 2) Pro Rata: 5 years minimum.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Central battery equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated central battery equipment shall be tested and certified by an NRTL as meeting ICC-ES AC 156 test procedure requirements.

2.2 UNINTERRUPTIBLE (UPS-TYPE) CENTRAL BATTERY EQUIPMENT

- A. Manufacturers:
 - 1. Dual-Lite
 - 2. Myers
 - 3. ELC
 - 4. Or approved equal.
- B. General Requirements for Central Battery Equipment:
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. NRTL Compliance: Fabricate and label central battery equipment to comply with UL 924.
 - 3. Comply with the IBC, NFPA 70, and NFPA 101.
 - 4. Comply with NEMA PE 1.
- C. Performance Requirements for UPS-Type Central Battery Equipment:
 - 1. Type: On-line, double conversion.
 - 2. Continuously provide uninterrupted ac power to connected emergency electrical lighting system.
 - 3. Automatic Operation:

- a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, through rectifier and inverter, with battery connected in parallel with rectifier output.
 - b. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, battery supplies constant, regulated, inverter ac power output to the load without switching or disturbance.
 - c. If normal power fails, battery continues to supply regulated ac power through the inverter to the load without switching or disturbance.
 - d. When power is restored at normal supply terminals of system, controls automatically synchronize inverter with the external source before transferring the load. Rectifier then supplies power to the load through the inverter and simultaneously recharges battery.
 - e. If battery becomes discharged and normal supply is available, rectifier charges battery. When battery is fully charged, rectifier automatically shifts to float-charge mode.
 - f. If any element in the rectifier/inverter string fails and power is available at normal supply terminals of system, static transfer switch transfers the load to normal ac supply circuit without disturbance or interruption of supply.
 - g. If a fault occurs in system supplied by the inverter output, and current flows in excess of the overload rating of the inverter, static transfer switch operates to bypass fault current to normal ac supply circuit for fault clearing.
 - h. When fault has cleared, static transfer switch returns the load to inverter output.
 - i. If battery is disconnected, inverter continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.
4. Manual Operation:
- a. Turning inverter off causes static transfer switch to transfer the load directly to normal ac supply circuit without disturbance or interruption.
 - b. Turning inverter on causes static transfer switch to transfer the load to inverter.
- D. Unit Operating Requirements:
- 1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of central battery equipment input voltage rating.
 - 2. Input Frequency Tolerance: Plus or minus 5 percent of central battery equipment frequency rating.
 - 3. Synchronizing Slew Rate: 1 Hz per second, maximum.
 - 4. Minimum Off-Line Efficiency: 97 percent at 60 Hz, full load.
 - 5. Minimum Displacement Primary-Side Power Factor: 97 percent under any load or operating condition.
 - 6. Ambient Temperature Rating (Other Than Batteries): Not less than 68 deg F (20 deg C) and not exceeding 86 deg F (30 deg C).
 - 7. Ambient Storage Temperature Rating (Other Than Batteries): Not less than minus 4 deg F (minus 20 deg C) and not exceeding 158 deg F (70 deg C).
 - 8. Ambient Temperature Rating (Batteries): Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).
 - 9. Ambient Storage Temperature Rating (Batteries): Not less than 0 deg F (minus 18 deg C) and not exceeding 104 deg F (40 deg C).
 - 10. Humidity Rating: Less than 95 percent (noncondensing).
 - 11. Altitude Rating: Not exceeding 400 feet.
- E. Inverter and Controls Logic: Microprocessor based, isolated from all power circuits; provides complete self-diagnostics, periodic automatic testing and reporting; with alarms.
- F. Controls and Indication:

1. Status Indication: Door-mounted, labeled LED indicators or digital screen displaying the following conditions:
 - a. Normal power available.
 - b. Status of system.
 - c. Battery charging status.
 - d. On battery power.
 - e. System fault.
 - f. External fault.
 2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
 - a. Keypad: In addition to required programming and control keys, include the following:
 - 1) Control Authority: Supports at least three conditions: Off, local manual control at unit and local automatic control at unit.
- G. Self-Protection and Reliability Features:
1. Integral, programmable, self-diagnostic and self-test circuitry; with alarms and logging.
 2. Battery deep-discharge and self-discharge protection; with alarms.
 3. Battery self-test circuitry; with alarms and logging.
- H. Integral Input Disconnecting Means and OCPD: Thermal-magnetic circuit breaker, complying with UL 489.
1. Integrated Equipment Minimum Short-Circuit Current (Withstand) Rating: 10kA.
- I. Rectifier:
1. Description: Solid state, with the following operational features:
 - a. Automatically convert incoming ac voltage to regulated dc bus voltage, with less than 2 percent rms ripple voltage with inverter fully loaded and batteries disconnected.
 - b. Rectified Efficiency: Not less than 97 percent.
 - c. Generator compatible.
- J. Inverter:
1. Description: Solid-state, high-frequency, PWM type, with the following operational features:
 - a. Automatically regulate output voltage to within plus or minus 5 percent, for all load ranges and for maximum 25 percent step-load changes; regulation may increase to 8 percent for 100 percent step-load changes, with recovery within 3 cycles.
 - b. Automatically regulate output frequency to within plus or minus 0.05 Hz, from no load to full load, at unity power factor, over the operating range of battery voltage.
 - c. Inverter Overload Capability: 115 percent for 10 minutes; 150 percent surge for 10 seconds.
 - d. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.
 - e. Load Power Factor: 0.5 lead to 0.5 lag.
- K. Battery Charger:

1. Description: Solid state, variable rate, temperature compensated; automatically maintains batteries in fully charged condition when normal power is available.
2. Maximum Battery Recharge Time from Fully Discharged State: 24 hours.
3. Low-voltage disconnect circuit reduces battery discharge during extended power outages, monitors battery voltage, and disconnects inverter when battery voltage drops to no less than 85.7 percent of nominal voltage.

L. Batteries:

1. Description: Standard VRLA batteries.
 - a. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.
2. Battery Disconnect and OCPD: Manufacturer's standard.

M. Integral Output Disconnecting Means and OCPD:

1. Single-Output OCPD: Thermal-magnetic circuit breaker, complying with UL 489; voltage rating matching unit output voltage rating; 20 A, single pole.
 - a. Normally Closed: 1

2.3 ENCLOSURES

- A. Central Battery Equipment Enclosures: NEMA 250, to comply with environmental conditions at installed location.
1. Dry and Clean Indoor Locations: Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
 2. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store central battery equipment according to NECA 411.
- B. Examine areas, surfaces, and substrates to receive central battery equipment, with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work. Remove existing shelves in installation area.
1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.
- C. Examine equipment before installation. Reject equipment that is wet, moisture damaged, or mold damaged.
- D. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of central battery equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install central battery equipment and accessories according to NECA 411.
- C. Wall-Mounted Central Battery Equipment: Install central battery equipment on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For units not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Comply with NECA 1.
- F. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used for low-voltage control and alarm wiring. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- G. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- H. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 CONNECTIONS

- A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.
- C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between central battery equipment and remote devices and facility's central-control system.

- B. Bundle, train, and support wiring in enclosures.

3.5 IDENTIFICATION

- A. Identify central battery equipment, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Label central battery equipment with engraved nameplates.
 - 2. Label each separate cabinet, for multicabinet units.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect central battery equipment, wiring, components, connections, and equipment installation. Test and adjust components and equipment.
 - 2. Perform each visual and mechanical inspection and electrical test stated in manufacturer's written instructions.
 - 3. Perform a load-duration test at rated voltage and rated output current to verify the correct functional operation of the unit under full-load stable operating conditions for the minimum time limits required by UL 924. Monitor and record ambient temperature and temperatures within the unit.
 - 4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Central battery equipment will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies central battery equipment and describes all test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, and other adjustable parts.
- C. Adjust the trip settings of thermal-magnetic circuit breakers with adjustable, instantaneous-trip elements; install fuses if not factory installed.

- D. Set the automatic system test parameters.

3.9 PROTECTION

- A. Replace central battery equipment whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain central battery equipment, and to use and reprogram microprocessor-based control, monitoring, and display functions.

END OF SECTION 26 33 23

**SECTION 26 43 00
SURGE PROTECTIVE DEVICES**

PART 1 – GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. SPD for Service Entrance - Modular Type
 - 2. SPD for Distribution Panels - Nonmodular Type

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements (if available) apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements (if available).
- B. In addition, meet the following:
 - 1. Listed per UL 1449, third edition, and complimentary listed per UL 1283 as FRI/EMI filter.
 - 2. Comply with ANSI/IEEE C62.45 test procedures for Category-C3 established in C62.41.2 and CSA certified (C22.2).

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements (if available).

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements (if available).

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements (if available).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Current Technology
- B. Eaton Electrical
- C. Lea International
- D. Liebert

- E. Square D
- F. Surge Suppression Inc. (SSI)
- G. Or approved equivalent.

2.2 SPD FOR SERVICE ENTRANCE - MODULAR TYPE

- A. List SPD in accordance with UL 1449 (third edition), Standard for Safety, Surge Protective Devices, and UL 1283, Electromagnetic Interference Filters.
- B. Provide SPD with copper bus bars for surge current path. Small gauge round wiring, plug-in type connections, or printed circuit boards not to be used in path for surge current diversion. Equally distribute surge current to individually fused MOV components to ensure equal stressing and maximum performance. Surge suppression platform must provide equal impedance paths to each matched (plus or minus one volt) MOV.
- C. Construct SPD using field replaceable surge current diversion modules (MOV based). Each module fused with user replaceable 200,000 AIC rated fuses. Monitor status of each module and MOV and indicate on front of SPD's enclosure as well as on each module.
- D. Encapsulated SPD, whether modular or chase nipple units, utilizes an encapsulant that is UL listed and holds 94-V2 fire retardant rating. Allow no encapsulant compounds that incorporate epoxy.
- E. Equip SPD with an audible alarm that activates when one of surge current modules have failed. Provide an alarm on/off switch to silence the alarm. Provide an alarm push-to-test switch to test alarm. Locate switches and alarm on front cover of SPD's enclosure. Equip unit with an Event Counter that will indicate how many surges, sags, swells and outages have occurred at the location.
- F. Meet or exceed the following criteria:
 - 1. Maximum Single Impulse Current Rating: No less than 200 kA per phase.
 - 2. Pulse Life Test: Capable of protecting against and surviving 5000 ANSI/IEEE C62.41.2 Category-C3 transients without failure or degradation of UL 1449, third edition, clamp voltage by more than 10 percent.
 - 3. UL 1449, third edition, clamping voltage not-to-exceed exceed the following:

VOLTAGE	L-G	L-N	N-G
208Y/120V	800V	800V	800V
480Y/277V	1200V	1200V	1200V

- 4. ANSI/IEEE C62.41.2 (2002) Category-C3 clamping voltage not to exceed the following:

VOLTAGE	L-N	L-5	N-G
208Y/120V	470V	470V	470V
480Y/277V	920V	920V	800V

- G. Provide response time that is no greater than five nanoseconds for any of individual protection modes.
- H. Provide SPD designed to withstand maximum continuous operating voltage (MCOV) of not less than 115 percent of nominal RMS voltage.

1. Provide visible indication of proper SPD connection and operation. Indicator lights indicates which phase as well as which module is fully operable.
2. Equip SPD with the following items:
 - a. Provide connector along with dry contacts (normally open or normally closed) to allow connection to remote monitoring system.
 - b. Output of dry contacts indicates failure of phase or entire unit.
3. Provide terminals for necessary power and ground connections.
4. Provide SPD with minimum EMI/RFI filtering of 30dB at 100KHZ with an insertion loss ratio of 316:1 using Military Standard 220A methodology.
5. Provide SPD with 1 year warranty, incorporating unlimited replacement parts if they are destroyed by transients during warranty period.

2.3 SPD FOR DISTRIBUTION PANELS - NONMODULAR TYPE

- A. List SPD in accordance with UL 1449 (third edition), Standard for Safety, Surge Protective Devices, and UL 1283, Electromagnetic Interference Filters.
- B. Provide SPD with copper bus bars for surge current path. Small gauge round wiring, plug-in type connections, or printed circuit boards not be used in path for surge current diversion. Equally distribute surge current to MOV components to ensure equal stressing and maximum performance. Surge suppression platform must provide equal impedance paths to each matched MOV.
- C. Use no plug in component modules or printed circuit boards as surge current conductors. Hardwire internal components with connections utilizing low impedance conductors and compression fittings.
- D. In order to isolate SPD under any fault condition, manufacturer to provide:
 1. Individually fuse the MOV via copper fuse. Copper fuse provides protection during high (ka) surge events.
 2. Equip MOVs with thermal fuse which allows disconnection of suppression component at overheating stage common during TOV.
 3. Test over-current protection components in compliance with UL 1449 (third edition) -Limited Current Test and AIC rating test.
- E. Equip SPD with an audible alarm that activates when one of surge current modules have failed. Provide an alarm on/off switch to silence alarm. Provide an alarm push-to-test switch to test the alarm. Locate switches and alarm on the front cover of the SPD's enclosure.
- F. Provide SPD that Meet or Exceed the Following Criteria:
 1. Provide maximum single impulse current rating at no less than 100 kA per phase. Manufacturers must provide documented proof of independent third party verification of single impulse current withstand capabilities.
 2. Pulse Life Test: Capable of protecting against and surviving 2000 ANSI/IEEE C62.41.2 Category-C3 transients without failure or degradation of UL 1449 (third edition) clamp voltage by more than 10 percent.
 3. UL 1449 (third edition) clamping voltage not to exceed the following:

VOLTAGE	L-G	L-N	N-G
208Y/120V	800V	800V	800V
480Y/277V	1200V	1200V	1200V

- 4. Nominal discharge current of 20KA I (n).
- G. Make SPD of solid-state components which operate bidirectionally.
- H. Provide SPD with response time no greater than five nanoseconds for individual protection modes.
 - 1. SPD designed to withstand maximum continuous operating voltage (MCOV) of not less than 115 percent of nominal RMS voltage.
- I. Provide visible indication of proper SPD connection and operation. Provide 10 year warranty, incorporating unlimited replacements of SPD if they are destroyed by transients within warranty period.
- J. Provide SPD designed to withstand maximum continuous operating voltage (MCOV) of not less than 115 percent of nominal RMS voltage.
 - 1. Provide terminals for necessary power and ground connections.
 - 2. Provide SPD with minimum EMI/RFI filtering of 30dB at 100KHZ with an insertion loss ratio of 316:1 using Military Standard 220A methodology.
 - 3. Provide SPD with 10 year warranty, incorporating unlimited replacement parts if they are destroyed by transients during warranty period.

PART 3 – EXECUTION

3.1 SERVICE ENTRANCE

- A. Install SPD on load side of service entrance as directed by manufacturer's installation instructions. Provide 3 pole breaker for disconnect in service entrance equipment, size breaker to manufacturers installation instructions.
- B. Install one primary SPD at each utility service entrance to facility, according to manufacturer's recommendations.
- C. Integrate SPD unit into switch gear to maximize performance and reliability.
- D. Bond SPD's ground to service entrance ground.

3.2 DISTRIBUTION PANELS

- A. Install one secondary SPD at each distribution panel location as indicated on Drawings. SPD unit to be integral to panelboard.

END OF SECTION 26 43 00

**SECTION 26 50 00
GENERAL LIGHTING PROVISIONS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes general information related to providing and installing all interior and exterior lighting systems throughout the project.

B. RELATED REQUIREMENTS

- 1. Section 26 09 23 "Interior Lighting Controls"

1.3 DEFINITIONS

- A. Fixture: See "Luminaire."
- B. IP: International Protection or Ingress Protection Rating.
- C. LED: Light-emitting diode.
- D. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 WARRANTIES

- A. Submit a copy of manufacturers' written guarantees for each manufacturer for transmittal to the Owner, agreeing to repair or replace any and all defects in workmanship and/or materials for a period of two (2) years, or as otherwise specified, from the date of final acceptance of the installation, without cost to the Owner.
- B. Submit the Contractor's written guarantee for a period of one (1) year after the date of final acceptance, all apparatus installed by the Contractor to be free of mechanical and electrical defects in workmanship, and to replace the same if, in the opinion of the Architect, the responsibility lies with the Contractor.

1.5 REQUIREMENTS OF REGULATORY AGENCIES

- A. All equipment covered in this section shall comply with all applicable standards of IESNA, National Electrical Code and all laws, codes and regulations of Federal, State, County and City authorities having jurisdiction over this work.
- B. All equipment shall be U.L. Listed. Equipment shall be listed for Wet or Damp locations, as stated in the luminaire schedule, or as specified by the luminaire catalog number.

- C. Luminaires shall be located so as not to provide any conflicts with barrier free spaces: Public Law 90-480 and American National Standards Institute A1117.1-1961
- D. NEMA WD 6 – Wiring Devices-Dimensional Requirements
- E. All work shall be inspected and approved by the appropriate authorities.

1.6 MATERIALS AND WORKMANSHIP

- A. All materials and apparatus required for the work, except as specified otherwise, shall be new, of first class quality, and shall be furnished, delivered, erected, connected and finished in every detail, and shall be so selected and arranged as to fit properly into the spaces. Where no specific kind or quality of material is given, an article acceptable to the Architect shall be furnished.
- B. All component parts of each item of equipment or device shall bear the Manufacturer's Nameplate, giving at least the name of the manufacturer, description, size, type, serial number, and electrical characteristics in order to facilitate maintenance or replacement. This nameplate shall not be visible during normal operation of the equipment.
- C. Blemished, damaged, or unsatisfactory luminaires shall be replaced at the direction of the Architect in a satisfactory manner at no cost to the Owner. This includes manufacturer defects as well as damage or blemishes to luminaires during handling and installation. Special attention should be paid to the blades and baffles of luminaires.
- D. Luminaires that are installed and or used during construction must be protected from the construction activities, dirt and debris. Any luminaires showing dirt or debris must be cleaned prior to turnover of the area to the Owner.
- E. Whenever possible luminaires should not be used during construction. Whenever luminaires are used for work lights during construction, light sources shall be replaced according to the project specifications and/or luminaire schedule prior to turnover of area to Owner. All luminaires installed during construction must be sealed, bagged, and covered in plastic to prevent dirt and construction debris from entering the luminaire and accumulating on the reflector.

1.7 SUBMITTALS

- A. Cost Estimate
 - 1. Contractor to provide line item pricing for each luminaire type listed in the luminaire schedule. Contractor to specify if labor is included.
 - 2. Contractor to provide line item pricing for each control type listed in the luminaire schedule. Contractor to specify if labor is included.
- B. Substitute Products Approval during Bidding
 - 1. Substitutions for lighting equipment other than that specified will be considered if equal (or better and/or higher) in quality, performance, ratings and function; and similar in type, size and appearance.
 - 2. Substitutions are to be provided to the Architect, Electrical Engineer and Lighting Consultant at least (14) days prior to proposals being presented to the Owner. Said substitution package shall include data on both the proposed substitution and the specified product is such detail as to permit the two products to be adequately compared. Said substitution package shall include samples of each substitution being proposed. Substitutions are solely at the proposer's risk and should not be considered as being acceptable until a written approval from the Architect, Electrical Engineer, or Lighting Consultant is issued to that effect. In the absence of approval not occurring prior to bid, the substitution should be considered as not being approved.

3. Submit Electronic Submittals or (4) hard copies on request, of the substitution requests to the Architect. The Architect will distribute to the Owner, Electrical Engineer and Lighting Consultant. Contractor shall submit bid alternates for approval prior to bidding. Proposed alternates shall include specification sheets with adequate information for comparison. The Architect, Electrical Engineer or Lighting Consultant will issue a statement of approval or rejection within (14) days of receiving the substitution documents.
- C. Shop Drawings & Product Submittals
1. Before releasing any materials, the Contractor shall submit manufacturers catalog cut sheets, diagrams, and a complete list of all of the equipment and materials which the Contractor intends to install. This list shall include, but is not limited to, the following:
 - a. Light standards and anchor bolts;
 - b. Bases including elevations showing depth in to soil, depth above finished surface, interface with adjacent surface elements, reinforcing steel, and concrete mix and strength.
 - c. Details on backing to be provided for wall mounted fixtures over ten pounds to be wall mounted.
 - d. Luminaire mountings, luminaires, finishes, light sources, fixture hickey's, fixture studs, visible chains, visible cables, seismic supports, and ballasts;
 - e. Bolt plate covers;
 - f. Performance and Photometric data, and UL listing;
 - g. Wiring and connection diagrams of all luminaires, etc.
 - h. Lighting dimming control components specifications, if applicable.
 2. The list shall include the brand name, any identifying numbers, relevant technical data, and any other information necessary for the agency responsible for maintenance of the system to procure exact replacements of any and all equipment and material used on the project. All equipment shall be new, first quality and approved by Underwriter's Laboratories, Inc.
 3. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
 4. All luminaires of the same type classification shall be provided by the same manufacturer.
 5. Before releasing any non-standard, modification of standard specification product, semi-custom, or custom luminaires, the Contractor shall submit shop drawings which detail methods of assembly and fastening. Shop drawings shall also indicate colors and their locations on each lighting element for review and approval prior to releasing. Contractor shall also supply manufacturer descriptions on luminaires, light standard materials, fabrication performance, and installation.
 6. The Contractor shall submit all Certificates of Compliance supplied by the manufacturer of the equipment. This equipment shall include, but is not limited to, the following:
 - a. Luminaire mountings.
 - b. Luminaire standards and accessories.
 - c. Pole base and accessories.
 - d. Luminaires, light sources, drivers and ballasts.
 - e. Photometric data (if requested).
- D. Samples (when requested by the Architect, Electrical Engineer or Lighting Consultant)
1. Submit samples of finishes and also submit photometric data in electronic format from an independent testing laboratory to completely describe luminaire performance. Unless otherwise indicated, samples shall be as follows:
 - a. For standard catalog types: complete, production line samples, with all installation hardware, proper lamp(s), and equipped with a cord and plug.
 - b. Sample of a specially designed or developed luminaire shall be submitted for the purpose of ascertaining its photometric performance, quality of visible parts and details, maintenance features (including relamping process), method of installation, and safety features.
 - c. Luminaire samples shall be submitted for final review within 30 days after review of shop drawings. If, after a period of 30 days from rejection of samples, the luminaire

cannot be made acceptable, then a luminaire (shop drawing and sample) by an alternative manufacturer shall be submitted at no cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS REQUIREMENTS

- A. Provide accessories as required for compatibility with installation requirements. Luminaire catalog numbers do not necessarily denote specific mounting accessories for where/how luminaire is to be installed.
- B. All materials used in fabrication and mounting luminaires shall be of a non-corrosive nature.
- C. Luminaires shall be free of light leaks. Luminaires shall be designed to provide adequate ventilation for both light sources and drivers or transformers.
- D. Luminaires shall be designed to hide mounting hardware from view when luminaire is completely installed. Exposed fasteners shall not be acceptable, except as noted on details.
- E. Wiring channels and lamp holder mountings shall be rigid and accurately manufactured.
- F. In adjustable luminaires, aiming and positive locking devices shall be provided.
- G. All luminaires when installed shall be set true and free of warps, dents, or other irregularities. The finish of exposed parts or trims shall be as specified or as directed by the Architect/Engineer.
- H. All lamp holders shall be of high quality and shall securely hold light sources preventing vibration.
- I. Rivets, springs, and other hardware shall not be visible after installation.

2.2 PRODUCT DELIVERY AND STORAGE

- A. All components shall be packed in a manner consistent with ICC regulations to minimize damage during shipping.
- B. Store all luminaires, light sources, drivers and hardware flat, in a clean, dry area off the ground under watertight cover.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Report all defects. Contractor shall be held responsible for any existing defects that adversely affect the luminaire or its performance.
- B. Upon Architect's request, Contractor shall provide one sample of selected luminaires.

3.2 INSTALLATION

- A. The installation shall be in accordance with all governing local ordinances and regulations, the Drawings, these special provisions and those sections of the Standard Specifications which apply. All workmanship shall be first class and finished work shall present a neat, uncluttered appearance. The Contractor shall coordinate his work with other construction phases so as to provide a minimum of interference to the combined operations. Contractor shall also coordinate their work with the work on adjacent projects where required.
- B. Provide seismic calculations as necessary to validate the installation of all fixtures as appropriate for the seismic zone in to which they are being installed. Furnish and install seismic components as necessary to complete the installation.
- C. Clean the housing, trim, reflector surfaces, lens of all luminaires after construction is complete, so as to render them free of any material.
- D. Any luminaire or lamp or lighting device damaged during construction shall be replaced without cost to the Owner.
- E. Replace all inoperative light sources, ballasts, drivers and transformers just prior to acceptance of Project by Owner. Verify that all light sources are installed are exactly as specified for each luminaire type.
- F. Notify Owner and/or Architect about field conditions at variance with contract documents before commencing installation. This includes but is not inclusive of changes in landscape type and location, and field verification of walls, boundary markers, signs, walkways, and other changes that affect location of equipment.
- G. It shall be the Contractor's responsibility to replace and restore all surface materials in kind, equal to, or exceeding those disturbed by trenching, excavation or backfilling operations. This includes but is not limited to: seeding, sodding, replacement of sub base, pavement, trees, and shrubs. All excess materials shall be disposed of as directed by the Architect.
- H. It is the contractor's responsibility to review and coordinate with the Architectural drawings for placement of luminaires and lighting control devices. The contractor shall also coordinate with Landscape drawings for location of luminaires at the exterior of the project.
- I. It is the Contractor's responsibility to coordinate with other trades and with the local utility locator service.

3.3 LIGHTING AIM AND FOCUS

- A. It is the Contractor's responsibility to provide all necessary labor and materials for final focusing of all adjustable luminaires under the Architect's and/or Lighting Consultant's observation. The focusing of all adjustable luminaires will take place in a night test of system.
- B. Focusing shall take place immediately before the Project is turned over to the Owner. Focusing shall be complete after approval by the Architect and/or Lighting Consultant.
- C. All track mounted luminaires and accessories shall be stored by the contractor during construction and only installed during the focusing period. Track mounted luminaires should not be installed prior to the focusing period unless directed by the Architect and/or Lighting Consultant.
- D. Prior to the focusing, the Contractor shall verify in writing to the Architect and/or Lighting Consultant that all materials stored on site, including track luminaires, accessories and light sources are accounted for and ready for the focusing procedure.

3.4 TESTS

- A. Prior to final acceptance, the Contractor shall demonstrate by test to the Architect's and/or Lighting Consultant 's satisfaction that all the electrical and lighting equipment installations are in proper condition per drawings and specifications. The Contractor shall furnish all equipment and appliances to make the test.
- B. All lighting circuits and equipment shall be given an initial operational test, consisting of having the entire system energized for 72 consecutive hours without any failures of any type occurring anywhere in the system. All circuits shall test clear of faults, grounds and open circuits to the satisfaction of the Architect.
 - 1. Submit information of witness participation for all testing including but not limited to:
 - a. Witness(s) name, title, employer, address of the associated business, e-mail, and telephone information.
- C. After satisfactory completion of all tests, the illumination system shall be placed in operation. Final acceptance will not be made until the system has operated satisfactory for a period of not less than (14) days.
- D. The Contractor shall be fully responsible for the system during this period of operation and he shall make any adjustment or repairs which may be required, and remedy any defects or damages which may occur, at Contractor's expense.
- E. Operation of the system shall not in any way be construed as an acceptance of the system or any part of it or as a waiver of any of the provision of the contract. Acceptance of the system is to occur when the Owner accepts the building.
- F. The Contractor shall not be required to pay for electrical energy consumed by the system during the period of trial operation.

END OF SECTION 26 50 00

SECTION 27 05 28
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Optical-fiber-cable pathways and fittings.
 - 4. Metal wireways and auxiliary gutters.
 - 5. Nonmetallic wireways and auxiliary gutters.
 - 6. Metallic surface pathways.
 - 7. Nonmetallic surface pathways.
 - 8. Hooks.
 - 9. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid conduit.
- C. IMC: Intermediate metal conduit.
- D. RTRC: Reinforced thermosetting resin conduit.

1.4 ACTION SUBMITTALS

- A. Product data for the following:
 - 1. Surface pathways
 - 2. Wireways and fittings.
 - 3. Tele-power poles.
 - 4. Boxes, enclosures, and cabinets.
 - 5. Underground handholes and boxes.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of pathway groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
 - 3. Underground ducts, piping, and structures in location of underground enclosures and handholes.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Data: Provide seismic bracing for all pathway racks, enclosures, cabinets, equipment racks, and their mounting provisions, including those for internal components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
 - 4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.
- D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. Manufacturers:
 - 1. AFC Cable Systems
 - 2. Allied Tube & Conduit
 - 3. Republic Conduit
 - 4. Thomas & Betts
 - 5. Or approved equal.
- C. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- D. GRC: Comply with ANSI C80.1 and UL 6.
- E. ARC: Comply with ANSI C80.5 and UL 6A.
- F. IMC: Comply with ANSI C80.6 and UL 1242.
- G. PVC-Coated Steel Conduit: PVC-coated IMC.

1. Comply with NEMA RN 1.
 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- H. EMT: Comply with ANSI C80.3 and UL 797.
- I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Set screw.
 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.
- B. Manufacturers:
 1. AFC Cable Systems
 2. Carlon
 3. Hubbell Incorp.
 4. Thomas & Betts
 5. Or approved equal.
- C. General Requirements for Nonmetallic Conduits and Fittings:
 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 2. Comply with TIA-569-D.
- D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. Rigid HDPE: Comply with UL 651A.
- F. Continuous HDPE: Comply with UL 651A.
- G. RTRC: Comply with UL 2515A and NEMA TC 14.
- H. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.
- I. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for general-use installation unless otherwise indicated.
- B. Manufacturers:
 - 1. Maxcell
 - 2. Or approved equal.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.
- E. Extend innerduct complete from conduit to fiber distribution unit.
- F. Provide in all backbone conduit.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.
- B. Manufacturers:
 - 1. B-line
 - 2. Hoffman
 - 3. Square D
 - 4. Or approved equal.
- C. General Requirements for Metal Wireways and Auxiliary Gutters:
 - 1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 - 2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 3. Comply with TIA-569-D.
- D. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- E. Wireway Covers: Hinged type unless otherwise indicated.
- F. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- B. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

- C. Manufacturers:
 - 1. Allied Moulded Products
 - 2. Carlon
 - 3. Hoffman
 - 4. Or approved equal.
- D. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- F. Solvents and Adhesives: As recommended by conduit manufacturer.

2.6 SURFACE METAL PATHWAYS

- A. Description: Galvanized steel with snap-on covers, complying with UL 5.
- B. Manufacturers:
 - 1. MonoSystems
 - 2. Pnduit Corp
 - 3. Wiremold
 - 4. Or approved equal.
- C. Finish: Manufacturer's standard enamel finish in color selected by Architect.
- D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- E. Comply with TIA-569-D.

2.7 SURFACE NONMETALLIC PATHWAYS:

- A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.
- B. Manufacturers:
 - 1. Carlon
 - 2. Hubbell
 - 3. Panduit
 - 4. Wiremold
 - 5. Or approved equal.
- C. Finish: Texture and color selected by Architect from manufacturer's standard colors.
- D. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
- E. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

- F. Comply with TIA-569-D.

2.8 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Manufacturers:
 - 1. MonoSystems
 - 2. Panduit Corp
 - 3. Wiremold
 - 4. Or approved equal.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.
- E. Galvanized steel.
- F. J shape.

2.9 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. Manufacturers:
 - 1. Carlon
 - 2. FSR
 - 3. Oldcastle
 - 4. Or approved equal.
- C. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-D.
 - 2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
 - 3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
 - 4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep)
 - 5. Gangable boxes are prohibited.
- D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- H. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, with continuous-hinge cover with flush latch unless otherwise indicated.
 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures:
 - a. Material: Plastic.
 - b. Finished inside with radio-frequency-resistant paint.
 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- J. Cabinets:
 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.
 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
 1. Exposed Conduit: IMC.
 2. Concealed Conduit, Aboveground: IMC.
 3. Underground Conduit: RNC, Type EPC-40-PVC.
 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
 1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: IMC. Pathway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 5. Damp or Wet Locations: IMC.
 6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
 7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT.
 8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT.
 9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.

- C. Minimum Pathway Size: 3/4-inch (21-mm) trade size for copper and aluminum cables, and 1 inch (25 mm) for optical-fiber cables.
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - 3. EMT: Use set-screw, steel fittings. Comply with NEMA FB 2.10.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA/BICSI 568.
 - 3. TIA-569-D.
 - 4. NECA 101
 - 5. NECA 102.
 - 6. NECA 105.
 - 7. NECA 111.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.
- E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- F. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- G. Complete pathway installation before starting conductor installation.
- H. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.

- J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- L. Pathways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
 - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
 - 3. Arrange pathways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from nonmetallic conduit and fittings to RNC, or IMC and fittings before rising above floor.
- M. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- Q. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- S. Cut conduit perpendicular to the length. For conduits of 2-inch (50-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- T. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- U. Surface Pathways:
 - 1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
 - 2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.
 - 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway

section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

- V. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
 - 1. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
 - 2. 1-Inch (25-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- W. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.
- X. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service pathway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- Y. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- Z. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F (55 deg C), and that has straight-run length that exceeds 100 feet (30 m).
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - b. Attics: 135 deg F (75 deg C) temperature change.
 - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
 - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
 2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
 3. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
 4. Space hooks no more than 5 feet (1.5 m) o.c.
 5. Provide a hook at each change in direction.
- BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- DD. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- EE. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- GG. Set metal floor boxes level and flush with finished floor surface.
- HH. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe of less than 6 inches (150 mm) in nominal diameter.
 2. Install backfill as specified in Section 312000 "Earth Moving."
 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete around conduit for a minimum of 12 inches (300 mm) on each side of the coupling.

- b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
- 6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
- 7. Underground Warning Tape: Comply with requirements in Section 270553 "Identification for Communications Systems."

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.5 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 27 05 36
CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Wire-mesh cable tray.
 - 2. Cable tray accessories.
 - 3. Warning signs.
- B. Related Requirements:
 - 1. Section 260536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cable tray.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
 - 2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to sides of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
- C. Delegated-Design Submittal: For seismic restraints.
 - 1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 - 2. Vertical and horizontal offsets and transitions.
 - 3. Clearances for access above and to side of cable trays.
 - 4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
- B. Seismic Qualification Data: Certificates, for cable trays, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.
- B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
 - 2. Component Importance Factor: 1.0.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 WIRE-MESH CABLE TRAY

- A. Manufacturers:
 1. Cablofill CF54 (450WH or 300WH, see drawings and section 2.7)
 2. Or approved equal.
- B. Description:
 1. Configuration: Galvanized-steel wire mesh, complying with NEMA VE 1.
 2. Width: 12 inches (300 mm) unless otherwise indicated on Drawings.
 3. Minimum Usable Load Depth: 2 inches.
 4. Straight Section Lengths: 10 feet (3.0 m), except where shorter lengths are required to facilitate tray assembly.
 5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
 6. Class Designation: Comply with NEMA VE 1.
 7. Splicing Assemblies: Bolted type using serrated flange locknuts.
 8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
- C. Materials and Finishes:
 1. Steel:
 - a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A510 Grade 1008, Carbon Steel.
 - b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
 - c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
 - d. Finish: Factory applied powder-coat enamel paint.
 - 1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
 - 2) Color: White

2.4 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.5 WARNING SIGNS

- A. Comply with requirements for identification in Section 270553 "Identification for Communications Systems."
- B. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

2.6 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA VE 1.

2.7 PART NUMBERS

- A. Preapproved part numbers by school district:

- 1. CABLOFIL INC #CF54/450WH
- 2. CABLOFIL INC #CF54/300WH
- 3. CABLOFIL INC #CABLEXIT100WH
- 4. CABLOFIL INC #FASL 450WH
- 5. CABLOFIL INC #FASL 300WH
- 6. CABLOFIL INC #FASU 450WH
- 7. CABLOFIL INC #FASU 300WH
- 8. CABLOFIL INC #HB 2 KIT WH
- 9. CABLOFIL INC #GNDSB

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure and install seismic restraints.
- G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems."

- H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Support bus assembly to prevent twisting from eccentric loading.
- K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- L. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
- M. Support wire-basket cable trays with center support hangers.
- N. Support center support hangers for wire-basket trays with 1/4-inch- (6-mm-) [3/8-inch- (10-mm-) diameter rods.
- O. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- P. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
- Q. Make changes in direction and elevation using manufacturer's recommended fittings.
- R. Make cable tray connections using manufacturer's recommended fittings.
- S. Seal penetrations through fire and smoke barriers.
- T. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- U. Install cable trays with enough workspace to permit access for installing cables.
- V. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
- W. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
- X. Clamp covers on cable trays installed outdoors with heavy-duty clamps.
- Y. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

- B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch (1800-mm) intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."
- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).
- E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.
- F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections.
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.

3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorquing in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 27 05 36

SECTION 27 05 44
SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections (if available), apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.
- B. Related Requirements:
 - 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items (if available).

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized-steel sheet.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
 - 1. Manufacturers:
 - a. CALPICO
 - b. Pipeline Seal
 - c. Proco
 - d. Or approved equal
 - 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Stainless steel.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 - 1. Manufacturers:
 - a. CALPICO
 - b. Pipeline Seal
 - c. Proco
 - d. Or approved equal

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 27 05 44

FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 SUMMARY

- A. The fire alarm system will consist of a new microprocessor controlled, addressable reporting fire alarm system design and installation, including all components, wiring and conduct required for a completed coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciators, power supplies, and wiring as specified herein.
- B. The design build fire alarm system shall include:
 - 1. Fire alarm system design and installation, including all components, wiring, and conduit.
 - 2. Transmitters for communication with supervising station.
 - 3. Circuits from protected premises to supervising station, including conduit.
 - 4. Replacement and removal of existing fire alarm system components, wiring, and conduit indicated.
 - 5. Maintenance of fire alarm system under contract for specified warranty period.

1.02 RELATED SECTIONS

- A. Section 07 84 00 - Firestopping: Materials and methods for work to be performed by this installer.
- B. Section 08 71 00 - Door Hardware: Electrically operated locks and door holder devices to be monitored and released by fire alarm system.
- C. Section 14 21 23 – Machine Room-Less Electric Traction Elevators: Sensors and interlocks monitored by fire alarm system.
- D. Section 21 05 00 – General Requirements for Fire Suppression: Monitoring by the fire alarm system
- E. Section 23 33 00 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.

1.03 REFERENCE STANDARDS

- A. In addition to those referenced in Division 1, all work shall conform to the following standards and codes (most current edition, revisions, and addenda), where applicable. When a conflict occurs, follow the most stringent requirements:
 - 1. 36 CFR 1191 - Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities; Final Rule; current edition; (ADA Standards for Accessible Design).NFPA 70, National Electrical Code

2. NFPA 70 - National Electrical Code
3. NFPA 72 - National Fire Alarm and Signaling Code American National Standard Institute (ANSI)
4. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures)
5. NFPA 601 - Standard for Security Services in Fire Loss Prevention BICSI

1.04 WORK INCLUDED

- A. Design, provide and install a new fire alarm system consisting of, but not limited to:
1. Main Fire alarm control unit (FACU) unit installed at the primary fire department entrance to the facility.
 2. Audible notification appliances installed, spaced and tapped so as to produce a sound output on alarm that is clearly audible above the ambient noise level in all areas including elevator cabs and stairwells throughout the building. Speakers shall meet the intelligibility requirements of NFPA 72.
 3. Emergency voice/alarm communications system in accordance with requirements of NFPA 72, with not fewer than one audible and one visible notification appliance installed within each occupancy evacuation elevator lobby.
 4. Visible notification appliances installed in all public areas including but not limited to, public restrooms, meeting rooms, classrooms/studios, computer labs, lounge, gallery, corridors, break room, open office, back of house areas and high noise areas and as required by local jurisdiction
 5. Duct smoke detectors in supply, return air, and exhaust air systems as per requirements of NFPA 90 and/or applicable mechanical code.
 6. Area smoke detectors within elevator machine rooms, top of elevator shafts, mechanical, storage and electrical rooms, phone rooms, back of house areas, smoke dampers, magnetically held-open doors at fire rated walls, office spaces and current locations.
 7. System-connected carbon monoxide (CO) detectors in rooms and areas containing fuel burning appliances and equipment CO detectors shall be installed following the manufacturer's recommended instructions. They shall be fully supervised and annunciated at the main fire alarm control panel.
 8. A manual fire alarm pull station at each exit.
 9. Devices, equipment and conductors necessary to monitor special fire suppression systems (if applicable).

10. Conductor and modules necessary to monitor the signals from the sprinkler and standpipe system alarm, and supervisory devices with each device having its own discrete address. Work shall include integration of any sprinkler monitoring points not already integrated into the system.
11. Devices, equipment and conductors necessary to monitor available generator functions in accordance with NFPA 110. These functions should be monitored as supervisory alarms with each device having its own discrete address.
12. Devices, equipment and conductors necessary to transmit alarm, trouble and supervisory signals in a Contact ID format to the central station as required by the local code.
13. Magnetic door holders.
14. Devices, relays, conductors and conduit necessary to monitor elevator status and initiate elevator recall, per NFPA requirements for Occupant Evacuation Elevators.
15. Devices, relays, conductors and conduit necessary to provide speakers and firefighter telephones in each elevator cab.
16. Fire-Fighter's telephone jacks/handsets designed and installed in accordance with NFPA 72 and State Fire Marshal's office. The system shall operate between the fire command center and each stairwell landing and elevator lobby and elevator cab, emergency and standby power rooms, Mechanical rooms, Elevator equipment rooms, fire pump rooms
17. UL listed electrical surge protection for all control equipment including primary power supplies.

1.05 SUBMITTALS

- A. Provide all of the items listed in the Design Documentation, Shop Drawings, and Minimum Required Documentation sections of NFPA 72.
- B. The Contractor's fire alarm shop drawings and product data sheets shall be submitted to the OSU Facilities Alarms Shop for review, including the Architect's/Engineer's review comments/submittal dispositions.
- C. Evidence of designer qualifications. Fire alarm systems shall be designed by a National Institute for Certification in Engineering Technologies (NICET) designer certified at Level III or Level IV in Fire Alarm Systems. The fire alarm designer will also have the necessary credentials as required by the State of Oregon and the City of Klamath Falls.
- 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. Copy (if any) of list of data required by authority having jurisdiction.

2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
 4. System zone boundaries and interfaces to fire safety systems.
 5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
 6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 7. List of all devices on each signaling line circuit, with spare capacity indicated.
 8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
 10. Detailed drawing of graphic annunciator(s).
 11. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
- E. Evidence of installer qualifications.
- F. Evidence of instructor qualifications; training lesson plan outline.
- G. Evidence of maintenance contractor qualifications, if different from installer.
- H. Inspection and Test Reports:
1. Submit inspection and test plan prior to closeout demonstration.
 2. Submit documentation of satisfactory inspections and tests.
 3. Submit NFPA 72 "Inspection and Test Form," filled out.
- I. Operating and Maintenance Data:
1. Original copy of NFPA 72 with portions that are not relevant to this project neatly crossed out by hand; label with project name and date.
 2. Complete set of specified design documents, as approved by authority having jurisdiction.

3. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
4. Contact information for firm that will be providing contract maintenance and trouble call-back service.
5. List of recommended spare parts, tools, and instruments for testing.
6. Replacement parts list with current prices, and source of supply.
7. Detailed troubleshooting guide and large scale input/output matrix.
8. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
9. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.

J. Project Record Documents:

1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
2. "As installed" wiring and schematic diagrams, with final terminal identifications.
3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

K. Closeout Documents:

1. Certification by manufacturer that the system has been installed in compliance with his 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.
4. Maintenance contract.
5. Report on training results.

L. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.

1. Furnish spare parts of same manufacturer and model as those installed; quantities as noted; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.

1.06 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 Owner 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.
 - 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 - 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 - 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
 - 4. Contract maintenance office located within 50 miles of project site.
 - 5. Certified in the State in which the Project is located as fire alarm installer.
- D. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- E. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

1.07 CODES AND PERMITS

- A. Provide all necessary permits and schedule all inspections in a timely manner, so that the fire alarm system is ready for operation on a date directed by the Owner.

1.08 WARRANTY

- A. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.
- B. C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

- A. All material shall be new and UL listed and free from damage or defects. The Contractor shall furnish all materials as required. The Contractor is responsible for furnishing any appropriate material needed for proper installation of the systems.
- B. All fire alarm system components furnished under this contract shall be fully addressable and compatible with the existing University fire alarm system.
- C. Where portions of a building remain occupied during a construction project, the fire alarm system will remain operational throughout the duration of the project. Construction phasing plans or planned fire watch periods will be included in the project design documents.
- D. Coordinate all work with other Contractors working in the building (e.g., adjusting water flow alarm switch retards by the Sprinkler Contractor). Fire alarm contractor to retain all sub-contractors necessary to conduct the work required in the specifications (i.e. sprinkler, elevator, electrical, etc.)

2.02 MANUFACTURER

- A. The new fire alarm system will be manufactured by SimplexGrinnell and be the 4100 Series equipment.

2.03 FIRE ALARM SYSTEM

- A. Provide a new automatic fire detection and alarm system:
 - 1. Provide all components necessary, included but not limited to those noted in this specification.
 - 2. Protected Premises: Entire building shown on drawings.
 - 3. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
 - 4. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital. Not fewer than one audible and one visible notification appliance shall be installed within each occupant evacuation elevator lobby.
 - 5. Hearing Impaired Occupants: Provide visible notification devices in all public areas
 - 6. Fire Command Center: installed at the primary fire department entrance to the facility.
 - 7. Master Control Unit (Panel): The new main Fire Alarm Control Panel (FACP) shall be installed at the primary fire department entrance to the facility.

8. Two-Way Communication: Provide two-way communication system at the lobby of each level served by an occupant evacuation elevator. The two-way communication call stations shall initiate communication to the building's fire command center or an alternate location approved by the AHJ.
9. System shall be designed class "B"
10. Provide a fire alarm transmitter capable of communicating over the campus Ethernet. Provide point identification for all alarm, supervisory and trouble signals as well as all intelligent/addressable devices and appliances.
11. Evaluate feasibility of a smoke detection system design where area smoke detectors are provided for smoke damper and air handler control in lieu of duct mounted smoke detectors.
12. Alarm Verification shall be permitted for smoke detectors where the conditions or activities are anticipated to cause nuisance alarms.
13. Provide FACP software bypass switches for the following points:
 - a. Notification Appliance Bypass
 - b. Fire Sprinkler/Fire Pump Input Bypass
 - c. HVAC Shutdown/FSD Closure/Door Holders Output Bypass
 - d. Elevator Recall/Shunt Trip Input/output Bypass

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. Signaling Line Circuits (SLC) Between Buildings: Class A, Style 2.
4. Notification Appliance Circuits (NAC): Class B, Style W.

C. Spare Capacity:

1. Initiating Device Circuits: Minimum 25 percent spare capacity.
2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
3. Speaker Amplifiers: Minimum 25 percent spare capacity.
4. Master Control Unit: 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.
4. Each Computer System: Provide uninterruptible power supply (UPS).

2.04 FIRE SAFETY SYSTEMS INTERFACES

A. Supervision: Provide supervisory signals, as required, in accordance with NFPA 72 for the following:

1. Sprinkler water control valves.
2. Dry-pipe sprinkler system pressure.
3. Dry-pipe sprinkler valve room low temperature.

B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:

1. Sprinkler water flow.
2. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
3. Duct smoke detectors.

C. Elevators:

1. Provide continuous monitoring of the occupant evacuation elevators at the fire command center or a central control point approved by the fire department and arranged to display all of the following information:
 - a. Floor location of each elevator car.
 - b. Direction of travel of each elevator car.
 - c. Status of each elevator car with respect to whether it is occupied
 - d. Status of normal power to the elevator equipment, machinery, and/or control rooms and associated equipment.
 - e. Status of standby power system that provides backup to the elevator equipment, machinery, and/or control rooms and associated equipment.

- f. Activation of any fire alarm initiating device in any elevator lobby, elevator machine room, machine room space containing a motor controller or electric driving machine, control room or elevator hoist way.
 - 2. The fire command center or an alternate location approved by the fire department shall be provided with the means to manually initiate a Phase I Emergency Recall of the occupant evacuation elevators in accordance with ASME A17.1/CSA B44.
- D. HVAC:
- 1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.
- E. Doors:
- 1. Only the detectors adjacent to fire shutters or elevator smoke doors will activate the door release function.
 - 2. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor.
 - 3. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from.
 - 4. Overhead Coiling Fire Doors: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor.

2.05 COMPONENTS

- A. General:
- 1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
 - 2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
 - 3. All equipment, devices, and appliances to be listed by Underwriters Laboratories as suitable for the purpose intended.
 - 4. All devices installed outdoors or within areas exposed to unconditioned spaces or wet locations shall be listed for "outdoor use." Electrical raceway, fittings and enclosures shall be NEMA Type 4X.
- B. Provide all required components, wiring, and equipment for a complete and operational system. Locate devices as required by current code requirement. Coordinate requirements for integration to building and campus systems. Devices to include, but not limited to:

1. Fire Alarm Control Unit (FACU)
 2. Remote Annunciators
 3. Power Supplies
 4. Initiating Devices, including manual pull stations, key operated pull stations, smoke detectors, duct smoke detectors, heat detectors, addressable interface devices.
 5. Notification appliances, including bells, speakers, strobes.
 6. Provide the following spare parts:
 - a. Fuses – (2) of each size used in the installed system.
 - b. Manual Pull Station – Minimum of one or 2% of total installation
 - c. Spot Type Area Smoke Detector – Minimum of one or 6% of total installation
 - d. Spot Type Heat Detector – Minimum of one or 6% of each type used in the total installation
 - e. Detector Base – Minimum of one or 2% of each type used in the total installation
 - f. Interior Notification Appliance – Minimum of one or 4% of each type used in the total installation
 - g. Exterior Notification Appliance – Minimum of one or 2% of each type used in the total installation
 - h. Intelligent Modules – Minimum of one or 4% of each type used in the total installation
- C. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.
- D. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
1. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
 2. 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.
 3. Signaling Line Circuits: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.

- E. Locks and Keys: Deliver keys to Owner.
 - 1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type
 - 2. Provide a different standard lock and key for each key operated alarm initiating device; provide 25 keys of each type.
- F. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
 - 1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
 - 2. Provide one for each control unit where operations are to be performed.
 - 3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
 - 4. Provide extra copy with operation and maintenance data submittal.
- G. Storage Cabinet: A document storage cabinet will be provided at the main FACP location, or other location as determined by the University. The cabinet will be sized to contain the record drawings, the testing and completion documents, and will contain a permanently mounted electronic storage device for a copy of the FACP resident software, a copy of the programming software (current version), BIN files and any other panel related files, CAD files of as built, and a list of programmed points.

PART 3 EXECUTION

3.01 EXECUTION AND INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and the contract documents.
- B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- C. Obtain Owner's approval of locations of devices, before installation.
- D. Install instruction cards and labels.
- E. Fire alarm system installation shall be supervised by a contractor NICET certified at Level II in Fire Alarm Systems.
- F. Provide a complete metallic raceway for fire alarm systems. Provide minimum 3/4 inch Electrical Metallic Tubing (EMT) for fire alarm wiring. A single cable run to a single device may be installed in 1/2 inch EMT. Provide minimum 4 inch square box for junctions and terminations.
- G. The main FACU and any additional Notification Appliance Circuit (NAC) panels will be connected to standby power branch circuits and provided with transient surge suppression.

- H. All fire alarm notification appliances will operate from one pair of conductors. Exceptions are allowed for Emergency Voice Alarm Communications Systems (EVACS) and for certain weatherproof or hazardous location applications.
- I. Emergency control functions shall have bypass switches located at the FACU.
- J. Door holder circuits will be 24VDC from dedicated, battery backed power supplies. Powering of non-fire alarm loads from the FACU is prohibited.
- K. Duct mounted smoke detectors will report as supervisory alarms at the FACU.
- L. Photoelectric Beam-Type smoke detectors will be provided with remote test capability. The test station will be installed in an accessible location.
- M. Provide isolation modules on Signaling Line Circuits (SLC) serving multiple floors or more than 50 devices on a single floor.
- N. Provide labeling of all devices and appliances with their respective system address. Label to be produced from an electronic labeling system visible from the floor without magnification. Hand written labels are not acceptable.
- O. Provide labeling of all conductors and cables at termination points in panels, cabinets and junction boxes. Label to be produced from an electronic labeling system. Hand written labels are not acceptable.
- P. Roll-down fire doors shall be equipped with electric motor up/motor down controls interfaced with the FACU. Roll-down fire door and Fire Curtains shall be closed only by the nearest smoke detector in alarm on either side of the door. Roll-down fire doors and Fire Curtains shall automatically be restored to the open position upon fire alarm system reset to normal.

3.02 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Owner will provide the services of an independent fire alarm engineer or technician to observe all tests.
- C. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- D. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- E. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- F. Provide all tools, software, and supplies required to accomplish inspection and testing.

- G. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- H. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
- I. 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. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
 - 4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.03 TRAINING

- A. Provide factory training for any untrained Alarms Shop personnel. Training to be provided for both Operator and Technician levels and training hours distributed accordingly. Operator training to include all control panel functions and creation of reports. Technician training to include hardware repair and maintenance by personnel of all building panels, devices, and appliances, diagnostic procedures, system expansion and maintenance techniques. Factory training shall include tuition, travel and lodging.
- B. For control equipment other than that specified in the Division 28 Products section, provide factory sponsored certified technical training for the system installed. This training shall certify two University technicians to maintain, service, and program the installed system. Provide for tuition, transportation and lodging for University technicians to attend this training. Include a subscription for direct manufacturer's technical support for the system

3.04 CLOSEOUT

- A. Provide all of the requirements of the Completion Documentation and Minimum Required Documentation sections of NFPA 72.
- B. Provide the NFPA 72 Inspection, Testing and Maintenance Documentation.
- C. Provide permanently mounted zone map adjacent to each FACU and FAA (fire alarm annunciator). Maps sized to be clearly visible without magnification.
- D. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 - 1. Be prepared to conduct any of the required tests.

2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
 5. Repeat demonstration until successful.
- E. Occupancy of the project will not occur prior to Substantial Completion.
- F. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
1. Specified diagnostic period without malfunction has been completed.
 2. Approved operating and maintenance data has been delivered.
 3. Spare parts, extra materials, and tools have been delivered.
 4. All aspects of operation have been demonstrated to Owner.
 5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
 6. Occupancy permit has been granted.
 7. Specified pre-closeout instruction is complete.
- G. Perform post-occupancy instruction within 3 months after Substantial Completion.

3.05 MAINTENANCE

- A. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.
- B. Provide to Owner, a proposal as an alternate to the base bid, for a maintenance contract for entire warranty period, to include the work described below; include the total cost of contract, proposal to be valid at least until 30 days after date of Substantial Completion.
- C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
 1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.

2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
 3. Record keeping required by NFPA 72 and authorities having jurisdiction.
- D. Provide trouble call-back service upon notification by Owner:
1. Provide on-site response within 2 hours of notification.
 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.

END OF SECTION 28 31 00

SECTION 31 1000 SITE CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Clearing and protection of vegetation.
- B. Removal of existing debris.

1.02 RELATED REQUIREMENTS

- A. Section 01 50 00 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- B. Section 01 57 13 - Temporary Erosion and Sediment 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.
- D. Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.
- E. Section 31 22 00 - Grading: Topsoil removal.
- F. Section 31 22 00 - Grading: Fill material for filling holes, pits, and excavations generated as a result of removal operations.
- G. Section 31 23 23 - Fill: Filling holes, pits, and excavations generated as a result of removal operations.
- H. Section 32 93 00 - Plants: Relocation of existing trees, shrubs, and other plants.
- I. Section 32 93 00 - Plants: Pruning of existing trees to remain.
- J. Reference: Project Geotechnical Design Report as prepared by The Galli Group.

1.03 PROJECT CONDITIONS

- A. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

PART 2 PRODUCTS

2.01 MATERIALS

- A. As specified in Section 31 23 23 - Fill and Backfill

PART 3 EXECUTION

3.01 SITE CLEARING

- A. Comply with other requirements specified in Section 01 70 00.
- B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.02 EXISTING UTILITIES AND BUILT ELEMENTS

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Protect existing structures and other elements that are not to be removed.

3.03 VEGETATION

- A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.

- B. Do not begin clearing until vegetation to be relocated has been removed.
- C. Do not remove or damage vegetation beyond the limits indicated on drawings.
 - 1. Exception: Specific trees and vegetation indicated on drawings to be removed.
- D. Install substantial, highly visible fences at least 4 feet high to prevent inadvertent damage to vegetation to remain:
 - 1. At vegetation removal limits.
 - 2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
 - 3. Around other vegetation to remain within vegetation removal limits.
- E. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.
- F. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
 - 1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
 - 2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 24 inches.
 - 3. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.
- G. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner. Coordinate any such work with Landscape Architect prior to construction.

3.04 DEBRIS

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 31 2200 GRADING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Rough grading the site for parking lots, site structures, building pads, retaining walls, and other necessary items.
- B. Finish grading.

1.02 RELATED REQUIREMENTS

- A. Section 31 10 00 - Site Clearing.
- B. Section 31 23 16 - Excavation.
- C. Section 31 23 16.13 - Trenching: Trenching and backfilling for utilities.
- D. Section 31 23 23 - Fill: Filling and compaction.
- E. Reference: Project Geotechnical Design Report as prepared by The Galli Group.

1.03 SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Oregon, Highway Department standards.

1.05 PROJECT CONDITIONS

- A. Protect above- and below-grade utilities that remain.
- B. Protect plants, lawns, and other features to remain as a portion of final landscaping.
- C. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from grading equipment and vehicular traffic.

PART 2 -PRODUCTS

2.01 MATERIALS

- A. As specified in Section 31 23 23 - Fill.

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. Locate, identify, and protect from damage above- and below-grade utilities to remain.
- D. Notify utility company to remove and relocate utilities.
- E. Provide temporary means and methods to remove all standing or ponding water from areas prior to grading.

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. Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key fill material to slope for firm bearing.
- G. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.
- H. 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 topsoil to be re-used on site; remove remainder from site.
- B. Stockpile subsoil to be re-used on site; remove remainder from site.
- C. Stockpiles: Contractor shall be responsible for identifying and coordinating stockpile locations on site with the project plans; pile depth not to exceed 12 feet; protect from erosion. Coordinate with Owner and Engineer at time of construction as required.

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 indicated - Refer to Landscape Plans as required.
- F. Place topsoil where required to level finish grade.
- G. Place topsoil to thickness as scheduled - Refer to Landscape Plans as required.
- H. Place topsoil during dry weather.
- I. Remove roots, weeds, rocks, and foreign material while spreading.
- J. Near plants spread topsoil manually to prevent damage.
- K. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
- L. Lightly compact placed topsoil.
- M. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.

3.06 CLEANING

- A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.
- B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

SECTION 31 2316.13 TRENCHING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Backfilling and compacting for utilities outside the building to existing private utilities on site or utility main connections.

1.02 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading: Site grading.
- B. Section 31 23 16 - Excavation: Building and foundation excavating.
- C. Section 31 23 23 - Fill: Backfilling at building and foundations.
- D. Section 33 41 00 - Subdrainage: Filter aggregate and filter fabric for foundation drainage systems.
- E. Reference: Project Geotechnical Design Report as prepared by The Galli Group.

1.03 REFERENCE STANDARDS

- A. 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; 2022, with Errata .
- B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).
- C. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)); 2012 (Reapproved 2021).
- D. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2005.

1.04 DEFINITIONS

- A. Finish Grade Elevations: Indicated on drawings.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. Verify that survey bench marks and intended elevations for the Work are as indicated.
- C. Protect plants, lawns, and other features to remain.
- D. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. As specified in Section 31 23 23 - Fill.

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.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. See Section 31 22 00 for additional requirements.
- C. Locate, identify, and protect utilities that remain and protect from damage.
- D. Grade top perimeter of trenching area to prevent surface water from draining into trench. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by the Engineer.

3.03 TRENCHING

- A. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- B. Slope banks of excavations deeper than 5 feet to angle of repose or less until shored.
- C. Do not interfere with 45 degree bearing splay of foundations.
- D. Cut trenches wide enough to allow inspection of installed utilities.
- E. Hand trim excavations. Remove loose matter.
- F. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.
- G. 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.
- H. Remove excavated material that is unsuitable for re-use from site.
- I. Stockpile excavated material to be re-used in area designated in Section 31 22 00.
- J. Remove excess excavated material from site.
- K. Provide temporary means and methods, as required, to remove all water from trenching until directed by the Engineer. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.
- L. 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 Engineer.

3.04 PREPARATION FOR UTILITY PLACEMENT

- A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with Granular 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.

3.05 BACKFILLING

- A. Backfill 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 in accordance with the Project Geotechnical Design Report as prepared by The Galli Group.
- G. Soil Fill: Place and compact materials in equal continuous layers in accordance with the Project Geotechnical Design Report as prepared by The Galli Group.
- H. Compaction densities shall be in accordance with the Project Geotechnical Design Report as prepared by The Galli Group.
- I. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- J. Correct areas that are over-excavated.
 - 1. Thrust bearing surfaces: Fill with concrete.
 - 2. Other areas: Use structural fill, flush to required elevation, compacted to minimum 95 percent of maximum dry density.
- K. Reshape and re-compact fills subjected to vehicular traffic.

3.06 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. Utility Piping, Conduits, and Duct Bank:
 - 1. Bedding: Use granular fill.
 - 2. Cover with granular fill.
 - 3. Fill up to subgrade elevation.
 - 4. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.
- B. At Pipe Culverts:
 - 1. Bedding: Use granular fill.
 - 2. Cover with granular fill.
 - 3. Fill up to subgrade elevation.
 - 4. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.
- C. Over Subdrainage Piping at Foundation Perimeter and Under Slabs:
 - 1. Drainage fill and geotextile fabric: Section 31 2323 and 33 46 00.
 - 2. Fill up to subgrade elevation.

3.07 TOLERANCES

- A. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.08 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 D2922 or ASTM D3017.
- C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor"), AASHTO T 180, or ASTM D698 ("standard Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Tests: In conformance with current Oregon APWA/ODOT Standard Specifications for Construction.

3.09 CLEANING

- A. Leave unused materials in a neat, compact stockpile.
- B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

- C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

SECTION 31 2316 EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavating for building volume below grade, footings, slabs-on-grade, paving, site structures, utilities within the building, and retaining walls.
- B. Trenching for utilities outside the building to utility main connections.
- C. Temporary excavation support and protection systems.

1.02 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.

1.03 RELATED REQUIREMENTS

- A. Section 01 57 13 - Temporary Erosion and Sediment Control: Slope protection and erosion control.
- B. Section 31 22 00 - Grading: Soil removal from surface of site.
- C. Section 31 22 00 - Grading: Grading.
- D. Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.
- E. Section 31 23 23 - Fill: Fill materials, backfilling, and compacting.
- F. Section 33 41 00 - Subdrainage: Filter aggregate and filter fabric for foundation drainage systems.
- G. Reference: Project Geotechnical Design Report as prepared by The Galli Group.

1.04 PROJECT CONDITIONS

- A. Verify that survey bench mark and intended elevations for the Work are as indicated.
- B. Protect plants, lawns, rock outcroppings, and other features to remain.
- C. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

PART 2 PRODUCTS (NOT USED)

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 Owner if any changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. See Section 31 22 00 for topsoil removal.
- C. Locate, identify, and protect utilities that remain and protect from damage.
- D. 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 Engineer.

3.03 TEMPORARY EXCAVATION SUPPORT AND PROTECTION

- A. Excavation Safety: Comply with OSHA's Excavation Standard, 29 CFR 1926, Subpart P.

1. Excavations in stable rock or in less than 5 feet in depth in ground judged as having no cave-in potential do not require excavation support and protection systems.
2. Depending upon excavation depth, time that excavation is open, soil classification, configuration and slope of excavation sidewalls, design and provide an excavation support and protection system that meets the requirements of 29 CFR 1926, Subpart P:
 - a. Sloping and benching systems.
 - b. Support systems, shield systems, and other protective systems.
- B. 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.
- C. Excavation support and protection systems not required to remain in place may be removed subject to approval of Owner or Owner'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.
- B. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- C. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- D. Do not interfere with 45 degree bearing splay of foundations.
- E. Cut utility trenches wide enough to allow inspection of installed utilities.
- F. Hand trim excavations. Remove loose matter.
- G. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 31 23 23.
- H. Provide temporary means and methods, as required, to remove all water from excavations until directed by Engineer. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.
- I. Remove excavated material that is unsuitable for re-use from site.
- J. Stockpile excavated material to be re-used in area designated on site 31 22 00.
- K. Remove excess excavated material from site.

3.05 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 Engineer before placement of foundations.

3.06 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 2323 FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Filling, backfilling, and compacting for building volume below grade, footings, slabs-on-grade, paving, site structures, utilities within the building, and retaining walls.
- 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 03 30 00 - Cast-in-Place Concrete.
- C. Section 31 22 00 - Grading: Site grading.
- D. Section 31 23 16 - Excavation: Removal and handling of soil to be re-used.
- E. Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.
- F. Section 33 41 00 - Subdrainage: Filter aggregate and filter fabric for foundation drainage systems.
- G. Reference: Project Geotechnical Design Report as prepared by The Galli Group.

1.03 REFERENCE STANDARDS

- A. 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; 2022, with Errata .
- B. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2019.
- C. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).
- D. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)); 2012 (Reapproved 2021).
- E. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2005.

1.04 DEFINITIONS

- A. Finish Grade Elevations: Indicated on drawings.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Soil Samples: 10 pounds sample of each type of fill; submit in air-tight containers to testing laboratory.
- C. Materials Sources: Submit name of imported materials source.
- D. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used, including manufactured fill.
- E. Compaction Density Test Reports.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. Verify that survey bench marks and intended elevations for the Work are as indicated.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. All materials shall be in accordance with the Project Geotechnical Design Report as prepared by The Galli Group.

2.02 ACCESSORIES

- A. Geotextile Fabric: Non-biodegradable
 - 1. Non-woven: PROPEX GEOTEX 801 or approved equal with laps per manufacturers specification.
 - 2. Woven: PROPEX GEOTEX 200ST or approved equal with laps per manufacturers specification.
 - 3. Filter: PROPEX GEOTEX 801 or approved equal.
 - 4. Waterproof Membrane: 10 mil. thick by StegoWrap or approved equal installed per manufacturers specification.

2.03 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. Identify required lines, levels, contours, and datum locations.
- B. See Section 31 22 00 for additional requirements.
- C. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.
- D. Verify structural ability of unsupported walls to support imposed loads by the fill.
- E. 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 structural 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 in accordance with the Project Geotechnical Design Report as prepared by The Galli Group.
- G. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- H. 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 structural fill, flush to required elevation, compacted to minimum 95 percent of maximum dry density.
- I. Compaction densities shall be in accordance with the Project Geotechnical Design Report as prepared by The Galli Group.
 - J. Reshape and re-compact fills subjected to vehicular traffic.
 - K. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Engineer. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.04 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 D2922 or ASTM D3017.
- C. 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.
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Tests: In conformance with current Oregon APWA/ODOT Standard Specifications for Construction.
- F. Proof roll compacted fill at surfaces that will be under slabs-on-grade and paving.

3.05 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.

END OF SECTION

**SECTION 32 1123
AGGREGATE BASE COURSES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aggregate base course.
- B. Paving aggregates.

1.02 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading: Preparation of site for base course.
- B. Section 31 23 16.13 - Trenching: Compacted fill over utility trenches under base course.
- C. Section 31 23 23 - Fill: Compacted fill under base course.
- D. Section 32 12 16 - Hot Mix Asphalt Paving: Finish and binder asphalt courses.
- E. Section 32 13 13 - Concrete Paving: Finish concrete surface course.
- F. Section 33 05 13 - Manholes and Structures: Manholes including frames.
- G. Section 33 41 00 - Subdrainage: Filter aggregate and filter fabric for foundation drainage systems.
- H. Reference: Project Geotechnical Design Report as prepared by The Galli Group.

1.03 REFERENCE STANDARDS

- A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm 18 inch.) Drop; 2010.
- B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.
- C. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2012.
- D. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.
- E. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2005.
- F. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2010.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Samples: 10 lb sample of each type of aggregate; submit in air-tight containers to testing laboratory.
- C. Materials Sources: Submit name of imported materials source.
- D. Aggregate Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- E. Compaction Density Test Reports.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. Verify that survey bench marks and intended elevations for the Work are as indicated.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials in accordance with the Project Geotechnical Design Report as prepared by The Galli Group.
- B. Materials in compliance with the current Oregon/APWA Standard Specifications for Construction.
- C. Geotextile Fabric: Non-biodegradable
 - 1. Woven: PROPEX GEOTEX 200ST or approved equal with laps per manufacturers specification.
 - 2. Non-woven: PROPEX GEOTEX 801 or approved equal with laps per manufacturers specification.
 - 3. Filter: PROPEX GEOTEX 801 or approved equal.

2.02 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for general requirements for testing and analysis of aggregate materials.
- B. Where aggregate materials are specified using ASTM D2487 classification, 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 substrate has been inspected, gradients and elevations are correct, and is dry.

3.02 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place aggregate on soft, muddy, or frozen surfaces.

3.03 INSTALLATION

- A. Place aggregate in maximum 8" layers and roller compact to specified density.
- B. Level and contour surfaces to elevations and gradients indicated.
- C. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- D. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for general requirements for field inspection and testing.
- B. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
- C. Results will be evaluated 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").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Tests: In conformance with current Oregon APWA/ODOT Standard Specifications for Construction.

- F. Proof roll compacted aggregate at surfaces that will be under slabs-on-grade and paving.

3.06 CLEANING

- A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION

**SECTION 32 1216
HOT MIX ASPHALT PAVING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single course asphalt concrete paving.
- B. Double course asphalt concrete paving.

1.02 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading: Preparation of site for paving and base.
- B. Section 31 23 23 - Fill: Compacted subgrade for paving.
- C. Section 32 11 23 - Aggregate Base Courses: Aggregate base course.
- D. Section 32 13 13 - Concrete Paving: Concrete curbs.
- E. Section 32 17 13 - Parking Bumpers: Concrete or recycled rubber bumpers.
- F. Section 32 17 23.13 - Painted Pavement Markings: Painted markings.
- G. Section 33 05 13 - Manholes and Structures: Manholes, including frames; gutter drainage grilles, covers, and frames for placement by this section.
- H. H.Reference: Project Geotechnical Design Report as prepared by The Galli Group.

1.03 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Oregon Highways standard.
- B. Mixing Plant: Complying with State of Oregon Highways standard.
- C. Obtain materials from same source throughout.

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable code for paving work on public property. Coordinate all work within Public Right-of-Way with City/County inspector or ODOT.

1.05 FIELD CONDITIONS

- A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees Fahrenheit, or surface is wet or frozen.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Aggregate Materials shall conform with Oregon Standard Specifications for Construction - Section 00744.10.
- B. Asphalt Cement shall conform with Oregon Standard Specifications for Construction - Section 00744.11.
- C. Mix Type and Broadband Limits shall conform with Oregon Standard Specifications for Construction - Section 00744.12.
- D. Job Mix Formula (JMF) Requirements: Job mix formula requirements shall conform with Oregon Standard Specifications for Construction - Section 00744.13.
- E. Tolerances and Limits: Tolerance and limits shall conform with Oregon Standard Specifications for Construction - Section 00744.14.
- F. HMAC Acceptance: HMAC acceptance shall conform with Oregon Standard Specifications for Construction - Section 00744.17.
- G. Asphalt Cement: PG 64-22.
- H. Aggregate for Base Course: In accordance with State of Oregon Highways standards.

2.02 EQUIPMENT

- A. Compactors: Compactors shall conform with Oregon Standard Specifications for Construction - Section 00744.24.

2.03 LABOR

- A. Quality Control Personnel: Provide quality control personnel in accordance with Oregon Standard Specifications for Construction - Section 00744.30.

2.04 ASPHALT PAVING MIXES AND MIX DESIGN

- A. Base Course: State of Oregon Highways standards, Level 2, 1/2" dense graded
- B. Wearing Course: State of Oregon Highways standards, Level 2, 1/2" dense graded
- C. Submit proposed mix design for review prior to beginning of work.

2.05 SOURCE QUALITY CONTROL

- A. Test mix design and samples in accordance with ODOT/APWA Standard Specifications for Construction..

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 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 other vertical edges.
- D. Coat surfaces of manhole frames with oil to prevent bond with asphalt pavement. Do not tack coat these surfaces.

3.03 PLACING ASPHALT PAVEMENT - SINGLE COURSE

- A. Install Work in accordance with State of Oregon Highways standards.
- B. Place asphalt to per plan inch compacted thickness per plan inch compacted thickness.
- C. Install gutter drainage grilles and frames in correct position and elevation.
- D. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- E. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.04 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

- A. Place asphalt binder course within 24 hours of applying primer or tack coat.
- B. Place asphalt binder course to one-half total inch compacted thickness one-half total inch compacted thickness.
- C. Place asphalt wearing course within two hours of placing and compacting binder course.
- D. Place asphalt wearing course to one-half total inch compacted thickness one-half total inch compacted thickness.
- E. Install gutter drainage grilles and frames in correct position and elevation.
- F. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- G. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.05 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 1/4 inch.

3.06 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 ODOT/APWA Standards.

3.07 PROTECTION

- A. Immediately after placement, protect pavement from mechanical injury for 5 days or until surface temperature is less than 140 degrees Fahrenheit.

END OF SECTION

SECTION 32 1313 CONCRETE PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concrete sidewalks, stair steps, integral curbs, gutters, parking areas, and retaining walls.
- B. Cast in place paving and retaining walls: Specialty color and finishes.

1.02 RELATED REQUIREMENTS

- A. Section 03 10 00 - Concrete Forming and Accessories.
- B. Section 03 30 00 - Cast-in-Place Concrete.
- C. Section 31 22 00 - Grading: Preparation of site for paving and base and preparation of subsoil at pavement perimeter for planting.
- D. Section 31 23 23 - Fill: Compacted subbase for paving.
- E. Section 32 11 23 - Aggregate Base Courses: Aggregate base course.
- F. Section 32 12 16 - Hot Mix Asphalt Paving: Asphalt single and double course.
- G. Section 32 17 13 - Parking Bumpers: Concrete and/or rubber parking bumpers.
- H. Section 32 17 26 - Tactile Warning Surfacing: Plastic and/or cast iron tactile detectable warning tiles for pedestrian walking surfaces.
- I. Section 33 05 13 - Manholes and Structures: Manholes, including frames; gutter drainage grilles, covers, and frames for placement by this section.
- J. Reference: Project Geotechnical Design Report as prepared by The Galli Group.

1.03 REFERENCE STANDARDS

- A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; 1991 (Reapproved 2009).
- B. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000.
- C. ACI 305R - Hot Weather Concreting; 2010.
- D. ACI 306R - Cold Weather Concreting; 2010.
- E. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement; 2015.
- F. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2015.
- G. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2013.
- H. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2015a.
- I. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2015.
- J. ASTM C150/C150M - Standard Specification for Portland Cement; 2015.
- K. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2014.
- L. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a.
- M. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2011.
- N. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2013.
- O. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2015.

- P. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2014.
- Q. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 2004 (Reapproved 2013).
- R. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction; 2004a (Reapproved 2013).

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on joint filler, admixtures, and curing compound.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301.
- B. Follow recommendations of ACI 305R when concreting during hot weather.
- C. Follow recommendations of ACI 306R when concreting during cold weather.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. A. Do not place concrete when base surface temperature is less than 40 degrees Fahrenheit, or surface is wet or frozen.

PART 2 PRODUCTS

2.01 PAVING ASSEMBLIES

- A. Comply with applicable requirements of ACI 301.
- B. Concrete Curbs and Sidewalks: 3,500 psi 28 day concrete, 4 inches thick, buff color Portland cement, trowel finish.
- C. Parking/Driving Area Pavement: 4,000 PSI 28 day concrete, 6" thick, reinforcing per plan, trowel finish.
- D. Retaining Walls: As indicated per plans.

2.02 FORM MATERIALS

- A. Form Materials: As specified in Section 03 10 00, comply with ACI 301.
- B. Joint Filler: Preformed; non-extruding bituminous type (((ASTM D1751))) or sponge rubber or cork (((ASTM D1752))).
 - 1. Thickness: 3/8 inch.

2.03 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 60,000 psi yield strength; deformed billet steel bars; unfinished.
- B. Steel Welded Wire Reinforcement: Plain type, ASTM A1064/A1064M; in flat sheets; unfinished.
- C. Dowels: ASTM A615/A615M, Grade 40 - 40,000 psi yield strength; deformed billet steel bars; unfinished finish.

2.04 CONCRETE MATERIALS

- A. Obtain cementitious materials from same source throughout.
- B. Concrete Materials: As specified in Section 03 30 00.

2.05 ACCESSORIES

- A. Curing Compound: ASTM C309, Type 1, Class A.

2.06 CONCRETE MIX DESIGN; STANDARD COLORS AND FINISHES

- A. 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 Engineer for preparing and reporting proposed mix designs.
- B. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.
- C. Concrete Properties:
 - 1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; 3,500 psi. (unless noted otherwise).
 - 2. For concrete surfaces in areas supporting vehicular traffic, such as roadway aprons and loading zones, the concrete shall have a low to moderate flexural strength (modulus of rupture: 550 psi. This property shall be identified in the mix design.
 - 3. Total Air Content: 6 percent, determined in accordance with ASTM C173/C173M.
 - 4. Maximum Slump: 4 inches.
 - 5. Maximum Aggregate Size: 3/4 inch.

2.07 CONCRETE MIX DESIGN; SPECIALTY COLORS AND FINISHES

- A. 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 Engineer for preparing and reporting proposed mix designs.
- B. Davis Color Additive: upon approval of sample, or approved.
 - 1. Rate of application by manufacturer, to be confirmed via mock-up.
 - 2. Colors: Pebble #641
- C. Other Admixtures: Add acceptable admixtures as recommended by integral color manufacturer.
- D. Finish: Chemical Surface Retarder
 - 1. ACC Top Face Surface Retarder: Micro Finish (05) – Sand Finish Exposure, or approved.
- E. Concrete Properties:
 - 1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; 3,500 psi. (unless noted otherwise)
 - 2. Total Air Content: 6 percent, determined in accordance with ASTM C173/C173M.
 - 3. Maximum Slump: 4 inches.
 - 4. Maximum Aggregate Size: 3/4 inch.

2.08 MIXING

- A. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify compacted granular base 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.

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 Engineer 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. Hold top of pre-molded joint filler down 1/2" and seal upper 3/8" with approved joint seal material.

3.05 REINFORCEMENT

- A. Place reinforcement as indicated.
- B. Interrupt reinforcement at contraction joints.
- C. Place dowels to achieve pavement and curb alignment as detailed.

3.06 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.
- C. Place concrete continuously over the full width of the panel and between predetermined construction joints.
- D. Place concrete to specified pattern.

3.07 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.
- D. Install joints as specified on the plan set.

3.08 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. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.09 TOLERANCES

- A. Maximum Variation of Surface Flatness: 1/4 inch in 10 feet
- B. Maximum Variation From True Position: 1/4 inch.

3.10 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.

3.11 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.

END OF SECTION

SECTION 32 1713 PARKING BUMPERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Precast concrete parking bumpers and anchorage.
- B. Recycled rubber parking bumpers and anchorage.

1.02 REFERENCE STANDARDS

- A. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2024.
- B. ASTM C150/C150M - Standard Specification for Portland Cement; 2024.
- C. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2024.
- D. ASTM C330/C330M - Standard Specification for Lightweight Aggregates for Structural Concrete; 2023.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide unit configuration, dimensions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Parking Bumpers: Precast concrete, complying with the following:
 - 1. Nominal Size: 4-6 inches high, 6-8 inches wide, 5-6 feet long.
 - 2. Cement: ASTM C150/C150M, Portland Type I - Normal; white color.
 - 3. Concrete Materials: ASTM C330/C330M aggregate, water, and sand.
 - 4. Reinforcing Steel: ASTM A615/A615M, deformed steel bars; unfinished, strength and size commensurate with precast unit design.
 - 5. Air Entrainment Admixture: ASTM C260/C260M.
 - 6. Concrete Mix: Minimum 5,000 psi compressive strength after 28 days, air entrained to 5 to 7 percent.
 - 7. Use rigid molds, constructed to maintain precast units uniform in shape, size and finish. Maintain consistent quality during manufacture. Embed reinforcing steel, and drill or sleeve for two dowels.
 - 8. Cure units to develop concrete quality, and to minimize appearance blemishes such as non-uniformity, staining, or surface cracking. Minor patching in plant is acceptable, providing appearance of units is not impaired.
- B. Parking Bumpers: Recycled rubber, conforming to the following:
 - 1. Nominal Size: 4-6 inches high, 6-8 inches wide, 5-6 feet long.
 - 2. 100% recycled plastic and/or rubber that will not crack.
 - 3. Impervious to salt, oil, gasoline, and other road chemicals.
 - 4. Optional colors available for ADA parking spaces (blue).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install units without damage to shape or finish. Replace or repair damaged units.
- B. Install units in alignment with adjacent work per manufacturers specifications.
- C. Fasten units in place with 3 dowels per unit.

END OF SECTION

**SECTION 32 1723.13
PAINTED PAVEMENT MARKINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Parking lot markings, including parking bays, crosswalks, arrows, handicapped symbols, and curb markings.
- B. Roadway lane markings and crosswalk markings.
- C. "No Parking - Fire Lane" curb painting.

1.02 RELATED REQUIREMENTS

- A. Section 32 12 16 - Hot Mix Asphalt Paving.
- B. Section 32 13 13 - Concrete Paving.

1.03 REFERENCE STANDARDS

- A. FHWA MUTCD - Manual on Uniform Traffic Control Devices; 2023.
- B. FS TT-P-1952 - Paint, Traffic and Airfield Marking, Waterborne; 2015f (Validated 2020).
- C. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; Current Edition.

1.04 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, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Certificates: Submit for each batch of paint and glass beads stating compliance with specified requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint in containers of at least 5 gallons accompanied by batch certificate.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.06 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.07 EXTRA MATERIALS

- A. See Section 01 60 00 - Product Requirements, for additional provisions.
- B. Supply 2 containers of each color for Owner's use.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Line and Zone Marking Paint: MPI (APL) No. 97 Latex Traffic Marking Paint; color(s) as indicated.
 - 1. Parking Lots: White.
 - 2. Handicapped Symbols: Blue.
 - 3. Crosswalks: White.
 - 4. Fire Lane: Red with White text.
- B. Paint For Obliterating Existing Markings: FS TT-P-1952; black for bituminous pavements, gray for Portland cement pavements.

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 Engineer of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Clean surfaces thoroughly prior to installation.
 - 1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
 - 2. Completely remove rubber deposits, existing paint markings, and other coatings adhering to the pavement, by scraping, wire brushing, sandblasting, mechanical abrasion, or approved chemicals.
- D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.
- E. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.
- F. Temporary Pavement Markings: When required or directed by Engineer, apply temporary markings of the color(s), width(s) and length(s) as indicated or directed.
 - 1. After temporary marking has served its purpose, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method so that surface to which the marking was applied will not be damaged.

3.03 INSTALLATION

- A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.
- B. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.
- C. Comply with FHWA MUTCD manual (<http://mutcd.fhwa.dot.gov>) for details not shown.
- D. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.
- E. Apply uniformly painted markings of color(s), lengths, and widths as indicated on drawings true, sharp edges and ends.
 - 1. Apply paint in two coats.
 - 2. Wet Film Thickness: 0.015 inch, minimum.
 - 3. Width Tolerance: Plus or minus 1/8 inch.
- F. Roadway Traffic Lanes: Use suitable mobile mechanical equipment that provides constant agitation of paint and travels at controlled speeds.
 - 1. Conduct operations in such a manner that necessary traffic can move without hindrance.
 - 2. Place warning signs at the beginning of the wet line, and at points well in advance of the marking equipment for alerting approaching traffic from both directions. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic.
 - 3. If paint does not dry within expected time, discontinue paint operations until cause of slow drying is determined and corrected.

4. Skip Markings: Synchronize one or more paint "guns" to automatically begin and cut off paint flow; make length of intervals as indicated.
 5. Use hand application by pneumatic spray for application of paint in areas where a mobile paint applicator cannot be used.
- G. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.
1. Mark the International Handicapped Symbol at indicated parking spaces.
 2. Hand application by pneumatic spray is acceptable.
- H. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.04 DRYING, PROTECTION, AND REPLACEMENT

- A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.
- B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.
- C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.
- D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.
- E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method.
- F. Replace removed markings at no additional cost to Owner.

END OF SECTION

**SECTION 32 1726
TACTILE WARNING SURFACING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tactile and detectable warning tiles for pedestrian walking surfaces.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for sidewalks and platforms.
- B. Section 32 13 13 - Concrete Paving: Concrete sidewalks.
- C. Section 32 17 23.13 - Painted Pavement Markings: Crosswalk and curb markings.

1.03 REFERENCE STANDARDS

- A. 49 CFR 37 - Transportation Services for Individuals with Disabilities (ADA); current edition.
- B. AASHTO LRFD - Bridge Design Specifications; 2024.
- C. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- D. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- E. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.
- F. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2019.
- G. ASTM C501 - Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser; 2021.
- H. ASTM C903 - Standard Practice for Preparing Refractory Specimens by Cold Gunning; 2015 (Reapproved 2020).
- I. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents; 2021.
- J. ASTM D2047 - Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine; 2025.
- K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- L. ASTM G155 - Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials; 2021.
- M. ATBCB PROWAG - Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way; 2023.

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
- D. Warranty: Submit manufacturer warranty; complete forms in Owner's name and register with manufacturer.

1.05 QUALITY ASSURANCE

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

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Cast Iron Tiles: Provide manufacturer's standard ten year warranty against manufacturing defects, breakage or deformation.
- C. Plastic Tiles: Provide manufacturer's standard five year warranty against manufacturing defects, breakage or deformation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Plastic Tactile and Detectable Warning Surface Tiles:
 - 1. Access Tile, a brand of Access Products, Inc.: www.accesstile.com
 - 2. ADA Solutions, Inc.: www.adatile.com
 - 3. Armor-Tile, a brand of Engineered Plastics, Inc.: www.armortiletransit.com
- B. Cast Iron Detectable Warning Plates:
 - 1. ADA Solutions, Inc.: www.adatile.com
 - 2. EJ: www.ejco.com
 - 3. Neenah Foundry, a division of Neenah Enterprises, Inc.: www.nfco.com

2.02 TACTILE AND DETECTABLE WARNING DEVICES

- A. Plastic Tactile and Detectable Warning Tiles: ADA Standards compliant, glass fiber and carbon fiber reinforced, exterior grade, matte finish polyester sheet with truncated dome pattern, solid color throughout, internal reinforcing of sheet and of truncated domes, integral radius cut lines on back face of tile; with factory-applied removable protective sheeting.
 - 1. Material Properties:
 - a. Slip Resistance: 0.50 minimum dry static coefficient of friction, when tested in accordance with ASTM D2047.
 - b. Chemical Stain Resistance: No reaction to 1 percent hydrochloric acid, motor oil, calcium chloride, gum, soap solution, bleach, or antifreeze, when tested in accordance with ASTM D543.
 - c. Abrasion Resistance: 300, minimum, when tested in accordance with ASTM C501.
 - d. Flame Spread Index: 25, maximum, when tested in accordance with ASTM E84.
 - e. Accelerated Weathering: Delta-E of less than 5.0 at 2,000 hours exposure, when tested in accordance with ASTM G155.
 - f. Adhesion: No delamination of tile prior to board failure in a temperature range of 20 to 180 degrees Fahrenheit, when tested in accordance with ASTM C903.
 - g. Loading: No damage when tested according to AASHTO LRFD test method HS20.
 - h. Salt and Spray Performance: No deterioration or other defect after 200 hours of exposure, when tested in accordance with ASTM B117.
 - 2. Installation Method: Cast in place.
 - 3. Shape: Rectangular.
 - 4. Square Dimensions: per plan inches by per plan inches.
 - 5. Pattern: In-line pattern of truncated domes complying with ADA Standards.
 - 6. Edge: Square.

7. Joint: Butt.
 8. Color: As selected by Engineer from manufacturer's standard range.
- B. Cast Iron Detectable Warning Plates:
1. Material: Cast gray iron; ASTM A48/A48M, Class 30 A (minimum).
 2. Installation Method: Cast in place.
 3. Shape: Rectangular.
 4. Square Dimensions: per plan inches by per plan inches.
 5. Pattern: Truncated cones in compliance with ADA Standards.
 6. Joint: Manufacturer standard, bolted connection.
 7. Finish: Manufacturer's factory-applied powder coat.
 8. Color: As selected by Engineer from manufacturer's standard range.

2.03 ACCESSORIES

- A. Fasteners: ASTM A666, 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. Adhesive: Type recommended and approved by surfacing tile manufacturer.
- C. 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. If existing conditions are not as required to properly complete the work of this section, notify Engineer.
 2. Do not proceed with installation until deficiencies in existing conditions have been corrected.
- C. Verify that dimensions, tolerances, and attachment methods for work in this section are properly coordinated with other work on site.

3.02 INSTALLATION, GENERAL

- 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 Fahrenheit during the preceding 8 daylight hours.
- B. Field Adjustment:
1. Locate relative to curb line in compliance with ATCB 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.

3.03 INSTALLATION, CAST IN PLACE PLASTIC TILES

- A. Concrete:
1. See Section 03 30 00.
 2. Slump: 4 to 7 percent.
- B. Tamp and vibrate units as recommended by manufacturer.
- C. Place and position weights on units while concrete cures as recommended by manufacturer. Ensure no voids or air pockets exist between top surface of concrete and underside of units.

3.04 INSTALLATION, SURFACE APPLIED PLASTIC TILES

- A. Cure concrete surfaces for a minimum of 4 days before installing units.

- B. Mechanically roughen surface as required to remove contaminants and prepare surface for adhesive and sealant application.
- C. Drill fastener holes straight, true and to depth recommended by manufacturer.
- D. Apply adhesive to back of unit as recommended by manufacturer.
- E. Mechanically fasten to substrate. Avoid striking or damaging the unit itself during installation.
- F. Apply sealant to edges in cove profile.

3.05 INSTALLATION - CAST IN PLACE, CAST IRON PLATES

- A. Install by method described in manufacturer's written instructions.
- B. Place units into wet concrete.
- C. Press assembly into concrete to achieve final elevation.
- D. Finish concrete adjacent to plate. Remove wet concrete spilled onto plate surface.

3.06 CLEANING PLASTIC UNITS

- A. Remove protective plastic sheeting within 24 hours of installation.
- B. Remove excess sealant or adhesive from joints and edges.
- C. Clean 2 days prior to date of scheduled inspection.

3.07 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 1816.13
PLAYGROUND PROTECTIVE SURFACING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Protective surfacing for playground area.
- B. Subbase under resilient surfacing.

1.02 REFERENCE STANDARDS

- A. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2019.
- B. ASTM F1292 - Standard Specification for Impact Attenuation of Surfacing Materials Within the Use Zone of Playground Equipment; 2022.
- C. ASTM F1487 - Standard Consumer Safety Performance Specification for Playground Equipment for Public Use; 2021.
- D. ASTM F2075 - Standard Specification for Engineered Wood Fiber for Use as a Playground Safety Surface Under and Around Playground Equipment; 2020.
- E. CPSC Pub. No. 325 - Public Playground Safety Handbook; 2015.

1.03 DEFINITIONS

- A. Use Zone: The area beneath and immediately adjacent to a play structure or equipment (play event) that is designated for unrestricted circulation around equipment, and on whose surface it is predicted that a user would land when falling from or exiting the equipment.
- B. Critical Fall Height: The maximum fall height at which the protective surfacing meets the requirements of ASTM F1292.
- C. Fall Height: The vertical distance between the finished elevation of the designated play surface and the finished elevation of the protective surfacing beneath it as defined by ASTM F1487.
- D. Protective Surfacing: Resilient ground surfacing. The characteristics of the protective surfacing are based on the fall height of the playground equipment. Changes in either the surfacing or the fall height, particularly reducing the resilience of the protective surfacing or increasing the fall height, will reduce safety-related performance.
- E. Subbase: A layer under the resilient layer of the protective surfacing but over the subgrade; may be rigid, as in concrete or bituminous, or aggregate.
- F. Subgrade: The surface of the ground on which the protective surfacing is installed.

1.04 SUBMITTALS

- A. Product Data: For all manufactured surfacing products, provide manufacturer's product data showing materials of construction, compliance with specified standards, installation procedures, and safety limitations.
 - 1. Include IPEMA certifications where required.
- B. Product Data: For natural surfacing materials, provide supplier's certification or mill certificate showing compliance with specified requirements.
- C. Shop Drawings: Detailed scale drawings showing locations of existing playground equipment and exposed footings, bases, and anchorage points.
 - 1. Clearly identify footing and base elevations in relation to a fixed survey point on site and to subgrade elevation and depth of protective surfacing, surveyed by land surveyor licensed in the State in which the Project is located.
 - 2. Show locations of underground utilities, storm-drainage system and irrigation system.
 - 3. Show locations of related construction such as walkways and roadways, fences, site furnishings, and plantings.

4. Show measured fall height for each playground equipment item, determined in accordance with ASTM F1487.
5. Show Use Zone perimeters, determined in accordance with ASTM F1487.
- D. Samples: For each product for which color must be selected provide color chart showing full range of colors.
Samples: Provide actual material samples for the following:
 1. Engineered wood fiber surfacing.
 2. Poured in place playground surfacing.
 3. Playground equipment samples.
- E. Percolation Test Report: Describing test method used and results.
- F. Maintenance Data:
 1. For manufactured surfacing products, provide manufacturer's recommended maintenance instructions and list of repair products, with address and phone number of source of supply.
 2. For loose fill surfacing products, provide detailed re-ordering information to enable Owner to match installed material exactly.
- G. Manufacturer's Field Report.

1.05 QUALITY ASSURANCE

- A. Maintain one copy of the latest edition of ASTM F1487 and CPSC Pub. No. 325 at project site.
- B. Manufacturer Qualifications: Company regularly engaged in manufacturing products specified in this section, with not less than three years of documented experience.
 1. Surfacing installed in minimum 10 sites and been in successful service minimum 5 years.
 2. Provide certificate of Insurance AA rated for minimum 1,000,000 dollars covering both product and general liability.
 3. Manufacturer's Representative: Provide name, company name and address, and qualifications.
- C. Installer Qualifications: Company certified by manufacturer for training and experience installing the protective surfacing; provide installer's company name and address, and training and experience certificate.

1.06 PRE-INSTALLATION MEETING

- A. Convene a meeting one week before starting earthwork for playground to discuss coordination between various installers.
 1. Require attendance by personnel responsible for grading and installers of playground equipment, protective surfacing, footings, and adjacent work.
 2. Include representatives of Contractor.
 3. Notify Engineer of Record at least 2 weeks prior to meeting.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store protective surfacing to project site in accordance with manufacturer's recommendations.
- B. Store materials in a dry, covered area, elevated above grade.

1.08 WARRANTY

- A. Poured in place surface shall maintain required impact attenuation characteristics and be guaranteed against defects in workmanship and material for a limited five-year period. Warranty will be specific to maintenance requirements and performance standards of completed product. Warranty is void if not installed by Manufacturer's Trained and Certified Poured in Place Surfacing Installers.

PART 2 PRODUCTS

2.01 PERFORMANCE CRITERIA

- A. Because the safety of the playground depends on strict compliance with the performance criteria, this information is provided for Contractor's information.
 - 1. The total depth available for protective surfacing, from surface of subgrade, is indicated on drawings.
 - 2. The top elevation of the protective surfacing is intended to be flush with adjacent grades.
 - 3. Use Zone: The protective surfacing has been designed to provide acceptable impact attenuation as defined in ASTM F1292 for Critical Height per manufacturer.
- B. If deviation from specified depth is required, it is the Contractor's responsibility to make all changes required to maintain specified top elevation and required impact attenuation at no extra cost to Owner; obtain approval prior to proceeding; follow approval request procedure as specified for substitutions.

2.02 MATERIALS

- A. Poured-In-Place Membrane Surfacing: Weather-resistant wear layer over impact attenuating substrate over rigid subbase.
 - 1. Wear Layer: Ethylene propylene diene monomer (EPDM) granules with polyurethane binder formulated to produce an even, uniform, seamless surface.
 - a. EPDM shall be peroxide cured with an EPDM content of 26% and shall include a processing aid to prevent hardness with 26% poly content to maintain dynamic testing characteristics, weatherization and UV stability.
 - b. ASTM D2240 (Shore A) hardness of 55-65, not less than 26% rubber hydrocarbons.
 - c. Size of EPDM granules shall be 1-4mm across. Binder shall be not less than 20% of total weight of rubber used in the wear surface and shall provide 100% coating of the particles.
 - d. The wear course shall be porous.
 - e. Wear Layer Thickness: As indicated on drawings.
 - f. Coefficient of Friction, when wet: 0.8, minimum, when tested in accordance with ASTM D2047.
 - g. Wear Layer Color(s): As indicated on drawings.
 - 2. Impact Attenuating Substrate: 100 percent recycled shredded styrene butadiene rubber (SBR) shreds or granules with 100 percent solids polyurethane binder to form a resilient material; do not use foam rubber.
 - a. Strands of SBR may vary from 0.5mm - 2.0mm in thickness by 3.0mm - 20mm in length.
 - b. Chunk Premium Black Rubber Granules are 5/8" granules: This rubber shall be pre-consumer, post-industrial, reclaimed rubber, granulated through a 5/8" screen and containing less than 2% dust.
 - c. SBR Crumb Rubber (5-9 Mesh) using sieve analysis ASTM D5644 with a fiber content of .1% or less mixed in.
 - d. Binder shall be between 7-12% of the total weight of the material and shall provide 100% coating of the particles.
 - e. The attenuation cushion layer shall be compatible with the wear course and must meet requirements herein for impact attenuation.
 - 3. Resilient Depth: As required to achieve specified Critical Fall Height as defined in ASTM F1292 but not more than depth indicated; maintain top elevation flush with adjacent grades.
 - 4. Certification: Provide IPEMA certification of ASTM F1292 Critical Fall Height at thickness specified.
 - 5. Manufacturers:
 - a. Robertson Industries, Inc. manufactured and installed by Robertson Industries Inc. or it's Certified Installers. Telephone (800) 858-0519.
 - 6. Accessories: Tot Turf Advantage Inserts

- a. Insert - Thermal Plastic Vulcanized angular granules with a (Shore A) hardness of 65°A +/- 5 and particle size between .5-1.5mm shall be used.
 - b. Thickness of the insert shall be .5"
 - c. Insert shall be porous.
 - d. Aromatic or aliphatic urethane to be used as a bi
 - e. Location - Insert to be installed under swings, swing bays, slide exits (unless otherwise noted in drawings). Customer to approve location of wear mat inserts.
 - f. Standard Color .5-1.5mm to be used. Color as shown on drawings.
 - g. Size - Swing bay use locations shall have TPV Inserts inclusive of all outside bay structure poles. Singular swings and slide exits shall be 4'x4'x.5" in thickness.
- B. Engineered Wood Fiber Fill: Manufactured for the purpose of protective surfacing; complying with ASTM F2075; do not use mulch manufactured from recycled pallets, or lumber containing nails or metal fasteners.
- 1. Depth: As required to achieve specified Critical Fall Height as defined in ASTM F1292 but not more than depth indicated; maintain top elevation flush with adjacent grades.
 - 2. Certification: Provide IPEMA certification of ASTM F1292 Critical Fall Height at thickness specified.

PART 3 EXECUTION

3.01 SITE PREPARATION

- A. Measure the location of all playground elements, including perimeter of safety surfacing.
- B. Stake the layout of the entire Use Zone perimeter before starting any work, based on manufacturer's instructions.
 - 1. Verify that Use Zone perimeters do not overlap hard surfaces, whether currently installed or not.
 - 2. If overlaps exist, notify Engineer of Record.
 - 3. Do not proceed until revised drawings have been provided, showing corrected layout.
- C. Inside Use Zones remove all obstructions that would extend into the resilient protective surfacing.
- D. Make surface of subgrade smooth and evenly sloped.
 - 1. Fill holes and depressions with borrow from same area or soil of similar type.
 - 2. Make changes to grades as indicated on drawings.
- E. After subgrade is correct, mark intended depth of surfacing on the base supports of each item of playground equipment using paint or tape in a manner that will be easily verifiable during installation of surfacing.
- F. Perform percolation test at the lowest elevation of the subgrade in the areas to be covered by protective surfacing.
 - 1. Report results to Engineer of Record.
 - 2. If percolation is less than 1 inch in a 3 hour period, do not proceed.

3.02 EXAMINATION

- A. Playground equipment installer will perform playground layout prior to installation of footings; verify correctness of layout before starting this work.
- B. Verify that playground equipment and site furnishings and irrigation system located within playground area are complete.
- C. Verify location of underground utilities and facilities in the playground area. Damage to underground utilities and facilities will be repaired at Contractor's expense.
- D. Verify that subgrades are at proper elevations and that smooth grading is complete.
- E. Verify that proper depth of surfacing is marked on base supports of playground equipment.

3.03 PREPARATION

- A. Correct subgrade irregularities to ensure that required depth of protective surfacing can be installed, and subgrade elevation is in accordance with manufacturer's requirements.
- B. Inside Use Zones remove all obstructions that would extend into the resilient protective surfacing.
- C. Remove rocks, debris, and other similar items.
- D. Install containment curbs with top surface flush with intended elevation of top surface of protective surfacing.

3.04 SUBBASE

- A. Install aggregate subbase as indicated on drawings.
- B. Install with top surface of subbase no higher than grades and levels indicated and not more than 1/4 inch lower than grades and levels indicated.
- C. Install in true, even plane, sloped to provide positive drainage.
- D. Flatness Tolerance: 1/4 inch in 10 feet, maximum.

3.05 RESILIENT SURFACING LAYER

- A. Install in accordance with CPSC Pub. No. 325, ASTM F1487, manufacturer's instructions, and requirements of authorities having jurisdiction (AHJ).
- B. Install proper thickness throughout Use Zone(s).
- C. Clean and dry surface of subbase.
- D. Cover aggregate subbase with geotextile:
 - 1. Verify that aggregate is free of ruts or protruding objects.
 - 2. Lap minimum width at seams per drawings. Adhere seams in accordance with manufacturer's recommendations.
 - 3. Install smooth, and free of tensile stresses, folds, or wrinkles.
 - 4. Protect from clogging, tears, or other damage during surfacing installation.
 - 5. Repair or replace damaged geotextile in accordance with manufacturer's recommendations.
- E. Poured In Place Surfacing:
 - 1. Mix components mechanically on-site in accordance with manufacturer's directions; do not mix by hand.
 - 2. Install seamlessly; ensure complete bond to subbase.
 - 3. Cover footings and foundations and adhere tightly around penetrating elements.
 - 4. Maintain full thickness of resilient layers within Use Zone; cover or abut containment curbs as indicated on drawings; completely cover tapered transition edges.
 - 5. Hand trowel exposed surface to smooth, even finish.
 - 6. Impact Attenuation Layer: Install entire layer in one continuous pour on the same day up to 2,000 square feet. When a second pour is required, step the seam (see manufacturer's detail) and fully coat the step of the previous work with polyurethane binder to ensure 100% bond with new work. Apply adhesive in small quantities so that new attenuation cushion layer can be placed before the adhesive dries.
 - 7. Wear Surface: Bond wear surface to substrate with adhesive. Apply adhesive in small quantities so that wear surface can be applied before adhesive dries. Installation of surfacing shall be seamless up to 2,000 square feet per day.
 - a. Install surfacing seamlessly. When wear surface is composed of different color patterns, pour surface continuously and seamlessly.
 - b. When seams are required due to color change or field conditions, place adjacent wear surface as soon as possible, before initial pour has cured. Coat edge of initial pour with adhesive and apply wear surface mixture immediately.

- c. Add a minimum of 1/16 inch depth to specified surfacing depth to ensure required impact attenuation performance is met.
- d. Install wear surface to cover foundations and adhere tightly around elements penetrating the surface.
- e. The edge of initial pour shall be coated with adhesive and wearing surface mixture shall immediately applied. Pads with multiple seams are encouraged to include a topcoat of urethane before being placed into use.
- f. Butt joint seams are not acceptable except for repairs.
- g. Under special conditions and with Owners written approval, seams may be permitted in same color pad. Consult with Manufacturer for specific applications.
- h. When connecting to a concrete curb or border, the inside vertical edge shall be primed with adhesive and the final 2" of the attenuation cushion layer shall be tapered to allow the wear surface materials to be 1.5" - 2" thick where it joins the concrete.
- i. Construction methods such as the use of measured screeds or guides shall be employed to ensure that the full depth of specified surfacing material is installed. Surfacing systems thickness throughout the playground equipment use zone shall be as required to meet the impact attenuation requirements specified herein.

3.06 LOOSE FILL SURFACING

- A. Install in accordance with CPSC Pub. No. 325, ASTM F1487, and requirements of authorities having jurisdiction (AHJ).
- B. Cover Subgrade with Geotextile:
 - 1. Lap minimum 4 inches width at seams. Adhere seams in accordance with manufacturer's recommendations.
 - 2. Install smooth, and free of tensile stresses, folds, or wrinkles.
 - 3. Protect from clogging, tears, or other damage during surfacing installation.
 - 4. Repair or replace damaged geotextile in accordance with manufacturer's recommendations.
- C. Install loose fill to depths indicated, with smooth even surface flush with tops of containment curbs.

3.07 FIELD QUALITY CONTROL

- A. Obtain the services of the equipment manufacturer's field representative to review the finished installation for compliance with specified requirements and with design criteria to the extent known to the Contractor; submit report of field review.
- B. Owner or Owner's representative will inspect playground surfacing after installation to verify that surfacing is of proper type and depth and that playground meets specified design safety and accessibility requirements.
- C. Repair or replace rejected work until compliance is achieved.

3.08 CLEANING AND PROTECTION

- A. Restore adjacent existing areas that have been damaged from the construction.
- B. Clean playground equipment of construction materials, dirt, stains, filings, and blemishes due to shipment or installation. Clean in accordance with manufacturer's instructions, using cleaning agents as recommended by manufacturer.
- C. Clean playground area of excess construction materials, debris, and waste.
- D. Remove excess and waste material and dispose of off-site in accordance with requirements of authorities having jurisdiction.
- E. Protect installed products until Date of Substantial Completion.
- F. Replace damaged products before Date of Substantial Completion.

- G. The safety surface shall be allowed to fully cure in accordance with Manufacturer's instructions. The surface shall be protected by the Contractor from all traffic during the curing period of at a minimum of 48 hours or as instructed by the Manufacturer.
- H. Manufacturer Services- For poured in place safety surfacing, a Manufacturer's representative who is experienced in the installation of playground surfacing shall be provided. The representative shall supervise the installation to ensure that the system meets the impact attenuation requirements specified herein.

END OF SECTION

**SECTION 32 3113
CHAIN LINK FENCES AND GATES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fence framework, fabric, and accessories.
- B. Excavation for post bases; concrete foundation for posts.
- C. Baseball backstop construction.

1.02 RELATED REQUIREMENTS

- A. Section 32 3119 - Decorative Metal Fences and Gates

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- C. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric; 2011a (Reapproved 2017).
- D. ASTM A491 - Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric; 2011 (Reapproved 2017).
- E. ASTM F567 - Standard Practice for Installation of Chain-Link Fence; 2014a (Reapproved 2019).
- F. ASTM F1043 - Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework; 2018.
- G. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures; 2018.
- H. FS RR-F-191/1D - Fencing, Wire and Post Metal (Chain-Link Fence Fabric); 1990.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures for submittal procedures.
- B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
- C. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components.
- D. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.

1.05 QUALITY ASSURANCE

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Chain Link Fences and Gates:
 - 1. Master-Halco, Inc.: www.masterhalco.com.
 - 2. Merchants Metals: www.merchantsmetals.com.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.

2.02 COMPONENTS

- A. Line Posts: 1.9 inch diameter.
- B. Corner and Terminal Posts: 2.38 inch diameter.
- C. Fabric: 2 inch diamond mesh interwoven wire, 6 gauge, 0.1920 inch thick, top selvage knuckle end closed, bottom selvage twisted tight.

- D. Tension Wire: 6 gauge, 0.1920 inch thick steel, single strand.
- E. Tie Wire: Aluminum alloy steel wire.

2.03 MATERIALS

- A. Posts, Rails, and Frames: _____:
- B. Posts, Rails, and Frames: ASTM F1083 Schedule 40 hot-dipped galvanized steel pipe, welded construction, minimum yield strength of 30 ksi.
- C. Line Posts: Type I round in accordance with FS RR-F-191/1D.
- D. Terminal, Corner, Rail, Brace, and Gate Posts: Type I round in accordance with FS RR-F-191/1D.
- E. Wire Fabric: _____:
- F. Wire Fabric: ASTM A 392 zinc coated steel chain link fabric.
- G. Concrete: Type specified in Section 03 3000.

2.04 COMPONENTS

- A. Line Posts: 2.38 inch diameter.
- B. Corner and Terminal Posts: 2.88 inch.
- C. Gate Posts: 3.5 inch diameter.
- D. Top and Brace Rail: 1.66 inch diameter, plain end, sleeve coupled.
- E. Bottom Rail: Match Top Rail.
- F. Gate Frame: 1.66 inch diameter for welded fabrication.
- G. Fabric: 2 inch diamond mesh interwoven wire, 9 gage thick, knuckle and tied back, top and bottom so there are no protruding edges.
- H. Fabric Height: As shown on the Drawings.
- I. Tension Wire: 6 gage thick steel, single strand.
- J. Tie Wire: 11 ga galvanized steel.

2.05 ACCESSORIES

- A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.
- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.

2.06 FINISHES

- A. See schedule end of this section.
- B. Components (Other than Fabric): Galvanized in accordance with ASTM A123/A123M, at 1.7 oz/sq ft.
- C. Components and Fabric: Vinyl coated over coating of 1.8 oz/sq ft galvanizing.
- D. Hardware: Hot-dip galvanized to weight required by ASTM A153/A153M.
- E. Accessories: Same finish as framing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install framework, fabric, accessories and gates in accordance with ASTM F 567.
- B. Place fabric on outside of posts and rails.
- C. Set intermediate posts plumb, in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.
- D. Line Post Footing Depth Below Finish Grade: ASTM F 567.
- E. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F 567.

- F. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.
- G. Provide top rail through line post tops and splice with 6 inch long rail sleeves.
- H. Install center brace rail on corner gate leaves.
- I. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.
- J. Position bottom of fabric 2 inches above finished grade.
- K. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.
- L. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.
- M. Install bottom tension wire stretched taut between terminal posts.
- N. Install gate with fabric to match fence. Install hardware.
- O. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.

3.02 BALL STOP NETTING SLEEVES

- A. Install per manufacturer's requirements.

3.03 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From True Position: 1 inch.
- C. Components shall not infringe adjacent property lines.

END OF SECTION

**SECTION 32 3119
DECORATIVE METAL FENCES AND GATES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Decorative steel fences and gates, located as indicated on drawings.
- B. Vehicle sliding cantilever gate with power operator and controls.
- C. Vehicle swing gates manually operated.
- D. Person swing gates.
- E. Provisions for gate hardware, exit signs, and security devices.

1.02 RELATED REQUIREMENTS

- A. Section 03 3300 - Cast-in-Place Concrete, concrete at fencing and gate operator.
- B. Section 05 5000 - Metal Fabrications, bollards
- C. Section 08 7100 and 08 07111 - Door Hardware and Door Hardware Schedule, preparation for door hardware.
- D. Section 09 9600 - High Performance Coating, finishing of Decorative Metal Fences and Gates.
- E. Division 28 - Electronic Safety and Security, access control devices and wiring.
- F. Division 26 - Electrical, power to exit devices and exit lights.
- G. Section 32 1610 - Sidewalks, concrete paving and mow strips at fences.
- H. Section 32 2000 - Earth Moving, fills at fence posts.

1.03 REFERENCE STANDARDS

- A. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2017.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2012.
- D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- E. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2013.
- F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2013.
- G. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2012.
- H. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2013.
- I. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.
- J. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.
- K. ASTM B210 - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes; 2012.

- L. ASTM B210M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes (Metric); 2012.
- M. ASTM B211 - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire; 2012e1.
- N. ASTM B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold-Finished Bar, Rod, and Wire (Metric); 2012e1.
- O. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2013.
- P. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; 2013.
- Q. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 2012.
- R. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2010.
- S. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; American Welding Society; 2008.
- T. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel; International Accreditation Service, Inc.; 2011.
- U. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings; 1999 (Ed. 2004).
- V. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings; 2002 (Ed. 2004).
- W. SSPC-SP 2 - Hand Tool Cleaning; Society for Protective Coatings; 1982 (Ed. 2004).
- X. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2019.
- Y. ASTM D523 - Standard Test Method for Specular Gloss; 2014 (Reapproved 2018).
- Z. ASTM D714 - Standard Test Method for Evaluating Degree of Blistering of Paints; 2002 (Reapproved 2017).
- AA. ASTM D822/D822M - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings; 2013 (Reapproved 2018).
- BB. ASTM D1654 - Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments; 2008, with Editorial Revision (2017).
- CC. ASTM D2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates; 2021.
- DD. ASTM D2794 - Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact); 1993 (Reapproved 2019).
- EE. ASTM D3359 - Standard Test Methods for Rating Adhesion by Tape Test; 2017.

1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design Decorative Metal Fencing and Gates, including comprehensive engineering analysis by a qualified professional engineer licensed in the State of Oregon, using performance requirements and design criteria indicated.

1.05 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures for submittal procedures.
- B. Product Data: Submit 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.
- C. Shop Drawings:
 1. Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
 2. Foundation details, concrete design mix and reinforcing schedule for anti-ram barrier system.
- D. Calculations: Provide structural calculations bearing the stamp of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
- E. Welders' Certificates: Submit manufacturer's certificates, certifying welders employed on the Work, verifying AWS qualification within the previous 12 months.
- F. Delegated-Design Submittal: For Decorative Metal Fencing and Gates indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Submit submittals as "Deferred Submittals" in accordance with Section 01 30 00 - Administrative Requirements. Transmit a copy of each submittal indicating agency approval to the Architect for record.
- G. Installer's Qualification Statement.
- H. Manufacturer's Warranty.

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: Experienced with type of construction involved and materials and techniques specified and approved by fence manufacturer.
- C. Design connections and size members not detailed on the drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
- D. Perform Work in accordance with Oregon Structural Specialty Code.
- E. Design gates for loads and deflection normal to conditions of use.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Store materials in a manner to ensure proper ventilation and drainage. Protect against damage, weather, vandalism and theft.

1.08 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Decorative Metal Fences:
 1. Basis of Design: Ameristar Perimeter Security, Montage Commercial, Genesis style, USA: www.ameristarfence.com.
 2. Other Manufacturers must fully match specification: Alumi-Guard, Inc: www.alumi-guard.com.
 3. Substitutions: See Section 01 6000 - Product Requirements.

2.02 FENCES

- A. Fences: Complete fabricated system of posts and panels, accessories, fittings, and fasteners; finished with electrodeposition coating, and having the following performance characteristics:
 - 1. Capable of resisting vertical load, horizontal load and infill performance requirements for fence categories defined in ASTM F2408.
- B. Electro-Deposition Coating: Multi-stage pretreatment/wash with zinc phosphate, followed by epoxy primer and acrylic topcoat.
 - 1. Total Coating Thickness: 2 mils, minimum.
 - 2. Color: As selected by Architect from manufacturer's standard range.
 - 3. Coating Performance: Comply with general requirements of ASTM F2408.
 - a. Adhesion: ASTM D3359 (Method B); Class 3B with 90 percent or more of coating remaining in tested area.
 - b. Corrosion Resistance: ASTM B117, D 714 and D 1654; 1/8 inch coating loss or medium No.8 blisters after 1,500 hours.
 - c. Impact Resistance: ASTM D2794; 60 inch pounds.
 - d. Weathering Resistance: ASTM D523, D822/D822M and D2244; less than 60 percent loss of gloss.
- C. Steel Tubing and Hollow Steel Sections: ASTM A 500, Grade B cold-formed structural tubing.
- D. Plates: ASTM A 283.
- E. Pipe: ASTM A 53/A 53M, Grade B Schedule 40, hot-dip galvanized finish.
- F. Bolts and Nuts: Carbon steel, ASTM A307, Grade A galvanized to ASTM A 153/A, Class C.
- G. Anchor Bolts, Headed Anchor Rods: ASTM F 1554 Grade 36.
- H. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- I. Fasteners: ASTM A276/A276M, Type 302 stainless steel; finished to match fence components.
- J. Perforated aluminum sheet:
 - 1. Thickness: 16 gauge.
 - 2. Perforations: 1/4 inch round holes on 3/8 inch staggered centers
 - 3. Material: Finish to match fencing.
 - 4. Edge: 2 inch unperforated border at panel edges.
 - 5. Manufacturer and brand: McNichols Round Hole Perforated Products; www.mcnichols.com
 - 6. Substitutions: See Section 01 6000 - Product Requirements.
 - 7. Extent of Work: Provide at inside face of sliding cantilever gate to reduce visibility into utility courtyard, mechanically fasten. Provide at personnel gate.

2.03 WELDED STEEL FENCE

- A. Provide fence meeting requirements for Industrial class as defined by ASTM F2408.
- B. Fence Posts:
 - 1. Size: 6 inch by 6 inch minimum.
 - 2. Material: Tubular steel.
 - 3. Finish: Match fencing.
- C. Fence Panels: Fusion welded; 4 feet high at school garden fence. 6 feet high elsewhere.
 - 1. Panel Style: Three rail.
- D. Posts: Steel tube.

1. Size: 2-1/2 inches square by 12 gage, 0.109 inch, with manufacturer's standard cap.
 2. Post Cap: Flush plate.
- E. Rails: Manufacturer's standard, double-wall steel channel 1-3/4 inch square by 12 gage, 0.1094 inch with pre-punched picket holes.
1. Picket Retaining Rods: 0.125 inch galvanized steel.
 2. Picket-to-Rail Intersection Seals: PVC grommets.
- F. Pickets: Steel tube.
1. Spacing: 3-3/4 inch clear.
 2. Size: 1 inch square by 18 gage, 0.0478 inch.
 3. Style: Square top pickets extend above top rail.
 4. Finial: None, square top..
- G. Flexibility: Capable of following variable slope of up to 1:2.

2.04 STEEL GATES

- A. Personnel Gates
1. Manufacturer and Brand: Match Fencing
 2. Material and finish: Steel to match fencing.
 3. Height: 7 feet
 4. Frames: Tubular steel. Increase size as needed to accommodate gate hardware and design criteria.
 5. Gate Posts: Sizes and shapes as shown on drawings.
 6. Provide Adjustable Mounting Plate with openings, supports, and fastenings for gate hardware specified in Section 08 7100 Door Hardware.
 7. Operation: Panic device from inside courtyard. Latch set from exterior. Card reader required to release latch from exterior.
 8. Do not provide openings in gate panel within 12 inches of panic device. Provide perforated metal mesh on interior face of gate to prevent "reaching through" to open gate.
 9. Provide steel shapes and fasteners for mounting to masonry walls where indicated.
 10. Provide stop and latching strike at jamb post.
 11. Provide cane bolt to hold gate in open position.
 12. Provide ability to route wiring within gate post from below grade to gate exit sign, electronic hardware, and security wiring.
- B. Vehicular Gates, Sliding Cantilever Gates
1. Manufacturer and Type: Transport II by Ameristar, Genesis style to match fence.
 - a. Material: Aluminum
 - b. Finish: Match fencing
 - c. Height: 7 feet
 - d. Width of Opening: As shown on drawings.
 - e. Provide mounting posts for gate support and operation. Materials and finish to match fence.
 - f. Provide with site obscuring round perforated aluminum sheet facing on interior face.
 - g. Operation: Power operation as indicated.
 - h. Provide steel shapes and fasteners for mounting to masonry walls where indicated.
 - i. Provide stop at jamb post.
 - j. Power Gates: Provide with operator as described in work of this section.

2.05 CANITLEVER GATE OPERATOR

- A. Manufacturer & Brand:
 - 1. Basis of Design: Liftmaster 1/2 HP Sliding Gate Operator
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
- B. Type: Heavy duty sliding gate operator, controls, and accessories.
- C. Power requirements: 24 Volts DC, low voltage control circuit.
- D. Available horse power: 1/2 HP for use in Class I through IV application.
- E. Maximum gate weight: 800 LBS.
- F. Maximum cycles per hour: 45 CPH.
- G. Maximum gate width: 14 feet.
- H. Gate speed: 13 seconds from open to close.
- I. Code: UL 325 Listed, comply with ASTM 2200
- J. Accessories and Features:
 - 1. Safety edges both by contact sensor and by photo cell.
 - 2. Magnetic gate lock.
 - 3. Control boards.
 - 4. Loop detectors able to detect vehicle presence at entry, exit, and mid point of passing through gate. Preformed loops to be placed at time of concrete pour. 3 loops located as recommended by Manufacturer.
 - 5. Ground mounted control pedestal able to operate gate using card reader or by entering numeric combination on keypad.
 - 6. Desired operation: Entry from exterior only by security card or correct entry of numeric combination. After vehicle clears gate, gate closes automatically. Exit from interior accomplished using 2 modes. First mode: gate opens automatically upon detection of vehicle presence. Second mode: gate is opened using push button with keyed lockout.
 - 7. Motor Operator Enclosure: Secure with access controlled by key or special tool.
 - 8. Concrete base for control pedestal and motor operator: Size and reinforcing as recommended by Gate Operator manufacturer. Material as specified in Section 03 3000 Poured in Place Concrete.
- K. Provide means of securing gate in closed position.

2.06 STEEL FINISHES

- A. Prepare and finish as specified in Section 09 9600 - High Performance Coatings.
- B. Provide painted images on fence and vehicle gate panels as indicated on drawings. Architect to provide digital files of images for painting. Apply image to exterior face of gate only.

2.07 ACCESSOIRES

- A. Fire Department Lock Box: As specified in Section 10 4400 - Fire Protection Specialties.

2.08 FABRICATION

- A. Steel connections; Fully welded.
- B. Cap open ends of tube steel.
- C. Ease edges.
- D. Attachment of steel face to frames: Tack weld. Do not cause welds to distort smoothness of steel panels.

- E. Provide custom cut openings in face panels at steel personnel gates. Architect to provide digital file of images to be cut in steel.
- F. Provide custom painted images on vehicular gates and fence panels. See Finishing.
- G. Provisions for Hardware: Provide openings, reinforcements, and penetrations allowing installation of hardware. Hardware mounting heights and locations to comply with Section 08 7100. Comply with Accessibility requirements of the Oregon Structural Specialty Code requirements for gates and hardware.
- H. Provisions for wiring: Provide open pathways for security and line voltage wiring to exit hardware, security devices, exit lights.

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 Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Set fence posts in accordance with approved shop drawings.
- C. Set fence panels level. Do not allow an open space greater than 4 inches between the bottom of a gate or fence to finished grade.
- D. Space gate posts according to the manufacturers' drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected.
 - 1. Base type and quantity of gate hinges on the application; weight, height, and number of gate cycles.

3.04 ERECTION TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From Indicated Position: 1 inch.
- C. Minimum distance from property line: 6 inches.
- D. Set gates level to hold in any position.

3.05 CLEANING

- A. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.

3.06 PROTECTION

- A. Protect installed products until completion of project.

END OF SECTION

**SECTION 32 8424
IRRIGATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Underground landscape irrigation system:
 - 1. Pipe and fittings, valves, sprinkler heads, emitters, bubblers, and accessories.
 - 2. Control system.

1.02 REFERENCE STANDARDS

- A. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds; 2020.
- B. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- C. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2024.
- D. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020 (Reapproved 2024).
- E. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings; 2021.
- F. ASTM A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

1.03 SUBMITTALS

- A. Product Submittals:
 - 1. Submit product data showing manufacturer's name, catalog number, technical data, and photo or drawing for each component of the irrigation system.
 - 2. Submit product data no later than 30 days prior to beginning work.
- B. Water Pressure Tests:
 - 1. Submit report of water pressure tests at irrigation water supply connection(s).
 - 2. Submit report of irrigation pressure tests for main line prior to backfilling.
- C. Submit Record Drawings at closeout of contract to include:
 - 1. Variations or changes to system.
 - 2. Main and lateral lines.
 - 3. Valves.
 - 4. Control wire:
 - a. Control wire runs.
 - b. Control wire splice valve box locations.
- D. Operating and Maintenance instructions for all irrigation equipment.

1.04 SITE CONDITIONS

- A. Weather Requirements:
 - 1. Do not solvent weld polyvinyl chloride pipe when ambient temperature is below 40°F or above 95°F.
 - 2. Do not solvent weld polyvinyl chloride pipe in wet conditions.
- B. Schedule for Installing Pipe, Sleeves, Sprinkler Heads, and Drip Irrigation:
 - 1. Schedule installation of pipe sleeves below paving and walks prior to construction.
 - 2. Schedule installation of sprinkler heads and drip lines after approval of main line pressure testing and lateral line leak testing.
- C. Complete removal of materials deleterious to plant growth as indicated in Section 32 9113 – Soil Preparation prior to start of irrigation installation.

1.05 DAMAGES

- A. Restore structures or facilities damaged by irrigation work to original condition.
- B. Repair damage caused by leaks or breaks in equipment and materials furnished or installed in this contract for one year after date of final acceptance.

1.06 EXISTING UTILITIES

- A. Locate and identify, with visible marking, existing underground utilities in areas of work. Utilities to remain in place shall be protected during excavation operations.
- B. Consult with utility owner for instructions before proceeding if uncharted piping or other utilities are encountered during execution of work.
- C. Cooperate with Owner and public or private utility companies in keeping their respective services and facilities in operation. Coordinate temporary interruptions to existing services and facilities and provide temporary utility services.

1.07 REGULATIONS

- A. Work to be accomplished in accordance with applicable Local, State and Federal codes and regulations.

1.08 RECORD DRAWINGS

- A. Maintain a current record of pipe, wire, and equipment placement, and record variations or changes.
- B. Include Record Drawings in Operating and Maintenance Manual.

1.09 WARRANTIES

- A. Equipment Warranty: Provide manufacturer's standard warranty for all specified equipment.
- B. Installer's Warranty:
 - 1. Warranty all irrigation pipes, fittings, and lines to be free of leaks for one year from the date of final acceptance.
 - 2. Warranty shall include repair of trench backfill that settles more than 1" and repair of plantings, paving, and improvements damaged by settlement of trench backfill soils during warranty period.

1.10 QUALIFICATIONS

- A. Irrigation Installer: The landscape construction professional as defined in ORS 671.520 and performing work under this section of the contract shall hold a valid landscape contractor's license in accordance with ORS 671.510 to 671.760.

PART 2 PRODUCTS

2.01 PVC PIPE

- A. Polyvinyl Chloride Plastic (PVC) Pipe: PVC 1220, Type 1, normal impact, I.P.S., N.S.F. approved or accepted substitute.
 - 1. Main and Lateral (Zone) Lines: Schedule 40 PVC pipe, conforming to ASTM D1784, ASTM D1785 and PS22.
 - 2. PVC pipe to be new, defect free, continuously and permanently marked with manufacturer's name or trademark, size, schedule and type of pipe.

2.02 PVC PIPE FITTINGS

- A. PVC Fittings: PVC 1220, schedule 40, type 1, normal impact, I.P.S., N.S.F. approved meeting requirements of ASTM D2466 or accepted substitute.
- B. PVC nipples to be standard weight schedule 80, with molded threads.

2.03 PVC SOLVENT CEMENT

- A. For pipe diameter up to 1-1/2": Weld-On 721 blue color, or accepted substitute, meeting N.S.F. approval for Type I and II PVC and requirements of ASTM D2564.

- B. For pipe diameter 2" and larger: Weld-On 711 gray color, or accepted substitute, meeting N.S.F. approval for Type I and II PVC and requirements of ASTM D2564.

2.04 PVC PRIMER

- A. Weld-On P-70, purple color, or accepted substitute meeting requirements of ASTM F656.

2.05 PVC SLEEVES

- A. Schedule 40 PVC, sized a minimum of 6" or two times the diameter of the pipes scheduled to be contained in the sleeve, whichever is larger.

2.06 GALVANIZED STEEL PIPE AND FITTINGS

- A. Pipe: Schedule 40, hot-dipped galvanized, conforming to ASTM A53.
- B. Fittings: Hot-dipped galvanized, malleable iron.

2.07 IRRIGATION HEADS

- A. See schedule on the Drawings.

2.08 DRIP COMPONENTS

- A. General: See schedule and details on the Drawings.
- B. Drip Headers: See schedule on the Drawings.
- C. Drip Fittings: Use only drip fittings that are recommended by the manufacturer.
- D. Drip Irrigation Flush Valves: Netafim TLFV-1, 1-gallon flush valve
- E. Drip Irrigation Air-Relief Valve: Rainbird ARV050 ½" Air-Vacuum Relief Valve, per manufacturer requirements.
- F. Drip Staples: Netafim TLS6-1000 6-inch staple, 4-foot on-center spacing.

2.09 VALVES AND ACCESSORIES

- A. Control Valves: See schedule on the Drawings.
- B. Main Line Isolation Valves:
 - 1. Manufacturer: Kennedy Ken-Seal II or approved equal.
 - 2. Type: Resilient wedge gate valve, 150-PSI min. rating, with cast iron body, handwheel, stainless steel gate valve, resilient rubber seat, and flanged fittings.
 - 3. Size: Same size as line on which it is installed, unless otherwise indicated on the Drawings.
- C. Valve Boxes for Control and Isolation Valves: 12" minimum size box, one box for each valve, with locking lid, and with 3" and/or 6" extensions as needed to facilitate required installation.
 - 1. Valve boxes shall be no closer than 12 inches apart, when multiple valve boxes are placed together.
 - 2. Manufacturer: Carson, Armor, or approved equal with "T" top lid.
- D. Manual Drain Valve:
 - 1. Brass ball valve, 1" size, lever-operated.
 - 2. Swing Check Valve: Spears 2" PVC Swing Check Valve (S1520-20) or approved equal.
- E. Ball Valve: Brass ball valve, size as noted, lever-operated.
- F. Manual Angle Valve: Brass manual angle valve with unions and "T" stem, same size as line on which it is installed.
- G. Quick Coupling Valves: See schedule on the Drawings.
- H. Valve Boxes for Quick Coupling Valves and Manual Drain Valves: Carson, Armor, or approved equal, 10" diameter round valve boxes, one box for each valve.
- I. Flow Sensor: See schedule on the Drawings. Size sensor for flow rather than pipe size.
- J. Master Valve: See schedule on the Drawings.

2.10 IRRIGATION CONTROLLER AND SURGE PROTECTION

- A. Controller: See schedule on the Drawings.
- B. Weather Sensor: See schedule on the Drawings.
- C. Surge Protection: Lightning arrestor surge protection as recommended by the manufacturer.

2.11 IRRIGATION CONTROL WIRE

- A. Control Wire: No. 14 AWG, solid copper, jacketed two-conductor, direct-burial cable as recommended by the manufacturer.

2.12 BACKFLOW PREVENTION DEVICE

- A. Backflow Prevention Device: See schedule on the Drawings.

2.13 WATER SOURCE

- A. New domestic water service dedicated for landscape irrigation as indicated on the Drawings.

2.14 OTHER MATERIALS

- A. Keys:
 - 1. Two (2) keys for each type of locking valve box, cover, or valve with integral locking lid.
 - 2. Two (2) valve-operating keys of type and length required to operate manual drain valves.
- B. Electrical Connectors: Water-tight electrical connectors.
 - 1. 3-M DBY.
 - 2. RainBird DB Series.
 - 3. Or accepted substitute.
- C. Locator Wire: All main lines to be marked with continuous 14-gauge, single-strand locator wire, with light blue color coating. Provide minimum 3'-0" long coiled loop of locator wire in each valve box.
- D. Concrete for Thrust-Blocking: Concrete for thrust blocks to be from same source and conform to pipe manufacturer's recommendations and applicable ASTM requirements.
- E. Pipe Joint Tape: Minimum of 1/2" Teflon tape intended for use in wrapping threaded PVC and/or galvanized pipe fittings and joints, as required.
- F. Drain Rock: 1/4" round clean, washed pea gravel.
- G. Steel Concrete Nails: 1-1/2" heavy-duty 10-Gauge shank concrete nails.

PART 3 EXECUTION

3.01 GENERAL

- A. Do not allow work to be covered or enclosed until it has been reviewed, pressure tested, and approved by the Landscape Architect.
- B. Code Requirements:
 - 1. Installation of materials and equipment shall be in accordance with manufacturer's written specifications and recommendations, and all local and state codes.
 - 2. Contractor is responsible for identifying conflicts between manufacturer's written specifications and recommendations, local and state codes, and the Contract Documents.
 - 3. Contractor shall correct work installed to meet manufacturer's or code requirements at no additional cost.
- C. Minor changes necessary to conform to ground conditions may be made without the Landscape Architect's approval. Changes shall be recorded on the Record Drawings.
- D. Obtain written permission to shut off any water lines prior to work. Keep disruptions in service to a minimum.
- E. Maintain system and protect it from damage, including damage caused by vandalism or adverse weather conditions, until date of final acceptance. Repair damage at no additional cost to the Owner.

3.02 PIPE TRENCHING

- A. Minimum depth of cover from top of prepared topsoil to top of irrigation piping shall be as follows:
 - 1. Lateral Lines: Minimum depth of 12", maximum depth of 18".
 - 2. Mainline: Minimum depth of 18", maximum depth of 24".
 - 3. Sleeves under vehicular pavement: Minimum depth of 18", maximum of 24".
- B. Backfill trenches in cool part of day to minimize expansion and contraction of PVC pipe.
- C. Remove debris, trash, rocks, and other foreign material from irrigation trenches.
 - 1. Irrigation lines to have a firm, uniform bearing surface for entire length of each line.
 - 2. Wedging or blocking of pipe other than specified thrust blocking is not permitted.
- D. Before backfilling trenches, pipe shall be flushed clear and clean of dirt and foreign material.
(See **FLUSHING, TESTING, AND ADJUSTING**)
- E. Backfill trenches in layers of not more than 6" in depth and compact each layer.
 - 1. Fill trenches to top of subsoil with prepared subsoil.
 - 2. Fill trenches between top of subsoil and top of topsoil with prepared topsoil.
 - 3. Restore disturbed surfaces to original condition or better.
- F. Repair or replace materials and equipment damaged or destroyed while backfilling.

3.03 PIPE

- A. Exercise care in handling and storing pipe and fittings.
 - 1. Store materials under cover before using.
 - 2. Transport materials in a vehicle of adequate size and capacity to prevent bending or concentration of an external load at any point on materials.
 - 3. Materials or portions of materials that are damaged shall be discarded and replaced.
- B. Remove foreign matter and dirt from inside pipe or fittings before lowering into trench.
- C. Install pipe and fittings per manufacturer's specifications with specified materials. Use Teflon tape on threaded joints.
- D. Install locator wire on top side of pipe.
 - 1. Tape locator wire to pipe at no less than 20'-0" intervals.
 - 2. Sections of locator wire shall be spliced together with watertight splice connectors, to provide a continuous run.
- E. Install concrete thrust blocks at changes of direction for main line pipe 2-1/2" or greater in diameter. Pour a minimum of 1.5 cubic feet of pre-mixed concrete against pipe and firm soil, in accordance with pipe manufacturer's recommendations.
- F. Snake pipe in trenches where applicable to allow for expansion and contraction as recommended by manufacturer.
- G. Cut pipe ends square and remove burrs.
- H. Repair settlement of backfilled trenches during warranty period and completely restore and repair plantings, paving and other site improvements disturbed by irrigation construction.

3.04 DRIPLINE EXCAVATION, TRENCHING, AND BACKFILL

- A. Excavate and install pipes at minimum cover indicated. Excavate trenches at appropriate width for connections and fittings.
- B. Minimum cover for dripline components:
 - 1. Drip zone lateral piping: 12" (dimension from top of pipe or tubing to top of prepared topsoil)
 - 2. Drip distribution tubing: on top of weed barrier and at bottom of mulch.
- C. Backfill only after lines have been reviewed, tested, and approved.

3.05 BACKFLOW PREVENTION DEVICE

- A. Install complete with fittings, valve boxes and extensions. Verify that backflow prevention device is tested and approved by authorities having jurisdiction.

3.06 FLOW SENSOR AND MASTER VALVE

- A. Install in accordance with manufacturer's recommendations, complete with fittings, control wire, valve boxes and extensions.

3.07 ISOLATION VALVES

- A. Install complete with fittings, valve boxes and extensions.

3.08 AIR RELIEF VALVES

- A. Install complete with fittings, valve boxes and extensions.
- B. Quantities and locations as recommended by the manufacturer.

3.09 CONTROL VALVES

- A. Valve boxes to be installed flush with with top of box 1/2" above finish grade of mulch or seed bed.
- B. Flush mainline pipe before installing control valve assemblies.
- C. Install valves in box allowing room to perform ongoing maintenance.
- D. Place drain rock in valve box to within 2" of bottom of valve assembly.
- E. A maximum of two one-inch valves may be installed per jumbo size valve box. Install one control valve assembly per valve box for valves larger than one inch.
- F. Provide jumbo valve box if necessary to allow room for maintenance.
- G. Connect control valve decoders to irrigation controller according to manufacturer's instructions.

3.10 DRAIN VALVES

- A. Install complete with fittings, valve boxes and extensions.

3.11 QUICK COUPLING VALVES

- A. Install quick coupling valves as detailed on the Drawings.

3.12 IRRIGATION HEADS

- A. Install irrigation heads of types, sizes, and coverage indicated in Irrigation Legend at locations shown on the Drawings.
 - 1. Minor changes in head location may be necessary to achieve the required coverage.
 - 2. Make changes at no additional expense to the Owner.
 - 3. Notify the Landscape Architect for approval prior to making major changes.
 - 4. Document changes on the Record Drawings.
- B. Locate heads no closer than 6" from any adjacent edge of paving curb, wall, or fence.

3.13 IRRIGATION SLEEVES

- A. Install sleeves for irrigation lines and/or control wire under pavement prior to placing pavement materials.
 - 1. Extend sleeves beyond pavement edge a minimum of 12".
 - 2. If length of required sleeve is greater than the length of a single piece of pipe, solvent weld joints, otherwise sleeves shall be one continuous length of pipe.
- B. Tape ends of sleeve closed with a minimum of three layers of duct tape to keep soil out of sleeve until irrigation lines and/or control wire are installed.
- C. Permanently attach a single length of 14-gauge locator wire to the entire length of the sleeve.
- D. Stake both ends of sleeves with a readily visible stake extending 12" above grade and below grade to the bottom of sleeve. After curb or sidewalk is installed mark sleeve location with steel concrete nail.

1. Mark above-grade portion of stake with words 'Irrig. Sleeve.'
2. Prior to removing stakes install concrete nail at sleeve location and note location on Record Drawings. Do not remove stakes until irrigation lines and/or control wires are installed and inspected.

3.14 IRRIGATION CONTROL WIRE

- A. Controller to Control Valve: Lay two-wire communication wire in trench under mainline and/or lateral lines whenever they occupy the same trench. Place communication wire in sleeves when under paving, and in conduit when not in common trench with mainline and/or lateral lines.
- B. Wire splices to be moisture proof using specified electrical connectors according to manufacturer's installation instructions.
 1. Make splices only in valve boxes.
 2. Provide minimum 1'-0" length of coiled slack between wire splices.

3.15 FLUSHING, TESTING, AND ADJUSTING

- A. Thoroughly flush all main and lateral (zone) lines before testing and installation of irrigation heads and before backfilling trenches.
- B. Do not install irrigation heads and drip irrigation components until after main line pressure testing and lateral line leak testing has been completed and approved.
- C. Do not backfill irrigation trenches before main line pressure testing and lateral line leak testing has been completed and approved.
 1. Soil may be placed in trenches between fittings and couplings to insure stability of line under pressure.
 2. Fittings and couplings must be left uncovered for visual inspection for full period of test.
 3. Do not test until last solvent welded joint has had a minimum of 24 hours to set and cure, or longer if required by manufacturer's instructions.
- D. Before testing, fill main lines with water and expel air from pipes.
- E. For irrigation systems with concrete thrust blocks:
 1. Allow minimum 5-day cure before testing.
 2. Allow 3-day cure for high early strength concrete.
- F. Main line pressure testing:
 1. Minimum Pressure Test on Main Lines, Valves, Joints and Fittings: 100 pounds per square inch without losing more than 3 pounds per square inch for a period of 1 hour. Provide airless paint sprayer with compressor, or other equipment, to achieve required hydraulic test pressure without injection of air into main lines.
 2. Close all valves and cap all piping and fittings as necessary to isolate main line and conduct pressure testing.
 3. Perform preliminary test and repair any leaks or defects.
 4. Testing to be performed with a certified liquid-filled pressure gauge.
 5. Perform final pressure test in the presence of the Landscape Architect.
 6. Contractor shall provide minimum 48-hour notice to Landscape Architect requesting observation of final pressure test.
 7. Piping may be pressure tested in sections if approved by Landscape Architect.
- G. Lateral (zone) line leak testing:
 1. Perform lateral line leak test before installing sprinkler heads, rotors, or drip irrigation components.
 2. Cap or crimp each riser pipe or flexible connection for sprinklers, rotors or drip irrigation prior to leak testing.
 3. Perform lateral line leak testing for each control valve in numerical sequence, immediately after main line pressure testing has been approved, in the presence of the Landscape Architect.
 4. Open each control valve, one at a time, under main line pressure to demonstrate the absence of leaks at valves, pipe joints, and fittings.

- H. Where inspected work does not comply with specified requirements or if pressure tests fail, replace rejected work until compliance is achieved.
- I. Adjust and balance irrigation system to provide uniform coverage.
 - 1. Change, reset or adjust heads, nozzles, headers, and emitters as required to provide uniform coverage and match final grades.
 - 2. Perform final coverage test by operating each control valve in the presence of the Landscape Architect when the irrigation system has been completely installed and adjusted.
- J. Locator wires must be tested and approved. Wire tests to be conducted by Owner or designated representative.
- K. Drip tubing and components operational and leak testing:
 - 1. Test with control zone components and dripline flush valve components installed.
 - 2. Partially backfill buried pipe and tubing to prevent movement under pressure. Expose couplings, fittings, and valve components.
 - 3. Subject installed dripline tubing and components to water pressure equal to specified operating pressure for ten (10) minutes.
 - 4. Visually inspect valve assemblies and fittings for leakage and replace defective pipe, fitting, joint, valve, or appurtenance. Repeat test until test segment is free from leaks. Cement or caulking to seal leaks is prohibited.
 - 5. Activate each drip control zone valve in sequence and inspect for leaks and any deficiencies in coverage uniformity.

3.16 IRRIGATION CONTROLLER

- A. Install controller and cabinet at location shown on the Drawings according to manufacturer's installation instructions.
- B. Connect controller to power supply according to all code requirements and manufacturer's installation instructions.
- C. Install electrical surge protection for irrigation control system according to all code requirements and manufacturer's installation instructions.
- D. Install weather sensor and connect to irrigation controller according to manufacturer's installation instructions.

3.17 CLEANING

- A. Remove packaging, excess materials, and trash, and dispose of in a legal manner.

3.18 FINAL SUBMITTALS AND TRAINING

- A. Irrigation Valve Schedule, laminated on both sides with plastic, for placement inside irrigation controller.
- B. Clean print of final Project Record Drawing, reduced by 50% and with zones clearly color-coded, for delivery to Owner's Representative.
- C. Provide a minimum of two (2) hours of training and orientation with Owner's Representative to demonstrate operation, adjustment, and maintenance of irrigation system. Review spring activation and winterization operations as part of the Owner's training and orientation procedures.

END OF SECTION

**SECTION 32 9113
SOIL PREPARATION**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Placing existing and imported topsoil in planting and seed areas.
- B. Preparing planting soil in areas to be planted with trees, shrubs, ground cover, and seed at locations indicated on the Drawings and as herein specified.

1.02 REFERENCES

- A. Definition of Noxious Weed: As designated on State of Oregon Dept. of Agriculture's Noxious Weed List. Species include but are not limited to Blackberry, Canada Thistle, Dandelion, Horsetail, Morning Glory, Nut Sedge, Poison Oak, Rush Grass, Annual Bluegrass, Bermuda Grass, Brome, Crabgrass, Johnson Grass, Nut Grass, and Quack Grass.

1.03 SUBMITTALS

- A. Topsoil:
 - 1. Submit written verification of source and type of imported topsoil.
 - 2. Submit analysis of existing (on-site) and imported topsoil from licensed soils testing laboratory for approval prior to reuse of existing topsoil or delivery of imported topsoil. See paragraph 2.1 A. for test requirements.
 - 3. Sample: Submit 1/2-gallon sample each of existing and imported topsoil.
- B. Submit manufacturer's or vender's certified analysis of compost, fertilizers, and soil amendments.

1.04 QUALITY ASSURANCE

- A. Qualifications of Topsoil:
 - 1. Prior to delivery of imported topsoil, submit written statement giving location of property from which topsoil will be obtained. The Landscape Architect may inspect site.
- B. Regulatory Requirements: Meet State of Oregon licensing requirements for the application of herbicides.
- C. Packing and Shipping: Deliver commercial fertilizer in original containers with labels indicating weight, chemical analysis and name of manufacturer.
- D. Storage and Protection:
 - 1. Store fertilizers and amendments in dry place and protect from contamination.
 - 2. Protect soil materials from deterioration by moisture, erosion, freezing temperatures, and chemical contamination during storage and handling.
 - 3. Protect existing and new improvements from damage and staining.
 - 4. Provide protective cover and barriers as necessary to prevent damage and staining.

1.05 SITE CONDITIONS

- A. Environmental Requirements: Prepare soil only when topsoil is not in a wet, muddy, or frozen condition.
- B. Complete subgrade preparation prior to placing topsoil (see paragraph 3.02, this section).
- C. Scheduling: Schedule preparation of areas to be seeded within 48 hours prior to application of seed.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Existing (On-site) and Imported Topsoil:
 - 1. Fertile, friable, natural loam, surface soil, capable of sustaining vigorous plant growth; porous and free draining; free of subsoil clay lumps, brush, noxious weeds, weed seeds, roots, stones larger than 1-1/2 inches in any dimension and other material harmful to plant

growth. Throughout landscape installation landscape shall be kept free of weeds. All landscape areas shall be treated to remove noxious weeds, and weed seeds.

2. Topsoil samples and analysis from a licensed soils laboratory shall be submitted to the Landscape Architect for approval prior to delivery or use of any topsoil on the project site. Soil sample shall be a composite acquired from four different sections of the stockpiled soil or four different locations on the site at a depth between six and twelve inches, for a total combined quantity of one-half gallon. Sampling shall be observed by the Architect or Inspector of Record and a written verification describing the sampling locations and process observed shall be provided to the Landscape Architect. Soil test shall include the following: sieve analysis of soil particle size; magnesium, nitrogen, phosphorous, boron, zinc, and potassium levels; soluble salt level; pH; organic matter; and infiltration rate. Test results shall include specific recommendations for soil conditioners, amendments and fertilizers to adjust the soil to meet the description noted above. A written narrative summarizing the analysis and recommendations shall be included in the submittal.
 3. Acceptable gradation as defined by USDA triangle of physical characteristics as measured by hydrometer:
 - a. Sand: 15 to 60 percent.
 - b. Silt: 10 to 60 percent.
 - c. Clay: 5 to 30 percent.
- B. On-Site or Imported Fill: See Section 31 2323 – Fill.
- C. Lime: Dolomite limestone, calcium magnesium carbonate, 50% passing through a 100 mesh sieve, 95% to 100% passing through a 20 mesh sieve, agricultural ground grade, minimum neutralizing value of 90%.
- D. Compost: 1/4-inch minus fir or hemlock sawdust aged a minimum of 2 years, or approved substitute.
- E. Fertilizers and Amendments:
1. Seed Area Fertilizer: Best Fertilizer Triple Pro 15-15-15, or approved equal.
 2. Planting Bed Fertilizer: Best Fertilizer Triple Pro 15-15-15, or approved equal.
 3. Mycorrhizae Soil Amendment: Plant Success Mycorrhizae Tablets, or approved equal.

PART 3 - EXECUTION

3.01 PERFORMANCE

- A. Site Verification of Conditions:
1. Examine site for conditions which will adversely affect execution, permanence, quality of work, survival of plant material, and survival of rough seed.
 2. Verify that grade and slopes of seed areas and planting beds are acceptable to the Landscape Architect prior to beginning soil preparation.
 3. Report existing conditions detrimental to completion of soil preparation work.
 4. Begin Work required in this Section only after conditions are satisfactory.
 5. Start of Work in this Section denotes acceptance of existing conditions.
- B. Protection of Existing Site:
1. Protect utility lines and site improvements.
 2. Stake location of underground utilities and avoid excavation in these areas beyond safe limits.
 3. Hand excavate where required to avoid utility line damage.

3.02 SUBGRADE PREPARATION

- A. Removal of Materials Deleterious to Plant Growth including the following:
1. Remove all gravel, aggregate base rock material, asphalt, concrete, roots of any dead tree or tree to be removed, and all construction debris from planting beds and areas to be seeded to a minimum depth of 6 inches below bottom of prepared topsoil mix.
 2. Replace with fill, if necessary, to bring subgrade to correct levels prior to placing topsoil.
- B. Scarify Subgrade:

1. Scarify subgrade to the following depths in two directions at 90 degrees to each other, where topsoil is scheduled to be placed, to ensure interfacing of subsoil and topsoil, and to achieve specified compaction density.
 - a. Shrub and groundcover areas: 12 inches
 - b. Seeded areas: 6 inches
2. Complete scarification in areas where topsoil is scheduled to be placed, and where native soils are to be amended.
3. Repeat cultivation and scarification prior to placing topsoil planting mix in planting and seed areas where compaction exceeds 75% of maximum density, and where surface soils have sealed and/or formed a soil lens inhibiting drainage.

3.03 PREPARATION

- A. Stockpiling:
 1. Stockpile and protect existing and imported topsoil on site in designated location as directed by Owner's representative.
 2. Do not mix other excavated materials with stockpiles.
- B. Preparing Shrub and Ground Cover Planting Bed Areas:
 1. Place 12" depth of topsoil at areas to be planted with shrubs and groundcovers.
 2. Place 18" depth of topsoil where trees are to be placed in a diameter of 3 times the root ball.
 3. Spread 4" depth of compost, and 13.5 pounds per 1,000 sq feet of Planting Bed Fertilizer.
 4. Apply additional soil amendments as required by soil test analysis at the rate indicated by the analysis.
 5. Till soil amendments into topsoil to a minimum depth of 8".
 6. Float amended topsoil to 3" below finish elevations.
 7. Place Mycorrhizae Tablets in each plant pit at the time of planting according to the manufacturer's specifications:
 - a. 1 tablet for each 4" pot
 - b. 2 tablets for each 1 gallon container
 - c. 4 tablets for each 3 gallon container
 - d. 8 tablets for each 5 gallon container
 - e. 10 tablets per inch of stem width for each tree (e.g. 20 tablets for each 2" caliper tree)
- C. Preparing Areas to be Seeded:
 1. Place 4" depth of topsoil.
 2. Apply lime 2 weeks prior to seeding if indicated by soil test analysis at the rate indicated by the analysis.
 3. Spread 2" depth of compost and 6.7 pounds per 1,000 sq feet of Seed Area Fertilizer.
 4. Apply additional soil amendments as required by soil test analysis at the rate indicated by the analysis.
 5. Till soil amendments into topsoil to a minimum depth of 6".
- D. Finish Grading:
 1. Remove high spots and fill depressions.
 2. Drag and hand rake to produce smooth, even grades.
 3. Maintain existing grades at limits of Work.
 4. Slope to grades acceptable to the Landscape Architect.
 5. Provide positive, 2% minimum drainage and as shown on the Drawings.
 6. Provide positive, 2% drainage away from each tree.
 7. Remove gravel and stones larger than 1".
 8. Remove or break up soil clods larger than 1".
 9. Remove sticks, trash, debris, and material deleterious to plant life.

3.04 COMPLETION

- A. Adjusting and Cleaning:

1. Restore eroded, settled, or compacted soil to specified condition prior to landscape planting and seeding.
2. Remove excess topsoil and soil amendments from adjacent paving, curb, and walk surfaces.
3. Provide protective cover and barriers as necessary to prevent damage and staining.
4. Remove debris, topsoil, fertilizer, soil amendments, and soil mixes from curbs, walks, paving, and other improvement surfaces daily.
5. Sweep and hose down curb, pavement, and walk areas daily as necessary to maintain clean surfaces.
6. Transport surplus materials to a legal disposal area.

END OF SECTION

**SECTION 32 9200
HYDROSEEDING**

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Hydroseeding of rough seed areas.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.
 - 2. Maintenance Fertilizer
 - 3. Hydro (Wood Fiber) Mulch
 - 4. Tackifier
- B. Submit seed vendor's certified statement of analysis for seed mix.
 - 1. Comply with standards established by the Association of Official Seed Analysts.
 - 2. Seed shall have a guaranteed minimum germination rate of 80%.
 - 3. Seed must contain a maximum of 1.0% total weed seed by weight.

1.03 REGULATORY REQUIREMENTS

- A. Meet State of Oregon licensing requirements for the application of herbicides.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

1.05 SITE CONDITIONS

- A. Environmental Requirements:
 - 1. Apply seed when wind velocity is less than 5 miles per hour at the site.
 - 2. Do not seed when the air temperature is below 40°F or above 90°F.
- B. Scheduling:
 - 1. Perform seeding work after seeding areas are prepared, and other work affecting ground surface has been completed.
 - 2. Seed between April 15 and October 15, unless otherwise approved by the Owner.
 - 3. Apply seed within 4 hours after final preparation of seeding areas.
 - 4. If approved by Owner to seed after October 15, increase seed mixture by one pound per 1000 sq feet per week up to a total of 12 pounds per 1000 square feet.

1.06 MAINTENANCE

- A. Establishment Period: Begin maintenance immediately after each area is seeded and continue until project construction is complete or acceptance conditions have been met, but for not less than the following periods:
 - 1. Sixty (60) days from the date of seeding, or
 - 2. When the establishment period has not elapsed or seed is not fully established before the end of the planting season, continue maintenance during the next planting season.
- B. Maintenance:
 - 1. Irrigate seeded areas at a maximum rate of 0.5" of water per hour to keep soil materials moist.
 - 2. Do not operate equipment on seeded areas for the first 30 days to irrigate, weed, or replace seed without using plywood protection boards over prepared areas.
 - 3. Apply Fertilizer within the maintenance period at 5 pounds per 1,000 sq feet if required to supplement establishment after germination or as directed by the Landscape Architect.
 - 4. Water fertilizer thoroughly into soil.

- C. Repair of Seeded Areas:
 - 1. Apply seed to bare areas that occur in seeded areas during the maintenance period.
 - 2. Reseed areas where soil erosion or poor germination causes bare areas.
 - 3. Immediately remove and replace seeded areas showing excessive growth of undesirable perennial and annual weeds, deficient growth, or damage.
 - 4. Completely remove weeds including weed roots.
 - 5. Remove and replace unaccepted areas in accordance with requirements in this Section.
- D. Maintenance Conclusion: Notify Owner in writing 14 days minimum prior to Owner assuming maintenance responsibility for seeded areas.
- E. Acceptance:
 - 1. Acceptance of seeded areas is contingent upon meeting the requirements of this Section and the establishment of a healthy, weed-free stand of the seed mix.
 - 2. Coverage Requirements: 90% coverage over any 10 sq. ft. area, with bare spots not exceeding 12 by 12 inches.
 - 3. Re-establish unaccepted areas and provide maintenance as necessary to achieve specified results.

1.07 QUALIFICATIONS

- A. Installer Qualifications: The landscape construction professional as defined in ORS 671.520 and performing work under this section of the contract shall hold a valid landscape contractor's license in accordance with ORS 671.510 to 671.760.

PART 2 – PRODUCTS

2.01 SEEDING MATERIALS

- A. Maintenance Fertilizer and Accessories:
 - 1. Maintenance Fertilizer: Best Turf Gold 22-5-6, or approved equal.
 - 2. Vapor Retarder: 6 mil thick, black polyethylene sheet.
- B. Seed Mixes:
 - 1. Rough Seed: Custom mix. All individual species of seed distributed by Sunmark Seeds, 12775 NE Marx St. Portland, OR 97230 (503) 241-7333. Provide mix in the following percentages of seed by weight:
 - a. *Agropyron Spicatum* var *Anatone* – *Anatone Bluebunch Wheatgrass* – 35%
 - b. *Elymus trachycaulus* – *Slender Wheatgrass* – 25%
 - c. *Festuca idahoensis* – *Idaho Fescue* – 20%
 - d. *Achnatherum hymenoides* – *Indian Ricegrass* – 10%
 - e. *Festuca avina* – *Sheep Fescue* – 5%
 - f. *Achillea millefolium occidentalis* – *Western Yarrow* – 5%
 - 2. All seed shall be State of Oregon Department of Agriculture Certified Blue Tag Seed.
 - 3. Inoculate all seed blends with mycorrhizae according to the manufacturer's recommended application rate.
- C. Hydro Mulch:
 - 1. Material: Virgin wood cellulose fiber containing no growth or germination inhibiting factors.
 - 2. Application Metering Material: Green dye to facilitate visual metering.
 - 3. Performance Characteristics: Forms homogenous slurry upon agitation for rapid and even dispersal.
 - 4. Acceptable Wood Fiber Mulches: Eco-Fiber by Profile Products or approved equal.
- D. Binder or Tackifier: Agritek-PAM or approved equal.

2.02 PESTICIDES AND HERBICIDES

- A. Pesticides and herbicides, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides or herbicides unless authorized in writing by Authorities Having Jurisdiction (AHJ).

- B. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.03 EQUIPMENT

- A. Hydraulic Hydroseeding Equipment: Continuous mixing and agitating action to mix water, seed, and mulch for distribution of the mixture on seeded areas.
- B. Temporary Fence:
 - 1. Posts: Pre-painted 6' long steel tee posts, or accepted substitute.
 - 2. Fence: 4' high orange plastic safety fence.

PART 3 – EXECUTION

3.01 PERFORMANCE

- A. Verification of Conditions:
 - 1. Inspect condition of areas to be seeded.
 - 2. Verify compliance with required soil preparation as specified and as shown on the Drawings.
 - 3. Start of Hydroseeding Work indicates acceptance of subgrade and finish grade conditions.
- B. Protection of Adjacent Surfaces Prior to Seeding:
 - 1. Protect existing utility systems, paving, walks, curbs, and other site improvements from damage during seeding.
 - 2. Install 10 feet minimum width vapor retarder sheet cover at perimeter of hydro-seeding area to prevent hydroseeding drift on adjacent surfaces.
- C. Surface Preparation for Seeding:
 - 1. Comply with required soil preparation as specified and as shown on the Drawings.
 - 2. Lightly irrigate dry planting soil.
 - 3. Allow time for free surface water to drain prior to seeding.
- D. Hydroseeding:
 - 1. Seed all areas indicated on the Drawings.
 - 2. Apply seed, mulch, fertilizer, amendments, and water uniformly in one application with hydraulic equipment to prepared areas.
 - 3. Rough Seed: Apply 4 pounds seed per 1000 sq feet.
 - 4. Apply 70 pounds (dry weight) wood fiber mulch for each 1,000 sq feet and 2 pounds binder or tackifier for each 1,000 square feet.
 - 5. Apply mixture through a pressure spray distribution system providing a continuous, non-fluctuating discharge of mixture in the above quantities uniformly on seeding areas.
 - 6. Apply seed and mulch mixture using a sweeping, horizontal motion of spray distribution system.

3.02 PESTICIDE AND HERBICIDE APPLICATION

- A. Apply pesticides, herbicides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations.
- B. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.03 COMPLETION

- A. Adjusting and Cleaning:
 - 1. Contractor may adjust method of seeding application only when written request is acceptable to the Owner.
 - 2. At completion of Work in each area, remove debris, equipment, and surplus materials.
 - 3. Wash walks, walls, and paving areas adjacent to seeded areas to completely remove seed, mulch, soil materials, and stains from exposed surfaces.
- B. Installation of Temporary Fence:

1. Install temporary fence at perimeter of seeded areas where necessary to prohibit public access, and as directed by the Owner.
2. Install posts at 10 feet on center maximum, to a minimum depth of 18".
3. Keep fence erect and taut at all times.
4. Remove fence upon conclusion of the maintenance period.

END OF SECTION

SECTION 32 9300 PLANTING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Planting trees, shrubs, and ground covers.
- B. Mulching.
- C. Weed barrier.
- D. Plant establishment and warranty period.

1.02 SUBMITTALS

- A. Product Submittals:
 - 1. Mulch: Submit 1/2 gallon product samples prior to delivery at the site.
 - a. Bark mulch.
 - b. Crushed rock mulch.
 - c. Rock cobble mulch.
 - 2. Plant Guys: Submit a minimum 6-inch long physical sample of plant guys.
 - 3. Path Edge Restraint: Product data to include construction details, material descriptions, dimensions of individual components and profiles, finishes, field-assembly requirements, and installation details.
 - 4. Weed barrier: Minimum 12-inch square product sample.
- B. Quality Assurance Submittals:
 - 1. Submit written confirmation of plant order with landscape bid. Substitution requests for plants must be submitted prior to bidding. See submittal procedures.
 - 2. Submit Certificates required by law with plant shipments in the Closeout Manual.
 - 3. Submit notification to Owner 14 days minimum prior to Owner assuming plant maintenance responsibility that indicates the recommended landscape maintenance procedures for the next 60 days.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with minimum requirements for plant quality, grade tolerances, and caliper to height ratios as specified in American Standards for Nursery Stock, ANSI Z60.1.
 - 2. Meet or exceed the specifications of federal, state, and county laws requiring inspection of plants and planting material for plant disease control.
- B. Plant Names:
 - 1. Conform to Sunset Western Garden Book, current edition.
 - 2. Botanical names take precedence over common names.
- C. The Landscape Architect may reject plant material that does not meet specified standards at any time prior to Final Acceptance.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping:
 - 1. Notify the Landscape Architect of the delivery schedule so plant materials may be inspected upon delivery.
 - 2. Do not deliver more plant materials than can be planted in 48 hours.
 - 3. Deliver packaged materials in manufacturer's unopened containers, fully identified by name, brand, type, weight, and analysis.
- B. Storage and Protection:
 - 1. Protect plants against damage and dehydration.
 - 2. Cover plant roots and root balls with soil or other accepted material upon delivery, if not scheduled for planting within 4 hours.

3. Store plant materials in shade and protect against harmful weather.
4. Store packaged materials to prevent damage and intrusion of foreign matter.

1.05 SITE CONDITIONS

- A. Environmental Requirements:
 1. Do not plant when air temperature is less than 35°F or above 90°F.
 2. Do not plant when ground is frozen, excessively wet or dry.
 3. Do not plant when wind velocity exceeds 25 mph.
- B. Scheduling:
 1. Conduct landscape work when within the acceptable planting season for each kind of plant.
 2. Coordinate Work with other contractors.

1.06 PLANT WARRANTIES

- A. Warranty begins on date of Final Acceptance.
- B. Plant materials shall be in healthy condition at end of one-year warranty period, or for one full growing season after installation, whichever is longer.
- C. Replace unhealthy plants within 15 days or as approved by the Landscape Architect.
- D. Corrective Work shall be done within 15 days or as approved by the Landscape Architect.
- E. Contractor is not responsible for plants damaged by vandalism or theft during warranty period.

1.07 MAINTENANCE SERVICE AND PERIOD

- A. Begin maintenance service immediately after planting and continue until Final Acceptance.
- B. Water, weed, fertilize, spray, cultivate, mulch, reset plants to correct grade and upright position, remove dead wood, and perform other necessary maintenance work necessary for healthy growth.
- C. Remove fallen leaves, cones, and plant litter from landscape areas.
- D. Irrigate planting soils when necessary to avoid drying out of plant materials and to promote healthy growth.

1.08 QUALIFICATIONS

- A. Installer Qualifications: The landscape construction professional as defined in ORS 671.520 and performing work under this section of the contract shall hold a valid landscape contractor's license in accordance with ORS 671.510 to 671.760.

PART 2 PRODUCTS

2.01 PLANTS

- A. Nursery Stock:
 1. Healthy, well-branched and rooted, full-foliaged when in leaf, free of disease, injury, insects, weeds, and weed roots.
 2. Typical of plant species and variety.
 3. Plants held in storage will be rejected if they show signs of growth during storage.
 4. Do not use cold storage plants.
 5. Where drawings indicate row planting, furnish plants matched in form.
 6. Plants larger than specified in the plant list may be used when acceptable to the Landscape Architect at no additional cost to Owner.
 7. If use of larger plants is acceptable to the Landscape Architect, then increase the spread of roots or root ball in proportion to the plant size.
- B. Plant Names:
 1. Furnish plants true to name.
 2. Tag a minimum of one of each bundle or lot with common and botanical name.
- C. Balled and Burlapped Plants (B&B):

1. Ball and Burlap with natural ball of size to insure healthy growth.
 2. Dig with firm natural balls of earth of sufficient diameter and depth to encompass the feeding root system necessary for full recovery of the plant.
 3. Comply with ball sizes listed by American Standard for Nursery Stock.
 4. Cracked or broken balls are not acceptable.
- D. Container Grown Plants:
1. Furnish plants in removable containers or integral peat pots.
 2. Furnish plants well rooted to ensure healthy growth.
 3. Furnish plants grown in containers from six months to two years prior to delivery, with roots filling container but not root bound.
 4. Furnish plants grown in container for sufficient length of time for root system to hold container soil together.
- E. Trees:
1. Furnish species that mature at heights over 25 feet with a single main trunk.
 2. Do not furnish trees that have a main trunk with two or more co-dominant leaders.
 3. Do not furnish conifers which have been sheared as for Christmas tree stock.
 4. Trees shall not contain pruning wounds with a diameter of more than 1 inch. Pruning wounds must be made at branch collar and have sound bark on all edges.
- F. Shrubs and Ground Covers:
1. Furnish plants with spread and height requirements typical for the species in the specified container size.
 2. Furnish plants in a moist and vigorous condition, free of dead wood, bruises, root injuries, and branch injuries.
- G. Plant List: As indicated on the Drawings.
1. Contractor shall verify plant quantities indicated on the Drawings. Quantity errors on the Drawings are not the responsibility of the Owner or the Landscape Architect. Provide sufficient quantities of plants to complete work shown on the Drawings.

2.02 ACCESSORIES

- A. Bark Mulch:
1. Rexius Forest Products #0301322 BeautiBark.
 2. Free from weeds, seeds, and material harmful to plant life.
- B. Crushed Rock Mulch:
1. Grey, clean 3/4 inch to #10 crushed aggregate, no fines.
- C. Rock Cobble Mulch:
1. Clean, washed round river cobble, 1 inch to 3 inch size.
- D. Wood Stakes:
1. Wood Species and Grade: Douglas Fir, WCLIB or WWPA No. 2 or Construction grade.
 2. Nominal Size for Deciduous Trees: 2" x 2" square, or 2" diameter round, by 8 feet long, or larger if needed.
- E. Plant Guys:
1. Broad belt-type strapping or plastic chain, minimum 1" width.
- F. Path Edge Restraint:
1. Manufacturer: Permaloc or approved equal
 2. Model: CleanLine
 3. Size: 3/16" thickness x 5.5" height
 4. Material: Aluminum
 5. Finish: Mill Finish (manufacturer's standard)
 6. Website: <https://permaloc.com/edging/cleanline/>
- G. Weed Barrier:
1. VEVOR 3.2-ounce, woven weed barrier landscape fabric, 10 foot wide roll.

PART 3 EXECUTION

3.01 ACCEPTABLE PLANT INSTALLERS

- A. Employ a planting field superintendent to be present and direct performance of planting Work. Planting superintendent shall be familiar with planting materials and methods of installation.

3.02 PERFORMANCE

- A. Verification of Conditions:
 - 1. Examine planting areas and site conditions prior to starting work.
 - 2. Verify location of underground utilities prior to starting work.
 - 3. Starting work indicates acceptance of existing site conditions.
- B. Protection:
 - 1. Protect utility lines.
 - 2. Barricade and cover excavations as required to protect pedestrians, employees, equipment, and adjacent property.
 - 3. Protect existing shrubs and trees from damage, discoloration, and soiling.
 - 4. Protect existing and new improvements from damage, discoloration, and soiling.
 - 5. Provide protective cover and barriers as necessary to prevent damage and staining.
- C. Preparation:
 - 1. Comply with requirements in Section 32 91 13, Soil Preparation.
 - 2. Excavate pit to a minimum of three times diameter of root ball or root system, not less than 6" deeper for shrubs, and not to exceed depth of root ball for holes for balled trees.
 - 3. Assure plant pit drainage by flooding prior to planting.
 - 4. Immediately prior to planting, scarify bottom and sides of hole with shovel.
- D. Path Edge Restraint: Install in accordance with manufacturer's instructions and as detailed on the Drawings.
- E. Placement of Trees and Shrubs:
 - 1. Set top of root ball 1-1/2 inches above top of prepared topsoil.
 - 2. If hole is too deep, fill hole with compacted soil to correct levels. Deep planting is not permitted.
 - 3. Install plants upright and face plants to give best appearance and relationship to adjacent plants and structures.
 - 4. Remove root ball containers completely.
 - 5. After trees have been set in plant pit, remove top and sides of wire baskets. Use bolt cutters to cut wire in several places and remove wire from plant pit. Remove fasteners and burlap wrapping from top third of root ball. Do not bury wire and fasteners in landscape; dispose of legally.
 - 6. Trim broken and frayed roots and any circularly growing roots conforming to the container shape.
 - 7. Adjust plant locations to minimize conflicts with irrigation equipment.
- F. Installation of Tree Support: Guy and stake deciduous trees from two directions as detailed on the Drawings.
- G. Planting Trees and Shrubs:
 - 1. Cut off broken and frayed roots.
 - 2. Place and compact prepared planting soil carefully to avoid injury to roots and fill voids.
 - 3. When hole is filled to within 4" of top of prepared topsoil, fill with water and let stand until water is absorbed by soil.
 - 4. Backfill with prepared topsoil and compact to eliminate voids.
 - 5. Place Mycorrhizae Tablets in each plant pit as specified in Section 32 91 13, Soil Preparation. Ensure tablets are in direct contact with plant roots or rootball.
 - 6. Do not perform initial watering of trees and shrubs by irrigation system. Water plants thoroughly by hand with a hose immediately after planting.

7. Plant Hydration System: For trees not provided with automatic irrigation (see Drawings), install 36" Tree Diaper per manufacturer's direction. Minimum four stakes per tree diaper.
- H. Planting Ground Covers:
 1. Install plants at spacing indicated.
 2. Dig holes large enough to allow spreading of roots.
 3. Backfill with prepared soil mix and compact to eliminate voids.
 4. Place Mycorrhizae Tablets in each plant pit as specified in Section 32 91 13, Soil Preparation. Ensure tablets are in direct contact with plant roots.
 5. Slightly dish soil surface at each plant and water thoroughly.
- I. Pruning Trees and Shrubs: Prune trees and shrubs to remove damaged, dead and poorly connected branches.
- J. Weed Barrier:
 1. Install weed barrier in all planter areas according to manufacturer's instructions.
 2. At each plant location cut a hole in the weed fabric twice the size of the plant container. At the edge of planting areas tuck the fabric into the soil.
 3. Secure weed barrier with stakes supplied by manufacturer according to installation instructions.
- K. Mulching:
 1. Apply mulch over weed barrier at the following thickness within two days after planting.
 - a. Bark Mulch: 3 inches.
 - b. Crushed Rock Mulch: 2 inches.
 - c. Rock Cobble Mulch: 4 inches.
 2. Keep mulch 2 inches away from tree trunk.
 3. Lift plant foliage above mulch where required to prevent mulch contact with foliage.

3.03 ADJUSTING AND CLEANING

- A. Remove defective trees, plants, and ground covers from the site within 8 hours after site delivery.
- B. Repair damage to utility lines and site improvements because of planting work.
- C. Reshape finish grade to match adjacent surfaces.
- D. Replace defective trees, plants, and ground covers prior to Final Acceptance or where necessary during next planting season.
- E. Remove all weeds from project landscape area.
- F. Ensure weed fabric is completely covered by mulch in all planter areas.
- G. Remove excess materials from the site.
- H. Sweep clean adjacent paving, curbs, walls, and walk surfaces.

END OF SECTION

**SECTION 33 0110.58
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 33 14 16 - Site Water Utility Distribution Piping.

1.03 REFERENCE STANDARDS

- A. AWWA B300 - Hypochlorites; 2024.
- B. AWWA B301 - Liquid Chlorine; 2024.
- C. AWWA B302 - Ammonium Sulfate; 2023.
- D. AWWA B303 - Sodium Chlorite; 2024.
- E. AWWA C651 - Disinfecting Water Mains; 2023.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Test Reports: Indicate results comparative to specified requirements.
- C. 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.
- D. 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 conforms, or fails to conform, to bacterial standards of Medford Water Commission.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with AWWA C651.

1.06 REGULATORY REQUIREMENTS

- A. Conform to applicable code or regulation for performing the work of this Section.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of water system.

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. Coordinate acceptable chemical with plumbing code and authority having jurisdiction.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping system 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 (verify with authority having jurisdiction).
- 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 150 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 0513
MANHOLES AND STRUCTURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Modular precast concrete manhole and vault sections with tongue-and-groove joints, covers, anchorage, and accessories.

1.02 REFERENCE STANDARDS

- A. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- B. ACI 530/530.1/ERTA - Building Code Requirements and Specification for Masonry Structures and Related Commentaries; 2011.
- C. ASTM C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections; 2015.
- D. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals; 2008 (Reapproved 2013).
- E. IMIABC (CW) - Recommended Practices & Guide Specifications for Cold Weather Masonry Construction; International Masonry Industry All-Weather Council; 1993.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate manhole and vault locations, elevations, piping sizes and elevations of penetrations.
- C. Product Data: Provide manhole and vault covers, component construction, features, configuration, and dimensions.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.05 FIELD CONDITIONS

- A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530/530.1/ERTA or applicable building code, whichever is more stringent.

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. Concrete: As specified in Section 03 30 00.
- C. Mortar and Grout: As specified in Section 04 20 00, Type S.

2.02 COMPONENTS

- A. Lid and Frame: ASTM A48/A48M, Class 30B Cast iron construction, machined flat bearing surface, removable lockable (where specified) lid, closed lid design; live load rating of 11,520 psf; lid molded with identifying name ;.

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. Pipe Entry: Provide openings as indicated.

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 MANHOLES

- A. Place manhole sections plumb and level, trim to correct elevations, anchor to base pad.
- B. Cut and fit for pipe.
- C. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required.
- D. Set cover frames and covers level without tipping, to correct elevations.
- E. Coordinate with other sections of work to provide correct size, shape, and location.

END OF SECTION

SECTION 33 1416
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. Pipe and fittings for site water lines including domestic water lines and fire water lines.
- E. Valves and Fire hydrants.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for thrust restraints.
- 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.
- E. Section 33 01 10.58 - Disinfection of Water Utility Piping Systems: Disinfection of site service utility water piping.

1.03 REFERENCE STANDARDS

- A. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- B. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- C. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020 (Reapproved 2024).
- D. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals; 2019.
- E. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2023.
- F. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2023.
- G. AWWA C502 - Dry-Barrel Fire Hydrants; 2024.
- H. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 48-In. (50-mm Through 1,200-mm) NPS; 2025.
- I. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service; 2023.
- J. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances; 2023.
- K. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 60 In. (100 mm through 1500 mm); 2022.
- L. UL 246 - Hydrants for Fire-Protection Service; Current Edition, Including All Revisions.
- M. City of Klamath Falls Standards for Water Facilities.

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, mechanical joint and fitting restraint devices, 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.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with City of Klamath Falls requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS

2.01 WATER PIPE

- A. Ductile Iron Pipe: AWWA C151/A21.51:
 - 1. Fittings: Ductile iron, standard thickness.
- B. Copper Tubing: ASTM B88, Type K, Annealed:
- C. PVC Pipe: ASTM D1785, Schedule 40.
 - 1. Joints: ASTM D2855, solvent weld.
- D. PVC Pipe: AWWA C900 Class 150:
 - 1. Joints: ASTM D3139 compression gasket ring.
- E. Trace Wire: Magnetic detectable conductor, brightly colored blue plastic covering, imprinted with "Water Service " in large letters.

2.02 VALVES

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Gate Valves Up To 3 Inches:
 - 1. Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, compression ends, with control rod, post indicator, valve key, and extension box.
- C. Gate Valves 3 Inches and Over:
 - 1. 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.
- D. Ball Valves Up To 2 Inches:
 - 1. Brass body, Teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA inlet end, compression outlet with electrical ground connector, with control rod, valve key, and extension box.
- E. 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.

2.03 HYDRANTS

- A. Hydrants: Type as required by Medford Water Commission.
- B. Hose and Streamer Connection: Match sizes with utility company, two hose nozzles, one pumper nozzle, pumper nozzle must face street.
- C. Finish: Primer and two coats of enamel in color required by utility company.

2.04 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in Section 31 23 16.13.
- B. Cover: As specified in Section 31 23 16.13.

2.05 ACCESSORIES

- A. Concrete for Thrust Restraints: Concrete type specified in Section 03 30 00.
- B. Mechanical Joint & Fitting Restraint: All pipe and fittings shall be restrained as specified on plan set. Mechanical restraint shall be by Romac Industries, Inc., or EBAA Iron, Inc, or

approved equal. Fitting and joint restraint systems shall be installed as specified by respective system manufacturer for the type of pipe being restrained. Contractor shall submit for approval the manufacturers installation specifications for product being used.

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 Section 31 23 16.13 for additional requirements.

3.04 INSTALLATION - PIPE

- A. Maintain separation of water main from sewer piping in accordance with applicable code.
- B. Establish elevations of buried piping to ensure not less than 3 ft of cover from finished grade for fire line. Domestic water line elevation to be established below local frost line.
- C. Install ductile iron piping and fittings to AWWA C600.
- D. Route pipe in straight line.
- E. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- F. Install access fittings to permit disinfection of water system performed under Section 33 01 10.58.
- G. Install trace wire 6 inches above top of pipe; coordinate with Section 31 23 16.13.

3.05 INSTALLATION - VALVES AND HYDRANTS

- 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.

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 150 pounds per square inch.
- D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

END OF SECTION

**SECTION 33 3113
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 existing sewer stubs, mains, or manholes.
- 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.
- D. Section 31 23 23 - Fill: Bedding and backfilling.
- E. Section 33 05 13 - Manholes and Structures.

1.03 REFERENCE STANDARDS

- A. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- B. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2025.
- C. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2021.
- D. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2024, with Editorial Revision (2025).
- E. City of Klamath Falls Design Standards.

1.04 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. 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.

1.06 REGULATORY REQUIREMENTS

- A. Conform to applicable code for materials and installation of the Work of this section.

1.07 PROJECT CONDITIONS

- A. Coordinate the Work with termination of sanitary sewer connection outside building, connection to existing system, and trenching.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

- A. Plastic Pipe: ASTM D3034, Type PSM, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter of (per plan) inches, bell and spigot style solvent sealed joint end.
- 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.

2.02 PIPE ACCESSORIES

- A. Trace Wire: Magnetic detectable conductor, brightly colored green plastic covering, imprinted with "Sewer Service " in large letters.

2.03 BEDDING AND COVER MATERIALS

- A. Pipe Bedding Material: As specified in Section 31 23 16.13.
- B. Pipe Cover Material: As specified in Section 31 23 16.13.

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.
 - 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 sanitary sewer outlet .
- 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 Owner.
- C. Pressure Test: Test in accordance with current Oregon Plumbing Specialty Code standards/requirements.
- D. Deflection Test: Test in accordance with current Oregon Plumbing Specialty Code standards/requirements.

3.06 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 33 4100 SUBDRAINAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Building Perimeter and Retaining Wall Drainage Systems.
- B. Filter aggregate and fabric and bedding.

1.02 RELATED REQUIREMENTS

- A. Section 31 23 16 - Excavation: Excavating for subdrainage system piping and surrounding filter aggregate.
- B. Section 31 23 16.13 - Trenching: Excavating and backfilling for site subdrainage systems.
- C. Section 31 23 23 - Fill: Backfilling over filter aggregate, up to subgrade elevation.

1.03 REFERENCE STANDARDS

- A. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2021.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- C. Project Record Documents: Record location of pipe runs, connections, cleanouts and principal invert elevations.

1.05 REGULATORY REQUIREMENTS

- A. Conform to applicable code for materials and installation of the work of this section.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

- A. Polyvinyl Chloride Pipe: ASTM D2729; plain end, 4 and 6 inch inside diameter (see plan); with required fittings.
- B. Corrugated Plastic Tubing: Flexible type; 4 and 6 inch diameter, with required fittings.
- C. Use perforated pipe at subdrainage system; unperforated through sleeved walls.

2.02 AGGREGATE AND BEDDING

- A. Filter Aggregate and Bedding Material: Granular fill as specified in Section 31 23 23.

2.03 ACCESSORIES

- A. Pipe Couplings: Solid plastic.
- B. Filter Fabric: Water pervious type, black polyolefin. Refer to Section 31 23 23: Geotextile Fabric - Filter

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

3.02 PREPARATION

- A. Hand trim excavations to required elevations. Correct over-excavation with approved 3/4" minus ODOT spec.
- B. Remove large stones or other hard matter that could damage drainage piping or impede consistent backfilling or compaction.

3.03 INSTALLATION

- A. Install and join pipe and pipe fittings in accordance with pipe manufacturer's instructions.
- B. Place drainage pipe on compacted impervious fill.
- C. Lay pipe to slope gradients noted on drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
- D. Place pipe with perforations facing down. Mechanically join pipe ends.
- E. Install filter aggregate at sides, over joint covers and top of pipe. Provide top cover compacted thickness of 12 inches.
- F. Place filter fabric around and over levelled top surface of Drainage Fill aggregate cover prior to subsequent backfilling operations.
- G. Refer to Section 31 23 23 for compaction requirements. Do not displace or damage pipe when compacting.
- H. Connect to storm sewer system with unperforated pipe at locations indicated on plan. Provide approved backflow check valves as specified on plan.

3.04 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspection and testing.
- B. Request inspection prior to and immediately after placing aggregate cover over pipe.

3.05 PROTECTION

- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation begins.

END OF SECTION

**SECTION 33 4211
SITE STORM UTILITY DRAINAGE PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Stormwater drainage piping.
- B. Stormwater pipe accessories.
- C. Connection of drainage system to existing drainage systems (public and private).
- D. Catch basins, Plant area drains, Paved area drainage, and Site surface drainage.

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 31 23 23 - Fill: Bedding and backfilling.
- E. Section 33 05 13 - Manholes and Structures.

1.03 REFERENCE STANDARDS

- A. AASHTO M 36 - Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains; 2024.
- B. AASHTO M 252 - Standard Specification for Corrugated Polyethylene Pipe, 75- to 250-mm (3- to 10-in.) Diameter; 2024.
- C. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- D. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe; 2020 (Reapproved 2025).
- E. ASTM C14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric); 2020 (Reapproved 2025).
- F. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 2022a.
- G. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2021.
- H. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric); 2021.
- I. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- J. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2025.
- K. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping; 2020.
- L. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2021.
- M. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2024, with Editorial Revision (2025).
- N. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials; 2024.
- O. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2014 (Reapproved 2021).

- P. ASTM F405 - Standard Specification for Corrugated Polyethylene Drainage Pipe and Fittings in Nominal sizes 3 inches to 6 inches in diameter.
- Q. ASTM F667 - Standard Specification for Large Diameter Corrugated Polyethylene Drainage Pipe and Fittings in Nominal sizes 8 inches to 24 inches in diameter.

1.04 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- C. Project Record Documents:
 - 1. Record location of pipe runs, connections, and invert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.06 REGULATORY REQUIREMENTS

- A. Conform to applicable code for materials and installation of the Work of this section.

1.07 PROJECT CONDITIONS

- A. Coordinate the Work with termination of storm sewer connection outside building, trenching, connection to foundation drainage system and municipal sewer utility service.

PART 2 PRODUCTS

2.01 STORMWATER PIPE MATERIALS

- A. Corrugated HDPE Pipe and Fittings: ASTM F 2306.
- B. Corrugated HDPE Pipe and Fittings: ASTM F 2648.
- C. Concrete Pipe: Nonreinforced, ASTM C14 ((ASTM C14M)), Class 1; inside nominal diameter of per plan inches, bell and spigot end joints.
- D. Concrete Pipe Joint Devices: ASTM C443 ((ASTM C443M)) rubber compression gasket joint.
- E. Reinforced Concrete Pipe Joint Device: ASTM C443 ((ASTM C443M)) rubber compression gasket joint.
- F. Plastic Pipe: ASTM D3034, Type PSM, Poly Vinyl Chloride (PVC) material; inside nominal diameter of per plan inches, bell and spigot style solvent sealed joint end.
- G. Corrugated Steel Pipe: AASHTO M 36 Type I; nominal diameter of per plan inches, _____ end joints; helical lock seam; coated inside and out with 0.050 inch thick bituminous coating.
- H. Coupling Bands: Galvanized steel, 0.052 inches thick x 10 inches wide; connected with two neoprene "O" ring gaskets and two galvanized steel bolts.
- I. Polyethylene Pipe: Corrugated HDPE pipe and fittings, Hancor Sur-Lok or ADS N-12 (all pipe joints to be water tight).

2.02 PIPE ACCESSORIES

- A. Elastomeric Seals (Gaskets): ASTM F477.
- B. Trace Wire: Magnetic detectable conductor, brightly colored green plastic covering, imprinted with "Storm Sewer Service " in large letters.
- C. Downspout Boots: Smooth interior without boxed corners or choke points; include integral lug slots and on-body cleanout and cover with neoprene gaskets.
 - 1. Configuration: Angular.
 - 2. Material: Cast iron; ASTM A48/A48M; casting thickness 3/8 inch, minimum.

3. Accessories: Manufacturer's standard stainless steel fasteners, stainless steel building wall anchors, and rubber coupling.

2.03 CATCH BASIN, TRENCH DRAINS, CLEANOUT, AND AREA DRAIN COMPONENTS

- A. Lids and Drain Covers:
 1. Catch Basin: Per plan
 2. Cleanout: Per plan
 3. Area Drain: Per plan

2.04 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 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

- 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 system.
- E. Connect to building collection pits .
- F. Install continuous trace wire 6 inches above top of pipe; coordinate with Section 31 23 16.13.

3.03 INSTALLATION - CATCH BASINS 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 (where applicable).
- 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.

3.04 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 Owner.
- C. Pressure Test: Test in accordance with Oregon Plumbing Specialty Code standards/requirements.
- D. Deflection Test: Test in accordance with Oregon Plumbing Specialty Code standards/requirements.

3.05 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION