

SPECIFICATIONS
(Volume 2 of 3)
DESIGN DEVELOPMENT PHASE



for

BLOOMFIELD PUBLIC LIBRARY
McMAHON WINTONBURY LIBRARY

1015 BLUE HILLS AVENUE
BLOOMFIELD, CT 06002

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SECTION 220500 - PLUMBING GENERAL CONDITIONS

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.
- B. This project will be commissioned. Refer to Section 019100, 220800, and other applicable sections for commissioning information and responsibilities. The commissioning process will require additional labor, material and/or other costs which must be provided by the work of this Division.

1.2 LEED BUILDING GENERAL REQUIREMENTS

- A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED (Leadership in Energy and Environmental Design) Green Building Rating System NC, Version 2.2, Silver rating. Specific project goals that may impact this area of work including, but not limited to: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the stated LEED BUILDING Performance Criteria.

1.3 COMMISSIONING

- A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 01 91 13 - General Commissioning Requirements.
- B. Complete installation, startup checks and functional tests according to Section 01 91 13 - General Commissioning Requirements and manufacturers written instructions.
- C. Operational Test: After electrical system has been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new ones and repeat the start up procedure.
- D. Verify that equipment is installed and commissioned as per requirements of Section 01 91 13 and manufacturers written instructions/requirements.

1.4 DESCRIPTION

- A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.
- B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein.
- C. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division.
- D. The following information contains specifications of Work in connection with, and in addition to, this Division:
 - 1. All drawings associated with the project.
 - 2. All specifications associated with the project.
- E. Division of work responsibilities shall be as defined and directed by the Bidding Agent and/or the Bidding General Contractor.

1.5 INTENT

- A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation.
- B. Furnish, deliver and install any apparatus, appliance, material or Work not shown on Drawings but mentioned in the Specifications, or vice versa, or any incidental accessories necessary to make the Work complete and perfect in all respects and ready for operation, even if not particularly specified, under their respective Section without additional expense to the Owner.
- C. Include in the work minor details not usually shown or specified but necessary for proper installation and operation, as though they were hereinafter shown or specified.
- D. Provide Engineer written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of Work omitted. In the absence of such written notice, it is mutually agreed that Work under each Section has included the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.
- E. The Work indicated is diagrammatic. The Architect and/or Engineer may require as part of this Contract, the relocation of devices to reasonable distances from the general locations shown.
- F. Verbal clarifications of the Drawings or Specifications during the bid period are not to be relied upon. Refer any questions or clarifications to the Engineer at least five Working days prior to bidding to allow for issuance of an addendum. After the five-day deadline, Bidder must make a decision and qualify the Bid, if the Bidder feels it necessary.

1.6 DRAWINGS

- A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. (Do not scale the Drawings.) Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect.
- B. Closely follow Drawings in layout of Work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom. Where space conditions appear inadequate, Engineer shall be notified before proceeding with installations.
- C. Engineer may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.
- D. Where variances occur between the Drawings and Specifications or within either of the Documents, include the item or arrangement of better quality, greater quantity or higher cost in the Contract price. The Engineer shall decide on the item and the manner in which the work shall be installed.

1.7 SURVEYS AND MEASUREMENTS

- A. Before submitting a Bid, the Contractor shall visit the site and shall become thoroughly familiar with all conditions under which the work will be installed. Contractor will be held responsible for any assumptions, omissions or errors made as a result of failure to become familiar with the site and the Contract Documents.
- B. Base all measurements, both horizontal and vertical, from established bench marks. All Work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the Work.
- C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or the intent of the Drawings and Specifications, notify the Engineer do not proceed with that Work until instructions have been received from the Engineer.

1.8 CODES AND STANDARDS

- A. The Codes and Standards listed below apply to all Work. Where Codes or Standards are mentioned in these Specifications, follow the latest edition or revision.
- B. The current adopted editions of the following State or local Codes apply:
 - 1. Connecticut State Building Code with Amendments to the following:
 - a. International Building Code
 - b. International Mechanical Code
 - c. International Plumbing Code
 - d. Connecticut Gas Equipment and Piping Code

- e. National Electrical Code (NFPA 70)
 - f. International Energy Conservation Code
 - g. ICC/ANSI A117.1-2009 Accessible and Usable Buildings and Facilities
- C. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.
- D. Include in the Work, without extra cost to the Owner, any labor, materials, testing, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on Drawings and/or specified.

1.9 PERMITS AND FEES

- A. Give all necessary notices, obtain all permits; pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the Work. File all necessary Drawings, prepare all Documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspections for Work and deliver a copy to the Engineer before request for acceptance and final payment for the Work.

1.10 SEISMIC RESTRAINT

- A. General: This project is in a seismic zone per State and/or Local Codes and Ordinances and all materials and equipment shall be installed, supported, and seismically restrained accordingly. Verify current seismic requirements based on project location and with Code requirements.
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of vibration isolation bases and seismic restraints that are similar to those required for this Project in material, design, and extent.
- C. Shop Drawings: Show designs and calculations, certified by a professional engineer, for the following:
- 1. Design Calculations: Calculations for selection of vibration isolators, design of vibration isolation bases, design of seismic supports and selection of seismic restraints for all equipment and materials.
 - 2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to the structure and to the supported equipment. Include auxiliary motor slides and rails, and base weights.
 - 3. Seismic Restraint Details: Detail fabrication and attachment of restraints, supports and snubbers.
 - 4. Seismic Separation Assemblies: Refer to the Architectural and/or Structural drawings for locations of seismic joints.

- D. Installation: Installation shall be carried out in strict accordance with the Seismic Engineer's submittal, current Code, accepted standards and the equipment and material manufacturers' recommendations.

1.11 COORDINATION

- A. Carry out all work in conjunction with other trades and give full cooperation in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the General Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, access doors, etc. required by other trades, and to allow for serviceable access to equipment.
- B. Mechanical contractors' shall initiate coordination drawings and sections clearly showing how the work is to be installed in relation to the work of other trades, at no extra charge to the Owner. The Contractors' shall prepare coordination drawings at a scale no less than 1/4"=1'-0", showing the work of all trades, including but not limited to, the following: proposed ductwork installation in detail, including ceiling heights, approved structural steel shop drawings, duct heights, access doors, light fixtures, registers and diffusers, sprinkler piping, electrical distribution conduits, wires, panels and any other electrical work which may conflict with the sheet metal ducts or piping, waste and vent piping, water piping, storm piping, and rain leaders. Provide elevation details showing connections and equipment layout and configuration based on approved submittals. Each shall use a different color code. A coordination meeting of all Contractors involved is then to be held and all possible conflicts are to be resolved. All trades shall sign acceptance of the drawings and then shall submit two (2) prints of each drawing to the Engineer for record.
- C. Contractors are required to examine all of the Project Drawings and mutually arrange Work so as to avoid interference. In general, ductwork, heating piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer regarding the arrangement of Work, which cannot be agreed upon by the Contractors, will make final decisions. Service of equipment will take precedence.
- D. Where the Work of the Contractor will be installed in close proximity to or will interfere with Work of other trades, assist in working out space conditions to make a satisfactory adjustment.
- E. If Work is installed before coordinating with other Divisions or so as to cause interference with Work of other Sections, the Contractor causing the interference will make necessary changes to correct the condition without extra charge to the Owner.
- F. Initial contact and coordination has been conducted with utility entities for the purpose of the preparation of Bid Documents. The Contractor shall coordinate all final specific utility requirements.

1.12 ACCEPTANCES

- A. The equipment, materials, Workmanship, design and arrangement of all Work installed are subject to the review of the Engineer.
- B. Within 30 days after the awarding of a Contract, submit to the Engineer for review a list of manufacturers of equipment proposed for the Work. The intent to use the exact makes specified does not relieve the Contractor of the responsibility of submitting such a list.
- C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, notify the Engineer, in writing, within 30 days of the awarding of the Contract. In such instances, deviations may be made pending acceptance by the Engineer or the Owner's representative.
- D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog or model number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.
- E. If material or equipment is installed before shop drawing review, liability for its removal and replacement is assumed by the Contractor, at no extra charge to the Owner, if, in the opinion of the Engineer, the material or equipment does not meet the intent of the Drawings and Specifications.
- F. Failure on the part of the Engineer to reject shop drawings or to reject Work in progress shall not be interpreted as acceptance of Work not in conformance with the Drawings and/or Specifications. Correct Work not in conformance with the Drawings and/or Specifications whenever non-conformance is discovered.

1.13 EQUIPMENT DEVIATIONS

- A. Where the Contractor proposes to deviate (substitute or provide an equivalent) from the equipment or materials as hereinafter specified, he shall do so by making a request in writing within 60 days from the Award of Contract. The Contractor shall state in his request whether it is a substitution or an equivalent to that specified, and the amount of credit involved. A copy of said request shall be included in the Base Bid with manufacturer's equipment cuts.
 - 1. The Base Product Specification shall be based on using the materials and equipment as specified and scheduled with no exceptions. Equipment Manufacturers Scheduled on Drawings are considered Base Product Specification and any other acceptable manufacturers listed in the specifications is considered an equivalent manufacturer to the Base Product Specification. Unlisted manufacturers are considered a substitution and equipment deviation and subject to the requirements for equipment substitution and deviation. When any alternate manufacturer does not qualify acceptable, as determined by the Engineer, provide the Base Bid manufacturer at no additional cost to Owner.

2. Where an equivalent manufacturer is listed in the specifications, it may or may not indicate that there is an equal product available. Any products must meet all criteria of the Base Product Specification as determined by the Engineer.
- B. Substitutions and Equipment Deviations will not be considered if they have a direct bearing on the changing or revising of Contract Documents or if it involves other Contractor's scope of work or thier equipment. Coordination with all trades is required and must be acceptable to all other involved Contractors.
- C. Substitutions may be considered for one of the following:
1. Substitution for Cause: Changes proposed by the Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of warranty terms.
 2. Substitutions for Convenience: Changes proposed by the Contractor or Owner that are not required in order to meet other Project requirements, but may offer advantage to either the Owner or Contractor.
- D. In these Specifications and on the accompanying Drawings, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. This has been done for convenience in fixing the standard of workmanship, finish and design required for installation. In the event that only one (1) manufacturer of a product is specified and it is found that the manufacturer has discontinued the product, the Contractor shall use an acceptable equivalent product that meets the requirements of an equivalent product, as noted below, and has all the features of the originally specified product. The details of workmanship, finish and design, and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.
- E. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineer's review.
- F. Where two or more names are given as equivalents, the Contractor must use the specified item or one of the named equivalents. Where one name only is used and is followed by the words "or acceptable equivalent", the Contractor must use the item named or he may apply for an equipment deviation through the prescribed manner in accordance with this Specification.
- G. Equipment, material or devices submitted for review as an "accepted equivalent" shall meet the following requirements:
1. The equivalent shall have the same construction features such as, but not limited to:
 2. Material thickness, gauge, weight, density, etc.
 3. Welded, riveted, bolted, etc., construction
 4. Finish, undercoatings, corrosion protection
 5. The equivalent shall perform with the same or better operating efficiency.
 6. The equivalent shall have equal or greater reserve capacity.
 7. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
 8. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as AMCA or ARI labels.

- H. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Designers of Record at the expense of the Contractor and at no additional cost to the Owner.
- I. Where such accepted deviation or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, with the acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the substitution.
- J. The Engineer shall determine if an "accepted equivalent" to a manufacturer listed in the Specifications is considered acceptable.

1.14 SHOP DRAWINGS

- A. Refer to individual specification sections for additional submittal information.
- B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed.
- C. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Contract. Refer to the General Conditions and Supplementary General Conditions for the quantity of copies required for submission. Where quantities are not specified, provide seven (9) copies for review.
- D. Provide shop drawings for all devices specified under equipment specifications for all systems, materials, equipment and/or devices. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures) of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal. Partial submissions shall be rejected.
- E. Equipment shop drawings shall contain full range performance curves, graphs, tables or other pertinent data which clearly indicates operational range of a given unit size. Computer generated/plotted curves, based solely on design performance, will not be accepted.
- F. All specific options and/or alternatives shall be clearly indicated. Failure to do so shall be grounds for rejection.

- G. Submittals shall be marked with the trade involved, i.e., HVAC, plumbing, fire protection, etc. and the specific associated specification section.
- H. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.
- I. Failure to submit shop drawings in ample time for review shall not entitle the Contractor to an extension of Contract time. Contractor must allow for a one week review at the Engineer's office plus normal delivery time to the G.C., Architect, Engineer, and return to the Architect, and G.C. No claim for extension by reason of such default will be allowed, nor shall the Contractor be entitled to purchase, furnish and/or install equipment which has not been reviewed by the Engineer. The Contractor shall incur all costs associated with delay of construction due to equipment and/or materials arriving late due to late or improper shop drawing submittal.
- J. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.
- K. Acceptance rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not indicate that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings.
- L. Acceptance of shop drawings shall not apply to quantity nor relieve Contractor of his responsibility to comply with intent of Drawings and Specifications.
- M. Acceptance of shop drawings is final and no further changes will be allowed without the written consent of the Engineer.
- N. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.
- O. Contractor shall make any corrections required by Engineer and shall resubmit required number of corrected copies of shop drawings or new samples until accepted. Contractor shall direct specific attention in writing or on resubmitted shop drawings to revisions other than corrections requested by Engineer on previous submissions. Engineer shall review no more than one resubmittal of any shop drawing or sample at Owner's expense. The fees for review of additional resubmittals shall be paid by the Contractor at the Engineer's standard rates.

1.15 CHANGES IN WORK

- A. A Change Order is a written order to the Contractor signed by the Owner and the Architect, issued after Contracts have been awarded, authorizing a change in the work or an adjustment in the Contract sum or the Contract time. A Change Order signed by the Contractor indicates his agreement therewith, including the adjustment in the Contract sum or the Contract time.
- B. All changes in the work shall follow the recommendations of the AIA "General Conditions of the Contract for Construction", Article 12.

1.16 MANUFACTURER'S IDENTIFICATION

- A. All component parts of each item of equipment or device shall bear the manufacturer's nameplate giving name of manufacturer, description, size, type, serial and model number, electrical characteristics, etc., in order to facilitate maintenance or replacement. Nameplate data shall not be obstructed. The nameplate of a Contractor or distributor will not be acceptable.
- B. All material and equipment for the electrical portion of the mechanical systems shall bear the label of or be listed by UL, or other accredited authoritative agencies or testing organizations approved by the authority having jurisdiction.

1.17 RECORD DRAWINGS

- A. Maintain at the job site a record set of Project Drawings on which any changes in location or routing of all equipment, materials and access panels shall be recorded.
- B. At the end of construction, the Contractor shall provide the Owner with a complete set of As-Built Drawings, including all updated coordination drawings, ductwork and piping plans. As-Builts shall be drawn on the latest version of Autocad or compatible software, approved in writing, prior to submittal. The Owner shall be provided with a "CD Rom" disk and one set of reproducible mylar sepias.

1.18 MATERIALS AND WORKMANSHIP

- A. All materials and apparatus required for the work, except as otherwise specifically indicated, shall be new, of first-class quality, and shall be furnished, delivered, erected, connected and finished in every detail and be so selected and arranged as to fit properly into the building spaces. Where no specific type or quality of material is given, a first-class standard article as accepted by industry standards shall be furnished.
- B. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, fitters, metal workers, welders, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.

- C. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.
- D. All labor for installation of mechanical systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.19 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.
- B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.
- C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.
- D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.20 BASES AND SUPPORTS

- A. Unless otherwise specifically noted, the Contractor shall furnish all necessary supports, rails, framing, bases and piers required for all equipment furnished under this Division.
- B. Unless otherwise indicated in individual trade Sections, pumps, fans, air handlers, boilers, chillers, tanks, compressors and other rotating machinery shall be mounted on a minimum of six (6") inch high concrete pads which shall be furnished and installed per Division 3. All pads shall be extended six (6") inches beyond machine base in all directions with top edge chamfered. Shop drawings of all foundations and pads shall be submitted to the Engineer for review before they are constructed. The Mechanical Contractor shall field coordinate all required dimensional and necessary loading information.

- C. Construction of foundations, supports, pads, bases and piers where mounted on the floor shall be of the same finish quality as the adjacent and surrounding flooring material.
- D. Unless otherwise shown, all equipment shall be securely attached to the building structure in an acceptable manner. Attachments shall be of a strong and durable nature; any attachments that are insufficient, in the opinion of the Engineer, shall be replaced as directed without extra cost to the Owner.
- E. All equipment supports shall be designed and constructed such that the equipment will be capable of resisting both vertical and horizontal movement. The equipment shall be positively anchored to the bases or supports to resist vertical movement. The equipment and its supports shall be provided with suitable restraints to resist horizontal movement from any direction as dictated by applicable seismic Codes.

1.21 SLEEVES, INSERTS AND ANCHOR BOLTS

- A. The Contractor shall provide, set in place and be held responsible for the location of all sleeves, inserts and anchor bolts required for the work. In the event that failure to do so requires cutting and patching of finished work, it shall be done at the Contractor's expense.
- B. It is the responsibility of the Contractor to furnish cast-in-place steel sleeves, inserts and anchors in sufficient time to be installed during initial concrete pours. Where job schedules make this impossible, coordinate and obtain acceptance from the Structural Engineer for alternate installation methods.
- C. All pipes and conduits passing through floors, walls or partitions shall be provided with sleeves having an inside diameter one (1") inch larger than the outside diameter of the pipe, conduit or insulation enclosing the pipe.
- D. Piping insulation shall run continuous through sleeve.
- E. Penetrations through fire-rated walls, ceilings and all floors (except slab on grade) in which piping or ducts pass shall be filled solidly with acceptable fire-stopping material. Sleeves shall be steel or a UL / FM listed and approved assembly.
- F. When ducts, piping or conduit penetrate the floor of a mechanical room located above an occupied space, such penetrations shall be made completely watertight, such that a liquid leak shall not pass through the penetration.

1.22 FIRE-STOPS AND SEALS

- A. Refer to Division 07 Specification for additional and more specific information.
- B. Fire-stopping systems shall be submitted as shop drawing.

- C. Penetrations through fire-rated walls, ceiling or floors shall be sealed with a UL approved fire-stop fitting classified for an hourly rating equivalent to the fire rating of the wall, ceiling or floor.
- D. Thruwall and floor seals shall be used to provide a positive means of sealing pipes or ducts which pass through the concrete foundation of a structure below grade or below ground water level. Seals shall also be used at entry points through concrete walls or floors which must be sealed.

1.23 CUTTING AND PATCHING

- A. All cutting and patching shall be done per Division 1 requirements. The Contractor shall furnish sketches showing the location and sizes of all openings, chases, etc., required for the installation of work.
- B. Work under this Division shall include furnishing, locating and setting inserts and/or sleeves required before the floors and walls are built or be responsible for cutting, drilling or chopping where sleeves and inserts were not installed or correctly located. The Contractor shall do all drilling required for the installation of hangers.
- C. Exercise extreme caution when core drilling or punching openings in concrete floor slabs in order to avoid cutting or damaging structural members. No structural members or structural slabs/floors shall be cut without the written acceptance of the Structural Engineer and all such cutting shall be done in a manner directed by him.
- D. SCAFFOLDING, RIGGING, HOISTING
 - 1. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises any equipment and apparatus furnished under this Division. Remove same from premises when no longer required.

1.24 EXCAVATION AND BACKFILLING

- A. Excavation and backfilling shall be done per Division 2 of the Specifications.
- B. It is the responsibility of the Contractor to coordinate sizes, depths, fill and bedding requirements and any other excavation work required under this Division per code and local utility requirements.

1.25 WATERPROOFING

- A. Where any work pierces waterproofing, including waterproof concrete and floors in wet areas, the method of installation shall be reviewed by the Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

1.26 ACCESSIBILITY AND ACCESS PANELS

- A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate thickness of partitions, and the adequate clearance in double partitions and hung ceilings for the proper installation of the work.
- B. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Equipment shall include, but not be limited to: motors, controllers, coil, valves, switchgear, drain points, etc. Access doors shall be furnished if required for better accessibility. Minor deviations from the Drawings may be made to allow better accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Engineer.
- C. Access doors in walls, ceilings, floors, etc., shall be field coordinated. It is the responsibility of the Contractor to coordinate and provide information regarding the sizes and quantities of access doors required for his work. The Contractor shall arrange his work in such a manner as to minimize the quantity of access doors required, such as grouping shutoff valves in the same area. Where possible, locate valves in already accessible areas, such as lay-in ceilings, etc.
- D. On a clean set of prints, the Contractor shall mark in red pencil the location of each required access door, including its size and fire rating (if any), and shall submit the print to the Architect for review before access doors are purchased or installed.
- E. Upon completion of the Project, the Contractor shall physically demonstrate that all equipment and devices installed have been located and/or provided with adequate access panels for repair, maintenance and/or operation. Any equipment not so furnished shall be relocated or provided with additional access panels by the installing Contractor at no additional cost to the Owner. All access panel or door locations shall be indicated on Owner's final as-built record drawings.
- F. Permanent ladders for access to equipment when shown on Plans shall be furnished and installed. Coordinate exact requirements in field.

1.27 TEMPORARY OPENINGS

- A. The Contractor shall ascertain from an examination of the Drawings whether any special temporary openings in the building will be required for the admission of apparatus provided under this Division and shall coordinate the requirements accordingly. In the event of failure of the Contractor to give sufficient notice in time to arrange for these openings during construction, the Contractor shall assume all costs of providing such openings thereafter.
- B. SHUTDOWNS
 - 1. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner's representative.
 - 2. The Architect and the Owner shall be notified of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.

3. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.28 TAGS AND CHARTS

- A. Each valve and piece of apparatus under this Division shall be provided with suitable brass or laminated plastic tags securely fastened with brass chains, screws or rivets. Equipment shall be numbered with laminated plastic tags or neatly stenciled letters two (2") inches high using designations in equipment schedules and/or shall conform to a directory indicating number, location and use of each item. Directories shall be prepared under each Section and shall be glass framed.
- B. Directory shall indicate valve tag number and the unit number, floor/area branch line, main line, service or other pertinent data to quickly and easily identify the valve's purpose.

1.29 ESCUTCHEONS

- A. The Contractor shall provide escutcheons on pipes wherever they pass through floors, ceilings, walls or partitions in finished visible locations.

1.30 PAINTING

- A. All finish painting in completed areas shall be performed per other divisions of the Specifications.
- B. All materials shipped to the job site under this Division, such as piping, fittings, plumbing fixtures, valves, etc., shall have standard manufacturer's finish, unless otherwise specified by Architect.
- C. All outdoor piping, fittings and hangers shall be properly primed with zinc-rich primer and finished with a minimum of two (2) coats of high grade exterior enamel.

1.31 PIPE EXPANSION

- A. All pipe connections shall be installed to allow for freedom of movement of the piping during expansion and contraction without springing. Provide engineered design, layout, details and fabrication, submitted with registered professional engineer sign and seal, of swing joints, expansion loops and expansion joints with proper anchors and guides. Pay particular attention to plastic piping with high coefficients of expansion.
- B. Consideration of required seismic lateral restraints shall be given when anchoring piping and making provision for expansion.

1.32 ELECTRICAL CONNECTIONS

- A. Unless otherwise specified, all wiring shall be furnished and installed per Division 26 Specifications.
- B. All motor controllers not factory mounted on mechanical equipment shall be furnished, mounted, and installed by the Division 26 contractor, and shall be coordinated with this contractor. Provide properly sized overload heaters and all required accessories with all motor controllers. See Division 26 Motor Controllers for motor controller requirements.
- C. All power wiring shall be furnished and installed per Division 26 complete from power source to motor or equipment junction box including power wiring through the motor controller and proper means of disconnect per NEC and Division 26. The Division 26 Contractor shall provide all disconnects, unless noted otherwise.

1.33 QUIET OPERATION

- A. Equipment and material used in the various systems described herein shall not produce a sound level greater than 55 decibels in the area served. If noise level is deemed objectionable by the Owner/Engineer, the Contractor shall test and record sound levels in the presence of the Owner/Engineer. The sound level shall be observed on the "A" weighting network of a sound level or sound survey meter. The ASHRAE "Guide and Data Book" provides a means to determine sound level of mechanical equipment when the total of background plus equipment sound levels exceeds the minimum acceptable equipment sound level.
- B. If objectionable noises or vibrations of any magnitude are produced and transmitted to occupied portions of the building by apparatus, piping, ducts or other parts of the mechanical work, the Contractor shall make such changes or additions as necessary without extra cost to the Owner.

1.34 MAINTENANCE

- A. The Contractor shall provide the necessary skilled labor to assure the proper operation and to provide all required current and preventative maintenance for all equipment and controls provided under this Division until final acceptance of the building by the Owner. The Contractor shall not assume acceptance of the building by the Owner until he receives written notification.
- B. The Contractor shall receive calls for any and all problems experienced in the operation of the equipment provided under this Division and he shall take steps to immediately correct any deficiencies that may exist.
- C. The Contractor shall provide a check list and shall put a copy of it in the boiler or main mechanical room. The check list shall itemize each piece of equipment furnished under his Section.

- D. The Contractor shall certify on this check list that he has examined each piece of equipment and that, in his opinion, it is operating as intended by the manufacturer, it has been properly lubricated, and that all necessary current and preventative maintenance has been performed as recommended by the manufacturer and by good and accepted practice.
- E. The Contractor shall check all controls in the building to ascertain that they are functioning as designed. This shall apply to all thermostats, aquastats, humidistats, freezestats and firestats, etc. This portion of the work shall be performed by the Contractor who installed the controls.
- F. During construction, the Contractor shall ensure that all filters are in place on all equipment. If the equipment is operated during construction (see restrictions section of this specification), strict attention shall be paid to maintaining clean and effective filters and cleaning ductwork and equipment. Filters shall be new and/or clean when the system testing and balancing takes place. The Contractor shall bear the cost of all filters and media during construction until final acceptance by the Owner. This requirement shall apply equally to fluid filters and strainers.
- G. Where normal preventative maintenance for any piece of equipment requires special tools, the Contractor shall furnish the appropriate tools for that piece of equipment (i.e., special filter removal hooks, valve wrenches, etc.).

1.35 LUBRICATION

- A. All equipment installed under this Contract having moving parts and requiring lubrication shall be properly lubricated according to manufacturer's recommendations prior to testing and operation. Any such equipment discovered to have been operated before lubrication by the Contractor is subject to rejection and replacement at no additional cost to the Owner.
- B. The Contractor shall furnish and install, as appropriate on all equipment requiring lubrication, Zerk pressure gun grease fittings or sight gravity-feed oilers equipped with shutoff and needle valve adjustment.
 - 1. Units furnished with sealed bearings and lifetime lubrication are exempted.
 - 2. All fittings and oilers are to be fully accessible for lubrication with equipment which does not require special adapters.
 - 3. Where fittings would be otherwise inaccessible, furnish and install extended grease lines.

1.36 CLEANING

- A. The Contractor shall be responsible for keeping the jobsite clean, safe and neat throughout the duration of construction. The Contractor shall clean up his own debris daily and shall coordinate removal of rubbish and debris with the General Contractor/Construction Manager.
- B. No debris, construction materials, cigarette butts, coffee cups, etc., shall be left above suspended ceilings.
- C. Terminal equipment and plumbing fixtures shall be cleaned at substantial completion.

- D. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.
- E. During the course of construction, all pipes shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.
- F. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work. Any oil or grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.

1.37 OPERATING INSTRUCTIONS

- A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner's representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least 72 hours notice to the Owner, Engineer, and Commissioning Agent in advance of this period.
 - 1. Prior to the instruction period, the contractor shall have approved Owner's Manuals on site for aiding in the instructions.
- B. The Contractor shall formally submit for delivery to the Engineer a minimum of three (3) Owner's Manuals, to be complete bound sets of typewritten or blueprinted instructions for operating and maintaining all systems and equipment included in this Division. All instructions shall be submitted in draft for review prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instruction.
- C. The Contractor, in the above-mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this Division.
- D. The appropriate Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.
- E. An authorized manufacturer's representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. These letters will be bound into the operating and maintenance books.
- F. Refer to individual trade Sections for any other particular requirements related to operating instructions.

1.38 ADJUSTING AND TESTING

- A. Prior to factory star-up procedures, the Contractor shall perform prefunctional checks and procedures to ensure that the equipment is installed properly and are operational.

1. The prefunctional checklists and procedures are to be provided by the Commissioning Agent. These forms must be filled out and approved before final start-up and adjustments are made by the factory representative.
- B. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer and the Commissioning Agent that they are in proper adjustment, the controls operate as described in the sequence of operation and all systems are in satisfactory, permanent operating condition.
- C. A factory service engineering representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service engineering representative shall supervise the initial operation of the equipment and instruct the personnel responsible for operation and maintenance of the equipment.
 1. The following equipment will require this inspection: pumps, equipment, water temperature controls and valves, water heaters, specialized plumbing fixtures, and electric/electronic faucets and flush valves.
 2. The service engineering representative shall notify the Contractor in writing that the equipment was installed according to manufacturer's recommendations and is operating as intended by the manufacturer.
 - a. The written notification shall include a complete start-up report on manufacturer's letterhead with all information including date and signature.
 - b. The report shall be made available to the Engineer and Commissioning Agent for review before acceptance is granted.

1.39 GUARANTEES

- A. The Contractor shall guarantee all equipment, material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner, unless otherwise noted.
- B. All refrigeration compressors shall have five (5) year guarantee from the date of final acceptance by the Owner unless otherwise noted.
- C. All water heaters shall have an optional minimum five (5) year guarantee from the date of final acceptance by the Owner unless otherwise noted.
- D. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by the Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.

1.40 RESTRICTIONS

- A. Water heaters provided under this Division may not be used for temporary hot water requirements due to premature wear and dirt/dust infiltration. Written approval may be obtained from the Owner only after submission of a written cleaning plan and guarantee/warranty extension.
- B. Piping shall not be run in any concrete floor slab. Written approval from the Structural Engineer may be obtained only after submission and approval of a layout shop drawing.

PART 2 PRODUCTS - NOT USED.

PART 3 EXECUTION - NOT USED.

END OF SECTION 22 05 00 220500

SECTION 220505 - PLUMBING DEMOLITION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Plumbing demolition.
 - 1. Existing plumbing fixtures, water piping, sanitary/waste piping, vent piping and storm piping as indicated on the plans, described in notes or implied by nature of the work.
 - a. All plumbing water piping removed from active lines to remain shall be capped watertight.
 - b. All sanitary branch piping removed from active systems to remain shall either have a new cleanout provided at termination or the branch line shall be removed to within 24" of the active main and capped.
 - c. Removal shall be complete to behind finished surfaces.
- B. Demolition shall include the removal of all hangers and supports, anchors and other items not required for the new work.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions in the field. Note which items are to remain and which items are to be removed as indicated on drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents.
- D. Report discrepancies to Engineer before disturbing existing installation.

- E. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Provide temporary piping, ductwork, control wiring, and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or piping, coordinate shut-down time with owner.
- C. Existing Domestic Cold Water System: Maintain existing systems in service. Disable systems only to make switchovers and/or connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
- D. Existing Sanitary System: Maintain existing system in service. Disable system only to make switchovers and/or connections. Minimize outage duration.

3.3 DEMOLITION AND EXTENSION OF EXISTING PLUMBING WORK

- A. All demolition work shall be scheduled and coordinated in order to accommodate construction phasing schedule.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned piping to source of supply, provide isolation valve and cap at mains.
- D. Contractor shall make safe all work associated with this division.
- E. Disconnect and remove plumbing piping and fittings serving equipment that has been removed .
- F. Disconnect and remove existing equipment, piping and fittings as indicated on the drawings.

3.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused in accordance with manufacturer's recommended maintenance procedures.

END OF SECTION 220505

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General construction and requirements.
- B. Single phase electric motors.
- C. Three phase electric motors.

1.2 RELATED REQUIREMENTS

- A. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. NEMA MG 1 - Motors and Generators 2021.
- B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

- A. See Section 013000 - 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.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.6 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.

1.7 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service: Refer to Section 260583 for required electrical characteristics.
- B. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 104 degrees F environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 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.

END OF SECTION 220513

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 210500 - Common Work Results for Fire Suppression.
- B. Section 221005 - Plumbing Piping.
- C. Section 232113 - Hydronic Piping.

1.3 REFERENCE STANDARDS

- A. EJMA (STDS) - EJMA Standards Tenth Edition.
- B. UL (DIR) - Online Certifications Directory Current Edition.

1.4 SUBMITTALS

- A. See Section 013000 - 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 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. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
- D. Maintenance Data: Include adjustment instructions.
- E. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Comply with UL (DIR) requirements.

2.2 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

- A. Manufacturers:
 - 1. Mercer Rubber Company
 - 2. The Metraflex Company
 - 3. Substitutions: See Section 016000 - Product Requirements.
- B. Inner Hose: Bronze.
- C. Exterior Sleeve: Braided bronze.
- D. Pressure Rating: 125 psi and 450 degrees F.
- E. Joint: Flanged.
- F. Size: Use pipe sized units.
- G. Maximum offset: 3/4 inch on each side of installed center line.
- H. Application: Copper piping.

2.3 EXPANSION JOINTS AND LOOPS - HOSE AND BRAID

- A. Manufacturers:
 - 1. The Metraflex Company; Metraloop: www.metraflex.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Provide flexible loops with two flexible sections of hose and braid, two 90 degree elbows, and 180 degree return with support bracket and air release or drain plug.
- C. Provide flexible loops capable of movement in the x, y, and z planes. Flexible loops to impart no thrust loads to the building structure.
- D. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
 - 1. Maximum Allowable Working Pressure: 150 psig at 120 degrees F.
 - 2. End Connections: Same as specified for pipe jointing.
 - 3. Provide necessary accessories including, but not limited to, swivel joints.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
- C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
- D. 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.
- E. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- F. 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 220516

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SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.

1.3 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).

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.

1.5 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.

1.6 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 PIPE SLEEVES

- A. Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.
 - 3. Drilled Penetrations: Provide 1-1/2 inch 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.

2.2 PIPE-SLEEVE SEALS

- A. Modular Mechanical Seal:
 - 1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
 - 2. Provide watertight seal between pipe and wall/casing opening.
 - 3. Elastomer element size and material in accordance with manufacturer's recommendations.
 - 4. Glass reinforced plastic pressure end plates.

PART 3 EXECUTION

3.1 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.

3.2 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. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- E. Aboveground Piping:
 - 1. Pack solid using mineral fiber complying with ASTM C592.
 - 2. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
- F. All Rated Openings: Caulk tight with fire stopping material complying with ASTM E814 in accordance with Section 078400 to prevent the spread of fire, smoke, and gases.
- G. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.
- H. 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.
- I. 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.

3.3 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 220517

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SECTION 220519 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Positive displacement meters.
- B. Flow meters.
- C. Pressure gauges and pressure gauge taps.
- D. Thermometers and thermometer wells.

1.2 RELATED REQUIREMENTS

- A. Section 221006 - Plumbing Piping

1.3 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments 2013.
- B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers 2014 (Reapproved 2020).
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers 2014 (Reapproved 2021).
- D. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case 2020.
- E. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance 2012, with Addendum (2018).
- F. UL 393 - Indicating Pressure Gauges for Fire-Protection Service Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013000 - 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.

1.5 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

2.1 POSITIVE DISPLACEMENT METERS (LIQUID)

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com.
 - 2. FMC Technologies: www.fmctechnologies.com.
 - 3. Venture Measurement, a Danaher Corporation Company: www.venturemeasurement.com.
- B. AWWA C700, positive displacement disc type suitable for fluid with bronze case and cast iron frost-proof, breakaway bottom cap, hermetically sealed register, remote reading.
- C. Meter: Brass body turbine meter with magnetic drive register.
 - 1. Service: Cold water, 122 degrees F.
 - 2. Accuracy: 1-1/2 percent.
 - 3. Maximum Counter Reading: 10 million gallons.
 - 4. Size: As indicated on drawings.

2.2 LIQUID FLOW METERS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc
 - 2. Venture Measurement, a Danaher Corporation Company
 - 3. McCrometer, Inc
 - 4. Substitutions: See Section 016000 - Product Requirements.

2.3 PRESSURE GAUGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc
 - 2. Moeller Instrument Company, Inc
 - 3. Omega Engineering, Inc
 - 4. Substitutions: See Section 016000 - 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 diameter.

3. Mid-Scale Accuracy: One percent.
4. Scale: Psi.

2.4 PRESSURE GAUGE TAPPINGS

- A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.
- B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.
 1. Manufacturers:
 - a. Substitutions: See Section 016000 - Product Requirements.
- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.

2.5 STEM TYPE THERMOMETERS

- A. Manufacturers:
 1. Dwyer Instruments, Inc
 2. Omega Engineering, Inc
 3. Weksler Glass Thermometer Corp
 4. Substitutions: See Section 016000 - 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 scale.
 2. Window: Clear Lexan.
 3. Stem: 3/4 inch NPT brass.
 4. Accuracy: 2 percent, per ASTM E77.
 5. Calibration: Degrees F.

2.6 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

2.7 TEST PLUGS

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

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

- B. Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.
- C. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- D. Install pressure gages with pulsation dampers. Provide gage cock to isolate each gage. Extend nipples to allow clearance from insulation.
- E. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- F. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- G. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- H. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- I. Locate test plugs adjacent thermometers and thermometer sockets.

3.2 SCHEDULES

- A. Positive Displacement Meters, Location:
 - 1. Domestic cold water.
- B. Flow Meters, Location:
 - 1. Heating water system.
- C. Pressure Gages, Location:
 - 1. Pumps
 - 2. Expansion Tanks
 - 3. Pressure reducing valves
 - 4. Scale range shall be consistent with the service
- D. Stem Type Thermometers, Location and Scale Range:
 - 1. Domestic hot water supply and recirculation, 0 to 150 degrees F.

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Applications.
- B. General requirements.
- C. Ball valves.
- D. Check valves.
- E. Plug valves.

1.2 RELATED REQUIREMENTS

- A. Section 220553 - Identification for Plumbing Piping and Equipment.
- B. Section 220719 - Plumbing Piping Insulation.
- C. Section 221005 - Plumbing Piping.

1.3 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. SWP: Steam working pressure.
- I. TFE: Tetrafluoroethylene.

1.4 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 B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
- D. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves 2022.
- E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
- F. ASME B16.34 - Valves — Flanged, Threaded, and Welding End 2020.
- G. ASME B31.9 - Building Services Piping 2020.
- H. ASTM A48/A48M - Standard Specification for Gray Iron Castings 2022.
- I. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).
- J. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).
- K. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.
- L. AWWA C606 - Grooved and Shouldered Joints 2015.
- M. MSS SP-45 - Drain and Bypass Connections 2020.
- N. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends 2018.
- O. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service 2010a.
- P. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends 2011.
- Q. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves 2019.
- R. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .

1.5 SUBMITTALS

- A. See Section 013000 - 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.

1.6 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.

1.7 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.

1.8 EXERCISE THE FOLLOWING PRECAUTIONS FOR HANDLING:

- A. Handle large valves with sling, modified to avoid damage to exposed parts.
- B. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.1 APPLICATIONS

- A. See Drawings for specific valve locations in addition to those locations listed below.
- B. Provide the following valves for the applications if not indicated on drawings:
 - 1. Shutoff: Ball, butterfly, gate or plug.
 - 2. Dead-End: Single-flange butterfly (lug) type.
 - 3. Throttling: Provide angle or ball.

- 4. Swing Check (Pump Outlet):
 - a. 2 NPS and Smaller: Bronze swing check valves with bronze disc.
 - b. 2-1/2 NPS and Larger for Domestic Water: Iron swing check valves with closure control, metal or resilient seat check valves.
 - c. 2-1/2 NPS and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- C. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.
- D. Required Valve End Connections for Non-Wafer Types:
 - 1. Steel Pipe:
 - a. 2 NPS and Smaller: Threaded ends.
 - b. 2-1/2 NPS to 4 NPS: Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 2. Copper Tube:
 - a. 2 NPS and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - b. 2-1/2 NPS to 4 NPS: Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.

2.2 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 NPS and larger.
 - 2. Handwheel: Valves other than quarter-turn types.
 - 3. Hand Lever: Quarter-turn valves 6 NPS and smaller except plug valves.
 - 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: With 2 NPS 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. 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 NPS through 24 NPS: ASME B16.5.
4. Solder Joint Connections: ASME B16.18.
5. Grooved End Connections: AWWA C606.

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. Valve Materials for Potable Water: NSF 61 and NSF 372.

H. Bronze Valves:

1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

I. Valve Bypass and Drain Connections: MSS SP-45.

J. Source Limitations: Obtain each valve type from a single manufacturer.

2.3 BRONZE ANGLE VALVES

A. Class 125: CWP Rating: 200 psig:

1. Comply with MSS SP-80, Type 1.
2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
3. Ends: Threaded.
4. Stem: Bronze.
5. Disc: Bronze.
6. Packing: Asbestos free.
7. Handwheel: Bronze or aluminum.

2.4 BRASS BALL VALVES

A. Three Piece, Full Port with Stainless Steel Trim:

1. Comply with MSS SP-110.
2. SWP Rating: 150 psig.
3. CWP Rating: 600 psig.
4. Body: Forged brass.
5. Ends: Threaded.
6. Seats: PTFE.
7. Stem: Stainless steel.
8. Ball: Stainless steel, vented.

2.5 BRONZE SWING CHECK VALVES

A. Class 125: CWP Rating: 200 psig (1380 kPa).

1. Comply with MSS SP-80, Type 3.
2. Design: Horizontal flow.

3. Body: Bronze, ASTM B62.
4. Ends: Threaded as indicated.
5. Disc: Bronze.

2.6 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

- A. Class 125 with Lever and Spring-Closure Control.
 1. Comply with MSS SP-71, Type I.
 2. Description:
 - a. CWP Rating: 200 psig.
 - b. Design: Clear or full waterway.
 - c. Body: ASTM A126, gray iron with bolted bonnet.
 - d. Ends: Flanged as indicated.
 - e. Trim: Bronze.
 - f. Gasket: Asbestos free.
 - g. Closer Control: Factory installed, exterior lever, and weight.

2.7 LUBRICATED PLUG VALVES

- A. Regular Gland with Flanged Ends:
 1. Comply with MSS SP-78, Type II.
 2. Class 125: CWP Rating: 200 psig.
 3. Body: ASTM A48/A48M or ASTM A126, cast iron with lubrication sealing system.
 4. Pattern: Regular or short.
 5. Plug: Cast iron or bronze with sealant groove.

PART 3 EXECUTION

3.1 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.

3.2 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 and larger where located 96 NPS or more above finished floor, terminating 60 NPS above finished floor.

END OF SECTION 220523

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SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Strut systems for pipe or equipment support.
- B. Beam clamps.
- C. Pipe hangers.
- D. Anchors and fasteners.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 055000 - Metal Fabrications.

1.3 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 (2018).
- 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 2018).
- 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 2018a.
 - J. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2019.
 - K. FM (AG) - FM Approval Guide current edition.
 - L. MFMA-4 - Metal Framing Standards Publication 2004.
 - M. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).
 - N. UL (DIR) - Online Certifications Directory Current Edition.
- 1.4 SUBMITTALS
- A. See Section 013000 - Administrative Requirements for submittal procedures.
- 1.5 QUALITY ASSURANCE
- A. Comply with applicable building code.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Provide required hardware to hang or support piping, equipment, or fixtures with related accessories as necessary to complete installation of plumbing work.
- B. Provide hardware products listed, classified, and labeled as suitable for intended purpose.
- C. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 10%. Include consideration for vibration, equipment operation, and shock loads where applicable.
- D. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
- E. Materials for Metal Fabricated Supports: Comply with Section 055000.

1. Zinc-Plated Steel: Electroplated in accordance with ASTM B633 unless stated otherwise.
2. Galvanized Steel: Hot-dip galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M unless stated otherwise.

F. Corrosion Resistance: Use corrosion-resistant metal-based materials fully compatible with exposed piping materials and suitable for the environment where installed.

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.

2.2 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.

C. Channel Nuts:

1. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring as indicated on drawings.

2.3 BEAM CLAMPS

- A. MSS SP-58 types 19 through 23, 25 or 27 through 30 based on required load.
- B. C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain, stainless steel, and zinc finish.
- C. FM (AG) and UL (DIR) Approved Beam Clamp: MSS SP-58 type 19, plain finish.
- D. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
- E. 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.

2.4 PIPE HANGERS

A. Band Hangers, Adjustable:

1. MSS SP-58 type 7 or 9, zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.

B. Swivel Ring Hangers, Adjustable:

1. MSS SP-58 type 10, epoxy-painted, zinc-colored.
2. 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.
3. FM (AG) and UL (DIR) listed for specific pipe size runs and loads.

C. Clevis Hangers, Adjustable:

1. Copper Tube: MSS SP-58 type 1, epoxy-plated copper.
2. Standard-Duty: MSS SP-58 type 1, zinc-colored, epoxy plated.
3. UL (DIR) listed: Pipe sizes 2-1/2 to 8 inch.

2.5 PIPE CLAMPS

A. 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. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.

2.6 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. 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

3.1 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.

3.2 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 Engineer, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.
- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- G. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.

END OF SECTION 220529

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SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe markers.
- D. Ceiling tacks.

1.2 RELATED REQUIREMENTS

- A. Section 221005 - Plumbing Piping
- B. Section 220719 - Plumbing Piping Insulation

1.3 REFERENCE STANDARDS

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

1.4 SUBMITTALS

- A. See Section 013000 - 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.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- F. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

- A. Heat Transfer Equipment: Nameplates.
- B. Piping: Pipe markers.
- C. Pumps: Nameplates.
- D. Small-sized Equipment: Tags.
- E. Tanks: Nameplates.
- F. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.2 NAMEPLATES

- A. Manufacturers:
 - 1. Brimar Industries, Inc.
 - 2. Kolbi Pipe Marker Co.
 - 3. Seton Identification Products
- B. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Black.
 - 4. Plastic: Comply with ASTM D709.

2.3 TAGS

- A. Manufacturers:
 - 1. Advanced Graphic Engraving
 - 2. Brady Corporation
 - 3. Brimar Industries, Inc.
 - 4. Craftmark Pipe Markers
 - 5. Seton Identification Products: www.seton.com.
- B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.4 PIPE MARKERS

- A. Manufacturers:

1. Brady Corporation
2. Brimar Industries, Inc
3. Craftmark Pipe Markers
4. MIFAB, Inc
5. Seton Identification Products: www.seton.com.

- B. 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 wide by 4 mil thick, manufactured for direct burial service.
- F. Color code as follows:
1. Potable, Cooling, Boiler, Feed, Other Water: Green with white letters.
 2. Fire Quenching Fluids: Red with white letters.
 3. Flammable Fluids: Yellow with black letters.
 4. Combustible Fluids: Brown with white letters.

2.5 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Install plastic 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 below finished grade, directly above buried pipe.
- F. Use tags on piping 3/4 inch diameter and smaller.
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION 220553

SECTION 220716 - PLUMBING EQUIPMENT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Equipment insulation.

1.2 RELATED REQUIREMENTS

- A. Section 221005 - Plumbing Piping: Placement of hangers and hanger inserts.

1.3 REFERENCE STANDARDS

- A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019.
- B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement 2007 (Reapproved 2019).
- C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- D. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2022a.
- E. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- G. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022.
- H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

PART 2 PRODUCTS

2.1 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.

2.2 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. Johns Manville Corporation.
 - 2. Knauf Insulation; Earthwool Insulation Board.
 - 3. Owens Corning Corp.
- B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
 - 1. K Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with self-sealing longitudinal laps and butt strips.
- D. Facing: 1 inch galvanized steel hexagonal wire mesh stitched on one face of insulation.
- E. Vapor Barrier Lap Adhesive: Compatible with insulation.
- F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that equipment has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

END OF SECTION 220716

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SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 221005 - Plumbing Piping: Placement of hangers and hanger inserts.

1.3 REFERENCE STANDARDS

- A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019.
- B. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2020a.
- C. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation 2022.
- D. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2018).
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- F. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022.
- G. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013000 - 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.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.7 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

2.1 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.

2.2 GLASS FIBER

- A. Manufacturers:
 - 1. CertainTeed Corporation
 - 2. Johns Manville Corporation
 - 3. Knauf Insulation
 - 4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
 - 1. K Value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION - FOR USE WITHIN CAVITIES OF MANSORY CONCRETE BLOCK WALLS.

- A. Manufacturer:
 - 1. Aeroflex USA, Inc
 - 2. Armacell LLC; AP Armaflex
 - 3. K-Flex USA LLC; Insul-Tube
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.4 JACKETS

- A. PVC Plastic.
 - 1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.
 - 2. Covering Adhesive Mastic: Compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.

- D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. Glass fiber insulated pipes conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- 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 diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert Location: Between support shield and piping and under the finish jacket.
 - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 078400.
- J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet 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.
- 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.

3.3 SCHEDULES

A. Plumbing Systems:

1. Domestic Cold Water:
 - a. Glass Fiber Insulation:
 - 1) Less than 1" Pipe Size: [1/2"]
 - 2) 1" Pipe Size and Larger 1"
 2. Domestic Hot Water Supply:
 - a. Glass Fiber Insulation:
 - 1) 1" pipe size and less: 1"
 - 2) 1-1/4" Pipe Size: 1" (1.5" if heat traced)
 - 3) 1-1/2" Pipe Size: 1.5" (1.5" if heat traced)
 - 4) 2" Pipe Size: 1.5" (2" if heat traced)
 - 5) 2.5" Pipe Size: 1.5" (2.5" if heat traced)
 - 6) 3" Pipe Size: 1.5" (3" if heat traced)
 3. Domestic Hot Water Recirculation:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 4. Thickness: 1 inch 1 inch.
 5. Roof Drainage Above Grade and Drain Bodies:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 - 2) Thickness: 1 inch 1 inch.
-
- #### B. Cooling Systems:
1. Condensate Drains from Cooling Coils:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 - 2) Thickness: 1/2 inch.

END OF SECTION 220719

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SECTION 220719.11 - UNDER-LAVATORY PIPE AND SUPPLY COVERS - PLUMBEREX

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Under-lavatory pipe and supply covers.

1.2 RELATED REQUIREMENTS

- A. Section 221005 - Plumbing Piping.

1.3 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design 2010.

PART 2 PRODUCTS

2.1 UNDER-LAVATORY PIPE AND SUPPLY COVERS

- A. Manufacturers:
 - 1. Plumberex Specialty Products, Inc
 - 2. Truebro IPS Corporation.
- B. General:
 - 1. Insulate exposed drainage piping including hot, cold, and tempered water supplies under lavatories or sinks per ADA Standards.
 - 2. Adhesives, sewing threads, and two-ply laminated materials are prohibited.
 - 3. Exterior Surfaces: Smooth nonabsorbent with no finger recessed indentations for easy cleaning.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that walls, floor finishes, lavatories, and piping are prepared and ready for installation of under-lavatory guards.
- B. Confirm location and size of fixtures and piping before installation.

3.2 INSTALLATION

- A. Install under-lavatory guards according to manufacturer's written instructions..

3.3 PROTECTION

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

END OF SECTION 220719.11

SECTION 221005 - PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pipe, pipe fittings, specialties, and connections for piping systems.
 - 1. Sanitary sewer.
 - 2. Domestic water.
 - 3. Storm water.
 - 4. Flanges, unions, and couplings.
 - 5. Pipe hangers and supports.
 - 6. Manufactured sleeve-seal systems.
 - 7. Valves.
 - 8. Water pressure reducing valves.
 - 9. Relief valves.
 - 10. Strainers.

1.2 RELATED REQUIREMENTS

- A. Section 083100 - Access Doors and Panels.
- B. Section 220516 - Expansion Fittings and Loops for Plumbing Piping.
- C. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- D. Section 220553 - Identification for Plumbing Piping and Equipment.
- E. Section 220719 - Plumbing Piping Insulation.

1.3 REFERENCE STANDARDS

- A. ANSI Z21.22 - American National Standard for Relief Valves for Hot Water Supply Systems 2015 (Reaffirmed 2020).
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.
- D. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV 2021.
- E. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes 2018.
- F. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV 2017.
- G. ASME B31.9 - Building Services Piping 2020.

- H. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers 2021.
- 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. ASSE 1003 - Performance Requirements for Water Pressure Reducing Valves for Potable Water Distribution Systems 2020.
- K. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2018).
- L. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- M. ASTM B32 - Standard Specification for Solder Metal 2020.
- N. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes 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 B306 - Standard Specification for Copper Drainage Tube (DWV) 2020.
- R. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube 2016.
- S. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings 2016.
- T. 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.
- U. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings 2017.
- V. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast 2017, with Errata (2018).
- W. AWWA C550 - Protective Interior Coatings for Valves and Hydrants 2017.
- X. AWWA C606 - Grooved and Shouldered Joints 2015.
- Y. AWWA C651 - Disinfecting Water Mains 2014, with Addendum (2020).

- Z. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications 2021.
- AA. 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.
- BB. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements 2015.
- CC. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements 2015.
- DD. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements 2015.
- EE. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements 2016.
- FF. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).
- GG. MSS SP-67 - Butterfly Valves 2022.
- HH. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .
- II. NSF 61 - Drinking Water System Components - Health Effects 2021.
- JJ. NSF 372 - Drinking Water System Components - Lead Content 2022.

1.4 SUBMITTALS

- A. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- B. Welder Certificate: Include welders certification of compliance with ASME BPVC-IX.
- C. Shop Drawings: For non-penetrating rooftop supports, submit detailed layout developed for this project, with design calculations for loadings and spacings.
- D. Sustainable Design Documentation: For soldered copper joints, submit installer's certification that the specified installation method and materials were used.
- E. Project Record Documents: Record actual locations of valves.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.

- C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
- E. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.6 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.

1.7 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.2 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: CISPI 301, hubless.
 - 1. Fittings: Cast iron.
 - 2. Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.

2.3 SANITARY SEWER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.
- B. Copper Tube: ASTM B306, DWV.
 - 1. Fittings: ASME B16.29, wrought copper, or ASME B16.23, sovent.
 - 2. Joints: ASTM B32, alloy Sn50 solder.

2.4 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Copper Pipe: ASTM B42, annealed.
 - 1. Fittings: ASME B16.26, cast bronze.
 - 2. Joints: Flared.
- B. Ductile Iron Pipe: AWWA C151/A21.51.
 - 1. Fittings: Ductile or gray iron, standard thickness.
 - 2. Joints: AWWA C111/A21.11, styrene butadiene rubber (SBR) or vulcanized SBR gasket with 3/4 inch diameter rods.

2.5 DOMESTIC WATER PIPING, ABOVE GRADE

- 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.
 - 3. Mechanical Press Sealed Fittings: Double pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, non toxic synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Grinnell Products, a Tyco Business: www.grinnell.com.
 - 2) Viega LLC: www.viega.com.

2.6 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.7 STORM WATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.8 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 Inches and Under:
 - 1. Ferrous pipe: Class 150 malleable iron threaded unions.
 - 2. Copper tube and pipe: Class 150 bronze unions with soldered joints.
- B. Flanges for Pipe Size Over 1 Inch:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
 - 2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

- 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. Housing Material: Provide ASTM A47/A47M malleable iron or ductile iron.
 - 3. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
 - 4. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 - 5. When pipe is field grooved, provide coupling manufacturer's grooving tools.
 - 6. Manufacturers:
 - a. Grinnell Products, a Tyco Business: www.grinnell.com.
- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.9 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.
 - a. Cold and Hot Pipe Sizes 6 Inches and Over: Double 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 under pipe to top of roofing.
 - f. Manufacturers:
 - 1) PHP Systems/Design: www.phpsd.com.
- B. Plumbing Piping - Drain, Waste, and Vent:
 - 1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 3. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

4. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Plumbing Piping - Water:

1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
2. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
3. Hangers for Hot Pipe Sizes 2 Inches to 4 Inches: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.
5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
7. Wall Support for Hot Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe roll.
8. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
10. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.
11. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

D. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:

1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
6. Other Types: As required.
7. Manufacturers:
 - a. Powers Fasteners, Inc
 - b. Substitutions: See Section 016000 - Product Requirements.

2.10 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Manufacturers:

1. The Metraflex Company; MetraSeal: www.metraflex.com/#sle.

B. Modular/Mechanical Seal:

1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
2. Provide watertight seal between pipe and wall/casing opening.

3. Elastomer element size and material in accordance with manufacturer's recommendations.
4. Glass reinforced plastic pressure end plates.

2.11 BALL VALVES

- A. Manufacturers:
 1. Grinnell Products, a Tyco Business
 2. Nibco, Inc
 3. Uponor, Inc
- B. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

2.12 BUTTERFLY VALVES

- A. Manufacturers:
 1. Crane Company
 2. Grinnell Products
- B. Construction 1-1/2 Inches and Larger: MSS SP-67, 200 psi CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.
- C. Provide gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

2.13 WATER PRESSURE REDUCING VALVES

- A. Manufacturers:
 1. Amtrol Inc
 2. Cla-Val Company
 3. Flomatic Valves
 4. Watts Regulator Company
- B. Up to 2 Inches:
 1. ASSE 1003, bronze body, stainless steel, and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends.
- C. Over 2 Inches:
 1. ASSE 1003, cast iron body with interior lining complying with AWWA C550, bronze fitted, elastomeric diaphragm and seat disc, flanged.

2.14 RELIEF VALVES

- A. Pressure:
 1. Manufacturers:

- a. Cla-Val Co
 - b. Henry Technologies
 - c. Watts Regulator Company
2. ANSI Z21.22, AGA certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

B. Temperature and Pressure:

1. Manufacturers:
 - a. Cla-Val Co
 - b. Henry Technologies
 - c. Watts Regulator Company
2. ANSI Z21.22, AGA certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME BPVC-IV certified and labelled.

2.15 STRAINERS

A. Manufacturers:

1. Armstrong International, Inc
2. Green Country Filter Manufacturing
3. WEAMCO

B. Size 2 inch and Under:

1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 1-1/2 inch to 4 inch:

1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.

D. Size 5 inch and Larger:

1. Class 125, flanged iron body, basket pattern with 1/8 inch stainless steel perforated screen.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 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.

3.3 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 220516.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
 - 1. Refer to Section 220719.
- H. Provide access where valves and fittings are not exposed.
 - 1. Coordinate size and location of access doors with Section 083100.
- I. Establish elevations of buried piping outside the building to ensure not less than 4 ft of cover.
- 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. Excavate in accordance with Division 31.
- N. Backfill in accordance with Division 31.
- O. Install valves with stems upright or horizontal, not inverted. Refer to Section 220523.
- P. Install water piping to ASME B31.9.
- Q. 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.
- R. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

- S. Sleeve pipes passing through partitions, walls and floors.
- T. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- U. 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 space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every other 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. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 - a. Painting of interior and exterior plumbing systems and components is specified in Division 09.
 - 10. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 220548.
 - 11. Support cast iron drainage piping at every joint.
- V. 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.

- W. 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.

3.4 APPLICATION

- A. Use grooved mechanical couplings and fasteners only in accessible locations.
- B. Install unions downstream of valves and at equipment or apparatus connections.
- C. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- D. Install gate, ball, or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Install globe valves for throttling, bypass, or manual flow control services.
- F. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
- G. Provide spring loaded check valves on discharge of water pumps.
- H. Provide flow controls in water recirculating systems where indicated.

3.5 TOLERANCES

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

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed and clean.
- B. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- 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.

3.7 SERVICE CONNECTIONS

- A. Provide new sanitary and storm 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, pressure reducing valve, 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.

3.8 SCHEDULES

- A. Pipe Hanger Spacing:
 - 1. Metal Piping:
 - a. Pipe Size: 1/2 inches to 1-1/4 inches:
 - 1) Maximum Hanger Spacing: 6.5 ft.
 - 2) Hanger Rod Diameter: 3/8 inches.
 - b. Pipe Size: 1-1/2 inches to 2 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 3/8 inch.
 - c. Pipe Size: 2-1/2 inches to 3 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 1/2 inch.
 - d. Pipe Size: 4 inches to 6 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 5/8 inch.
 - e. Pipe Size: 8 inches to 12 inches:
 - 1) Maximum hanger spacing: 14 ft.
 - 2) Hanger Rod Diameter: 7/8 inch.
 - 2. Plastic Piping:
 - a. All Sizes:
 - 1) Maximum Hanger Spacing: 6 ft.

- 2) Hanger Rod Diameter: 3/8 inch.

END OF SECTION 221005

SECTION 221006 - PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Drains.
- B. Cleanouts.
- C. Hose bibbs.
- D. Hydrants.
- E. Refrigerator valve and recessed box.
- F. Water hammer arrestors.
- G. Mixing valves.

1.2 RELATED REQUIREMENTS

- A. Section 221005 - Plumbing Piping.
- B. Section 223000 - Plumbing Equipment.
- C. Section 224000 - Plumbing Fixtures.

1.3 REFERENCE STANDARDS

- A. ASME A112.6.3 - Floor and Trench Drains 2019.
- B. ASME A112.6.4 - Roof, Deck, and Balcony Drains 2003 (Reaffirmed 2012).
- C. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers 2017.
- D. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance 2011 (Reaffirmed 2016).
- E. NSF 61 - Drinking Water System Components - Health Effects 2021.
- F. NSF 372 - Drinking Water System Components - Lead Content 2022.
- G. PDI-WH 201 - Water Hammer Arresters 2017.

1.4 SUBMITTALS

- A. See Section 013000 - 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. Certificates: Certify that grease interceptors meet or exceed specified requirements.
- E. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
- F. Sustainable Design Documentation: Submit appropriate evidence that materials used in potable water systems comply with the specified requirements.
- G. Operation Data: Indicate frequency of treatment required for interceptors.
- H. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- I. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.2 DRAINS

- A. Manufacturers:
 - 1. Jay R. Smith Manufacturing Company
 - 2. Josam Company
 - 3. Zurn Industries, LLC

- B. Roof Drains:
 - 1. Assembly: ASME A112.6.4.
 - 2. Body: Lacquered cast iron with sump.
 - 3. Strainer: Removable cast iron dome with vandal proof screws.
 - 4. Accessories: Coordinate with roofing type, refer to schedule on drawings:
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Adjustable under deck clamp.
 - c. Adjustable extension sleeve for roof insulation.
- C. Parapet Drains:
 - 1. Lacquered cast iron body with aluminum flashing clamp collar and epoxy coated sloping grate.
- D. Canopy and Cornice Drains:
 - 1. Lacquered cast iron body with aluminum flashing clamp collar and epoxy coated flat strainer.
- E. Roof Overflow Drains:
 - 1. Lacquered cast iron body and clamp collar and bottom clamp ring; pipe extended to 3 inches above flood elevation.
- F. Floor Drain:
 - 1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer. Refer to schedule on drawings for options and accessories.

2.3 CLEANOUTS

- A. Manufacturers:
 - 1. Jay R. Smith Manufacturing Company
 - 2. Josam Company
 - 3. Zurn Industries, LLC
- 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:
 - 1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.
- E. Cleanouts at Interior Finished Wall Areas:

1. Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.

- F. Cleanouts at Interior Unfinished Accessible Areas: Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.4 HOSE BIBBS

A. Manufacturers:

1. Jay R. Smith Manufacturing Company
2. Watts Regulator Company
3. Zurn Industries, LLC
4. Substitutions: See Section 016000 - Product Requirements.

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.

C. Interior Mixing Type Hose Bibbs:

1. Bronze or brass, wall mounted, double service faucet with hose thread spout, integral stops, chrome plated where exposed with handwheels, and vacuum breaker in compliance with ASSE 1011.

2.5 HYDRANTS

A. Manufacturers:

1. Jay R. Smith Manufacturing Company
2. Zurn Industries, LLC
3. Substitutions: See Section 016000 - Product Requirements.

B. Wall Hydrants:

1. ASSE 1019; freeze resistant, self-draining type with chrome plated wall plate hose thread spout, handwheel, and integral vacuum breaker.

2.6 REFRIGERATOR VALVE AND RECESSED BOX

A. Box Manufacturers:

1. IPS Corporation/Water-Tite: www.ipscorp.com.
2. Oatey Supply Chain Services, Inc: www.oatey.com.

B. Valve Manufacturers:

1. IPS Corporation/Water-Tite: www.ipscorp.com.
2. Zurn Industries, LLC: www.zurn.com.
3. Substitutions: See Section 016000 - Product Requirements.

- C. Description: Plastic preformed rough-in box with brass valves with wheel handle, slip in finishing cover.

2.7 WATER HAMMER ARRESTORS

- A. Manufacturers:
 - 1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
 - 2. Watts Regulator Company, a part of Watts Water Technologies: www.wattsregulator.com.
 - 3. Zurn Industries, LLC: www.zurn.com.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Water Hammer Arrestors:
 - 1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F and maximum 250 psi working pressure.

2.8 MIXING VALVES

- A. Thermostatic Mixing Valves:
 - 1. Manufacturers:
 - a. Honeywell International Inc: yourhome.honeywell.com.
 - b. Leonard Valve Company: www.leonardvalve.com.
 - 2. Valve: Chrome plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment.
 - 3. Accessories:
 - a. Volume control shut-off valve on outlet.
 - b. Stem thermometer on outlet.
 - c. Strainer stop checks on inlets.
 - 4. Cabinet: 16 gage, 0.0598 inch prime coated steel, for recessed mounting with keyed lock.

2.9 FLOOR DRAIN TRAP SEALS

- A. Manufacturers:
 - 1. MIFAB, Inc
 - 2. Oatey.
 - 3. Josam.
- B. Description: Push-fit EPDM or silicone fitting with a one-way membrane.

PART 3 EXECUTION

3.1 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 nearest drain.
- G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to washing machine outlets.
- 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 minimum, and minimum 18 inches long.

END OF SECTION 221006

SECTION 221250 - NATURAL GAS PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 LEED BUILDING GENERAL REQUIREMENTS

- A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED (Leadership in Energy and Environmental Design) Green Building Rating System NC, Version 2.2, Silver rating. Specific project goals that may impact this area of work including, but not limited to: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the stated LEED BUILDING Performance Criteria.

1.3 SECTION INCLUDES

- A. Pipe, pipe fittings, valves, and connections for gas piping systems.
 - 1. Natural Gas.
 - 2. Regulators and safety devices for Natural and L.P. gas systems

1.4 RELATED SECTIONS

- A. Section 07 84 13 - Firestopping
- B. Section 220510 - PLUMBING GENERAL CONDITIONS
- C. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Ststems
- D. Section 22 05 53 - Identification for Plumbing Piping and Equipment
- E. Section 22 05 19 - Meters and Gages for Plumbing Piping
- F. Section 22 10 05 - Plumbing Piping
- G. Section 22 30 00 - Plumbing Equipment

1.5 REFERENCES

- A. Connecticut Fuel Gas Code

- B. NFPA 54
- C. ANSI Z223.1
- D. CSA / AGA Standards
- E. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.
- F. ANSI/ASME B36.10 Welded and Seamless Wrought-Steel pipe
- G. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
- H. ANSI/ASME B1.20.1 - Pipe Threads, General Purpose, Inch

1.6 SYSTEM DESCRIPTION

- A. Provide piping from the gas meter as shown on the plans.
- B. Provide gas piping, including fittings and valves to form a complete system.
 - 1. Piping includes connections to equipment shown on the plans or provided by others.
 - 2. Provide any required gas regulators at equipment connections for reductions in pressure.
Coordinate with all other trades for requirements of equipment.

1.7 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures.
- B. Piping and fittings
 - 1. Product Data: Provide Manufacturers literature.
 - 2. Shop Drawings: Indicate all catlog data.
- C. Equipment and Valving
 - 1. Product Data: Provide Manufacturers literature.
 - 2. Shop Drawings: Indicate all catlog data.
- D. Test Reports: Indicate final testing, inspection and approval reports by the AHJ and/or the service utility.
- E. Certificates: Certify that products of this section meet or exceed specified requirements.

1.8 QUALITY ASSURANCE

- A. Perform in accordance with Connecticut Fuel Gas Code standard, State of Connecticut Building Code.
- B. Requirements of the service Utility

- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- D. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years of experience.
- E. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.
- F. All valves, regulators, etc. shall be tested and rated for respective natural gas applications by UL and CSA.

1.9 PROJECT CONDITIONS

- A. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Metallic pipe: Steel and wrought-iron pipe, minimum schedule 40, ANSI/ASME B36.10, ASTM A53
- B. Metallic pipe fittings: Steel or malleable iron.
- C. Piping shall be threaded up to 2" in diameter, over 2" piping shall be welded.

2.2 MANUFACTURED ITEMS

- A. Line Gas Pressure Regulators
- B. Gas Appliance Regulators
- C. Overpressure Protection Device
 - 1. For systems over 60 psi

2.3 ACCESSORIES

- A. Shutoff Valves
 - 1. Plug type - Heavy duty, iron body construction, flat head type with brass plug and washer, CSA / UL tested and approved
 - 2. Ball type - Bronze body, chrome plated ball, brass stem, PTFE seat, stem packing and bearing CSA/UL tested and approved.
 - 3. Strainer - Bronze body, CSA/UL tested and approved
 - 4. Roof Supports

PART 3 EXECUTION

3.1 PIPING - GENERAL

- A. The service entrance of the gas pipe to the building shall be provided with a line size, CSA/UL tested and approved shut-off plug valve. The valve shall be lockable open or shut with a standard padlock.
- B. Ream ends of pipe free from burrs. Keep free of scale, dirt and oil. Piping shall be blown out with compressed air.
- C. Pipe threads shall be tapered in compliance with ANSI/ASME B1.20.1. Apply pipe joint compound to male threads only.
 - 1. Threaded pipe shall be used for piping of 2" or less. All piping larger than 2" shall have welded fittings and joints.
- D. Provide couplings for pipe size transitions and for joining lengths of pipe. Bushings shall not be used.

3.2 PIPING INSIDE BUILDINGS

- A. Do not cut, notch or drill through beams or joists to install piping.
- B. Slope piping upwards towards risers or equipment at not less than 1/4" in 15 feet.
- C. Piping shall not be installed in concealed locations except with the use of elbows, tees and couplings.
 - 1. Where fittings are inserted in the piping, the pipe shall be reconnected by welding, flanges or a ground joint union.
 - 2. Valves shall not be installed in concealed locations.
- D. Where piping is installed in partition walls, a steel striker plate is to be provided the full length of the concealed pipe run
- E. Changes in direction shall be made by the use of fittings, factory or field bends.
 - 1. Bends shall be made only with bending equipment and shall be free from buckling, cracks or other damage.
 - 2. Pipe shall not be bent more than 90° with the inside radius not less than 6 times the outside diameter of the pipe.
- F. Provide drips at all risers or low points in the system. Drips are to be readily accessible for cleaning or emptying and are not to be used for supporting the piping.
- G. Provide plug type gas cocks in pipe branch lines and connections to equipment and cap until ready for connection to equipment.

1. Ball type shutoffs will be acceptable in branch lines off mains
- H. All gas piping inside and outside the building shall be painted yellow and pipe markers provided.
- I. Branch piping is to be connected from top or side of horizontal piping.
- J. Maximum hanger spacing:
 1. 1/2" pipe -6 feet
 2. 3/4" to 1" pipe -8 feet
 3. 1 1/4" and larger pipe -10 feet

3.3 PIPING OUTSIDE THE BUILDINGS (EXPOSED, NOT BURIED)

- A. Slope piping upwards towards risers or equipment at not less than 1/4" in 15 feet.
- B. Piping shall not be installed in concealed locations except with the use of elbows, tees and couplings.
 1. Where fittings are inserted in the piping, the pipe shall be reconnected by welding, flanges or a ground joint union.
 2. Valves shall not be installed in concealed locations.
- C. Changes in direction shall be made by the use of fittings, factory or field bends.
 1. Bends shall be made only with bending equipment and shall be free from buckling, cracks or other damage.
 2. Pipe shall not be bent more than 90° with the inside radius not less than 6 times the outside diameter of the pipe.
- D. Provide drips at all risers or low points in the system. Drips are to be readily accessible for cleaning or emptying and are not to be used for supporting the piping.
 1. Where drips could be subject to freezing, the AHJ may authorize the drips to be deleted.
- E. Provide plug type gas cocks in pipe branch lines and connections to equipment and cap until ready for connection to equipment.
 1. Ball type shutoffs will be acceptable in branch lines off mains
- F. All gas piping outside the building shall be painted yellow with primer, two coats of paint and pipe markers provided.
- G. Branch piping is to be connected from top or side of horizontal piping.
- H. Maximum roof support spacing:
 1. 1/2" pipe -4 feet
 2. 3/4" to 1" pipe -6 feet
 3. 1 1/4" and larger pipe -8 feet
 4. Within 12" either side of bends, valves and regulators.

3.4 TESTING

- A. All piping, new and existing, shall be tested and shall be in compliance with NFPA-54 with records of inspection and tests performed.
- B. Test medium shall be compressed air or other inert gas.
- C. Test pressure shall be 1-1/2 times the maximum working pressure but not less than 3 PSIG. Duration shall be ½ hour for each 500 cubic feet of pipe or fraction thereof.
 - 1. Piping shall be tested without valves installed.
 - 2. Valves are not to be used as a bulkhead between gas in one section of pipe and test medium in another.
- D. Provide gauges or a manometer of increments not greater than 1/10 pound. Soap solution shall be used at joints or fittings.
 - 1. Pressure gauges shall be permanently installed downstream from each line pressure regulator.
- E. After turning on the gas the piping shall be purged of all test medium and the system shall again be checked for leakage.
- F. The gas utility shall be the governing authority and shall be presented with copies of tests results and records. All rules and regulations must be complied with and coordinated to insure a safe installation.
- G. If any part of the gas system is defective or not in compliance with this specification the contractor shall repair or replace the items at no cost to the Owner.

3.5 REGULATORS

- A. Set primary regulator at no more than 14" W.C., specific equipment requirements and/ or as required by local Gas Co.
- B. Set secondary regulators as necessary for appliances and equipment.
- C. Vent regulators and other equipment to exterior of building and terminate with suppressor.
 - 1. Vents shall be run independently of each other and shall be field located.
- D. Provide strainers on the inlet of each line pressure regulator or electrically operated valve.
- E. Provide a shut-off valve upstream of each gas pressure regulator

3.6 EQUIPMENT CONNECTORS

- A. Connectors shall have a plug type shut-off gas cock installed in rigid tubing in an accessible location upstream of the connector.

1. Flexible connectors of semi-rigid stainless steel with polyethylene jacket may be used for connecting appliances to the shut-off valve.
 2. All connectors shall be provided with a drip leg, full line size.
- B. Connectors shall be made from the top or side of horizontal lines.
- C. Provide unions for connectors at gas-cocks and equipment.
- D. Connectors to kitchen equipment are to be the "quick disconnect" type.

END OF SECTION 22 12 50 221250

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SECTION 223000 - PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Water Heaters:
 - 1. Commercial electric.
- B. In-line circulator pumps.

1.2 REFERENCE STANDARDS

- A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels 2021.
- B. CSA P.3 - Testing Method For Measuring Energy Consumption And Determining Efficiencies Of Gas-Fired And Fuel Oil-Fired Water Heaters 2015 (Reaffirmed 2020).
- C. ICC (IPC) - International Plumbing Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 778 - Standard for Motor-Operated Water Pumps Current Edition, Including All Revisions.
- F. UL 1453 - Standard for Electric Booster and Commercial Storage Tank Water Heaters Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. See Section 013000 - 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:
 - 1. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.

- D. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- E. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS

2.1 WATER HEATERS

- A. Manufacturers:
 - 1. A.O. Smith Water Products Co
 - 2. Bock Water Heaters, Inc
 - 3. Rheem Manufacturing Company
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Commercial Electric:
 - 1. Type: Factory-assembled and wired, electric, vertical storage.
 - 2. Performance:
 - a. Storage Capacity: 10 gal.
 - b. Heating Element Size: 6 kW.
 - c. Number of Heating Elements: [____].
 - d. Minimum Recovery Rate: 25 gph with 100 degrees F temperature rise.
 - 3. Electrical Characteristics:
 - a. 208 volts, three phase, 60 Hz.
 - 4. Tank: Glass lined welded steel; 4 inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber encased in corrosion-resistant steel jacket; baked-on enamel finish.
 - 5. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 180 degrees F, flanged or screw-in nichrome elements, high temperature limit thermostat.
 - 6. Accessories:
 - a. Drain valve.
 - b. Anode: Magnesium.
 - c. Temperature and Pressure Relief Valve: ASME labeled.
 - 7. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 W/sq in.

2.2 IN-LINE CIRCULATOR PUMPS

- A. Manufacturers:
 - 1. Armstrong Fluid Technology
 - 2. Bell & Gossett, a xylem bran
 - 3. Grundfos.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Casing: Bronze, rated for 125 psig working pressure, with stainless steel rotor assembly.
- C. Impeller: Bronze.
- D. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.
- E. Seal: Carbon rotating against a stationary ceramic seat.
- F. Drive: Flexible coupling.
- G. Performance:
 - 1. Flow: [] gpm, at [] feet head.
 - 2. Electrical Characteristics:
 - a. [] hp.
 - b. 120 volts, single phase, 60 Hz, [] minimum circuit ampacity.

PART 3 EXECUTION

3.1 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 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.

END OF SECTION 223000

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SECTION 224000 - PLUMBING FIXTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Water closets.
- B. Lavatories.
- C. Sinks.
- D. Mop sinks.
- E. Under-lavatory pipe supply covers.
- F. Electric water coolers.

1.2 RELATED REQUIREMENTS

- A. Section 011000 - Summary: Owner-furnished fixtures.
- B. Section 221005 - Plumbing Piping.
- C. Section 223000 - Plumbing Equipment.
- D. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B. ASME A112.18.9 - Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures 2011 (Reaffirmed 2022).
- C. ASTM C1822 - Standard Specification for Insulating Covers on Accessible Lavatory Piping 2021.
- D. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration 2008 (Reaffirmed 2013).
- E. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use 1997 (Reaffirmed 2017).
- F. ASME A112.18.1 - Plumbing Supply Fittings 2018, with Errata.
- 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 1070 - Performance Requirements for Water Temperature Limiting Devices 2020.
 - K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
 - L. IAPMO Z124 - Plastic Plumbing Fixtures 2017 (Reaffirmed 2021).
 - M. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.
 - N. NSF 61 - Drinking Water System Components - Health Effects 2021.
 - O. NSF 372 - Drinking Water System Components - Lead Content 2022.
- 1.4 SUBMITTALS
- A. See Section 013000 - Administrative Requirements, for submittal procedures.
 - B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
 - C. Manufacturer's Instructions: Indicate installation methods and procedures.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.
- B. Water Efficiency: EPA WaterSense label is required for all water closets, urinals, and lavatory faucets.

2.2 FLUSH VALVE WATER CLOSETS

- A. Water Closets: Vitreous china, ASME A112.19.2, floor mounted, siphon jet flush action, china bolt caps.
 - 1. Bowl: ASME A112.19.2; 16.5 inches high with elongated rim.
 - 2. Flush Valve: Exposed (top spud).
 - 3. Flush Operation: Sensor operated.
 - 4. Handle Height: 44 inches or less.
 - 5. Color: White.
 - 6. Manufacturers:

- a. American Standard, Inc
 - b. Gerber Plumbing Fixtures LLC
 - c. Kohler Company
 - d. Substitutions: See Section 016000 - Product Requirements.
 - B. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
 - 1. Sensor-Operated Type: Solenoid or motor-driven operator, battery powered, infrared sensor with over-ride push button.
 - 2. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.
 - 3. Manufacturers:
 - a. American Standard, Inc
 - b. Sloan Valve Company
 - c. Zurn Industries, Inc
 - d. Substitutions: See Section 016000 - Product Requirements.
 - C. Seats:
 - 1. Manufacturers:
 - a. Bemis Manufacturing Company
 - b. Church Seat Company
 - c. Olsonite
 - d. Substitutions: See Section 016000 - Product Requirements.
 - D. Water Closet Carriers:
 - 1. Manufacturers:
 - a. Jay R. Smith MFG. Co
 - b. JOSAM Company
 - c. Zurn Industries, Inc
 - d. Substitutions: See Section 016000 - Product Requirements.
 - 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.
- 2.3 LAVATORIES
- A. Lavatory Manufacturers:
 - 1. American Standard, Inc
 - 2. Kohler Company
 - 3. Zurn Industries, Inc
 - 4. Substitutions: See Section 016000 - Product Requirements.
 - B. Vitreous China Wall Hung Basin: ASME A112.19.2; vitreous china wall hung lavatory, 20 by 18 inch minimum, with 4 inch high back, rectangular basin with splash lip, front overflow, and soap depression.
 - C. Sensor Operated Faucet: Cast brass, chrome plated, deck mounted with sensor located on neck of spout.
 - 1. Spout Style: Standard.

2. Power Supply: Per manufacturer's requirements.
 - a. For 6V or 24V applications, provide transformer.
3. Mixing Valve: Under sink.
4. Water Supply: 3/8 inch compression connections.
5. Aerator: Vandal resistant, 0.35 GPM, laminar flow device.
6. Finish: Polished chrome.
7. Lead Content: Extra low; maximum 0.25 percent by weighed average.
8. Sensor Operated Faucet Manufacturers:
 - a. American Standard, Inc
 - b. The Chicago Faucet Company
 - c. Sloan Valve Company
 - d. Substitutions: See Section 016000 - Product Requirements.

- D. Thermostatic Mixing Valve: Thermostatic mixing valve, ASSE 1070 listed, with combination stop, strainer, and check valves, and flexible stainless steel connectors.
1. Manufacturers:
 - a. Acorn Engineering Company
 - b. Symmons.
 - c. Substitutions: See Section 016000 - Product Requirements.

2.4 SINKS

- A. Sink Manufacturers:
1. American Standard, Inc
 2. Kohler Company
- B. Single Compartment Bowl: ASME A112.19.3; 21 by 25 by 5.5 inch outside dimensions 18 gage, [] inch, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.
- C. Single Compartment Bowl: ASME A112.19.3; 18 by 18 by 5.5 inch outside dimensions 18 gage, [] inch, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.

2.5 BI-LEVEL, ELECTRIC WATER COOLERS WITH BOTTLE FILLER

- A. Bi-level, Electric Water Cooler Manufacturers:
1. Elkay Manufacturing Company
 2. Murdock Manufacturing, Inc
 3. Substitutions: See Section 016000 - Product Requirements.
- B. Water Cooler: Bi-level, electric, mechanically refrigerated; surface mounted, ADA compliant; stainless steel top, vinyl on steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket; integral air cooled condenser and stainless steel grille.
1. Capacity: 8 gallons per hour of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F, when tested in accordance with ASHRAE Std 18.

2. Electrical: 115 V, 60 Hertz compressor, 6 foot cord and plug for connection to electric wiring system including grounding connector.

2.6 MOP SINKS

- A. Terrazzo Mop Sink
- B. Terrazzo Mop Sink Manufacturers:
 1. Acorn Engineering Company
 2. Just Manufacturing Company
 3. Zurn Industries, Inc; [_____]
 4. Fiat.
 5. Substitutions: See Section 016000 - Product Requirements.
- C. Material: Precast terrazzo composed of marble chips cast in Portland cement.
- D. Grid strainer: Stainless steel; integral; removable.
- E. Dimensions: As indicated on drawings.
- F. Accessories:
 1. 5 feet of 1/2 inch diameter plain end reinforced plastic hose.
 2. Hose clamp hanger.
 3. Mop hanger.

PART 3 EXECUTION

3.1 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.

3.2 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 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.
- E. Caulk and seal fixtures to wall and floor surfaces with sealant as specified in Section 079200, color to match fixture.

3.4 INTERFACE WITH WORK OF OTHER SECTIONS

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.5 ADJUSTING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

- A. Clean plumbing fixtures and equipment.

3.7 PROTECTION

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

END OF SECTION 224000

SECTION 230500 - MECHANICAL GENERAL CONDITIONS

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.
- B. The Contractor and each Subcontractor and/or supplier providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 LEED BUILDING GENERAL REQUIREMENTS

- A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED (Leadership in Energy and Environmental Design) Green Building Rating System NC, Version 2009, Silver rating. Specific project goals that may impact this area of work including, but not limited to: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the stated LEED BUILDING Performance Criteria.

1.3 DESCRIPTION

- A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.
- B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein.

This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division.

- C. The following information contains specifications of Work in connection with, and in addition to, this Division:
 - 1. All drawings associated with the project.
 - 2. All specifications associated with the project.
- D. Division of work responsibilities shall be as defined and directed by the Bidding Agent and/or the Bidding General Contractor.

1.4 INTENT

- A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation.
- B. Furnish, deliver and install any apparatus, appliance, material or Work not shown on Drawings but mentioned in the Specifications, or vice versa, or any incidental accessories necessary to make the Work complete and perfect in all respects and ready for operation, even if not particularly specified, under their respective Section without additional expense to the Owner.
- C. Include in the work minor details not usually shown or specified but necessary for proper installation and operation, as though they were hereinafter shown or specified.
- D. Provide Engineer written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of Work omitted. In the absence of such written notice, it is mutually agreed that Work under each Section has included the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.
- E. The Work indicated is diagrammatic. The Architect and/or Engineer may require as part of this Contract, the relocation of devices to reasonable distances from the general locations shown.
- F. Verbal clarifications of the Drawings or Specifications during the bid period are not to be relied upon. Refer any questions or clarifications to the Engineer at least five Working days prior to bidding to allow for issuance of an addendum. After the five-day deadline, Bidder must make a decision and qualify the Bid, if the Bidder feels it necessary.

1.5 DRAWINGS

- A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. (Do not scale the Drawings.) Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect.
- B. Closely follow Drawings in layout of Work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom. Where space conditions appear inadequate, Engineer shall be notified before proceeding with installations.
- C. Engineer may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.
- D. Where variances occur between the Drawings and Specifications or within either of the Documents, include the item or arrangement of better quality, greater quantity or higher cost in the Contract price. The Engineer shall decide on the item and the manner in which the work shall be installed.

1.6 SURVEYS AND MEASUREMENTS

- A. Before submitting a Bid, the Contractor shall visit the site and shall become thoroughly familiar with all conditions under which the work will be installed. Contractor will be held responsible for any assumptions, omissions or errors made as a result of failure to become familiar with the site and the Contract Documents.
- B. Base all measurements, both horizontal and vertical, from established bench marks. All Work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the Work.
- C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or the intent of the Drawings and Specifications, notify the Engineer do not proceed with that Work until instructions have been received from the Engineer.

1.7 CODES AND STANDARDS

- A. The Codes and Standards listed below apply to all Work. Where Codes or Standards are mentioned in these Specifications, follow the latest edition or revision.
- B. The Codes and Standards listed below apply to all Work. Where Codes or Standards are mentioned in these Specifications, follow the latest edition or revision.
- C. The current adopted editions of the following State or local Codes apply:
 - 1. 2021 International Building Code
 - 2. 2021 Connecticut State Building Code
 - 3. 2021 International Existing Building Code
 - 4. 2021 International Mechanical Code
 - 5. 2021 International Plumbing Code
 - 6. 2020 National Electrical Code (NFPA 70)
 - 7. 2021 International Energy Conservation Code
 - 8. 2021 International Fire Code
 - 9. 2021 Life Safety Code (NFPA 101)
 - 10. ICC/ANSI A117.1-2017 Accessible and Usable Buildings and Facilities
- D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.
- E. Include in the Work, without extra cost to the Owner, any labor, materials, testing, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on Drawings and/or specified.

1.8 PERMITS AND FEES

- A. Give all necessary notices, obtain all permits; pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the Work. File all necessary Drawings, prepare all Documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspections for Work and deliver a copy to the Engineer before request for acceptance and final payment for the Work.

1.9 SEISMIC RESTRAINT

- A. General: This project is in a seismic zone per State and/or Local Codes and Ordinances and all materials and equipment shall be installed, supported, and seismically restrained accordingly. Verify current seismic requirements based on project location and with Code requirements.
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of vibration isolation bases and seismic restraints that are similar to those required for this Project in material, design, and extent.
- C. Shop Drawings: Show designs and calculations, certified by a professional engineer, for the following:
 - 1. Design Calculations: Calculations for selection of vibration isolators, design of vibration isolation bases, design of seismic supports and selection of seismic restraints for all equipment and materials.
 - 2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to the structure and to the supported equipment. Include auxiliary motor slides and rails, and base weights.
 - 3. Seismic Restraint Details: Detail fabrication and attachment of restraints, supports and snubbers.
 - 4. Seismic Separation Assemblies: Refer to the Architectural and/or Structural drawings for locations of seismic joints.
- D. Installation: Installation shall be carried out in strict accordance with the Seismic Engineer's submittal, current Code, accepted standards and the equipment and material manufacturers' recommendations.

1.10 COORDINATION

- A. Carry out all work in conjunction with other trades and give full cooperation in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the General Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, access doors, etc. required by other trades, and to allow for serviceable access to equipment.

- B. Mechanical contractors' shall initiate coordination drawings and sections clearly showing how the work is to be installed in relation to the work of other trades, at no extra charge to the Owner. The Contractors' shall prepare coordination drawings at a scale no less than 1/4"=1'-0", showing the work of all trades, including but not limited to, the following: proposed ductwork installation in detail, including ceiling heights, approved structural steel shop drawings, duct heights, access doors, light fixtures, registers and diffusers, sprinkler piping, electrical distribution conduits, wires, panels and any other electrical work which may conflict with the sheet metal ducts or piping, waste and vent piping, water piping, storm piping, and rain leaders. Provide elevation details showing connections and equipment layout and configuration based on approved submittals. Each shall use a different color code. A coordination meeting of all Contractors involved is then to be held and all possible conflicts are to be resolved. All trades shall sign acceptance of the drawings and then shall submit two (2) prints of each drawing to the Engineer for record.
- C. Contractors are required to examine all of the Project Drawings and mutually arrange Work so as to avoid interference. In general, ductwork, heating piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer regarding the arrangement of Work, which cannot be agreed upon by the Contractors, will make final decisions. Service of equipment will take precedence.
- D. Where the Work of the Contractor will be installed in close proximity to or will interfere with Work of other trades, assist in working out space conditions to make a satisfactory adjustment.
- E. If Work is installed before coordinating with other Divisions or so as to cause interference with Work of other Sections, the Contractor causing the interference will make necessary changes to correct the condition without extra charge to the Owner.
- F. Initial contact and coordination has been conducted with utility entities for the purpose of the preparation of Bid Documents. The Contractor shall coordinate all final specific utility requirements.

1.11 ACCEPTANCES

- A. The equipment, materials, Workmanship, design and arrangement of all Work installed are subject to the review of the Engineer.
- B. Within 30 days after the awarding of a Contract, submit to the Engineer for review a list of manufacturers of equipment proposed for the Work. The intent to use the exact makes specified does not relieve the Contractor of the responsibility of submitting such a list.
- C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, notify the Engineer, in writing, within 30 days of the awarding of the Contract. In such instances, deviations may be made pending acceptance by the Engineer or the Owner's representative.

- D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog or model number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.
- E. If material or equipment is installed before shop drawing review, liability for its removal and replacement is assumed by the Contractor, at no extra charge to the Owner, if, in the opinion of the Engineer, the material or equipment does not meet the intent of the Drawings and Specifications.
- F. Failure on the part of the Engineer to reject shop drawings or to reject Work in progress shall not be interpreted as acceptance of Work not in conformance with the Drawings and/or Specifications. Correct Work not in conformance with the Drawings and/or Specifications whenever non-conformance is discovered.

1.12 EQUIPMENT DEVIATIONS

- A. Where the Contractor proposes to deviate (substitute or provide an equivalent) from the equipment or materials as hereinafter specified, he shall do so by making a request in writing a minimum of 14 calendar days prior to submitting his bid. The request shall include a detailed description of the proposed deviation, manufacturer's equipment cuts, copy of manufacturer's warranty and a line-by-line comparison detailing how the proposed product differs from the specified product. The proposed deviation must be equivalent or better than the specified product as judged by the Engineer.
 - 1. The Base Bid shall be based on using the materials and equipment as specified and scheduled with no exceptions. Equipment Manufacturers Scheduled on Drawings are considered Base Product Specification and any other acceptable manufacturers listed in the specifications is considered an equipment deviation and subject to the requirements above. When any alternate manufacturer does not qualify acceptable, as determined by the Engineer, provide the Base Product manufacturer at no additional cost to Owner.
 - 2. Where an equivalent manufacturer is listed in the specifications, it may or may not indicate that there is an equal product available. Any products must meet all criteria of the Base Product Specification as determined by the Engineer.
- B. Substitutions and Equipment Deviations will not be considered if they have a direct bearing on the changing or revising of Contract Documents or if it involves other Contractor's scope of work or their equipment. Coordination with all trades is required and must be acceptable to all other involved Contractors.
- C. Substitutions may be considered for one of the following:
 - 1. Substitution for Cause: Changes proposed by the Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of warranty terms.

2. Substitutions for Convenience: Changes proposed by the Contractor that are not required in order to meet other Project requirements, but may offer advantage to either the Owner or Contractor.
- D. In these Specifications and on the accompanying Drawings, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. This has been done for convenience in fixing the standard of workmanship, finish and design required for installation. In the event that only one (1) manufacturer of a product is specified and it is found that the manufacturer has discontinued the product, the Contractor shall use an acceptable equivalent product that meets the requirements of an equivalent product, as noted below, and has all the features of the originally specified product. The details of workmanship, finish and design, and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.
- E. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineer's review.
- F. Where two or more names are given as equivalents or where one name only is used and is followed by the words "or acceptable equivalent", the Contractor must use the item named or he may apply for an equipment deviation through the prescribed manner in accordance with this Specification.
- G. Equipment, material or devices submitted for review as an "accepted equivalent" shall meet the following requirements:
1. The equivalent shall have the same construction features such as, but not limited to:
 2. Material thickness, gauge, weight, density, etc.
 3. Welded, riveted, bolted, etc., construction
 4. Finish, undercoatings, corrosion protection
 5. The equivalent shall perform with the same or better operating efficiency.
 6. The equivalent shall have equal or greater reserve capacity.
 7. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
 8. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as AMCA or ARI labels.
- H. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Designers of Record at the expense of the Contractor and at no additional cost to the Owner.
- I. Where such accepted deviation or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, with the acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the substitution.

- J. The Engineer shall determine if an "accepted equivalent" to a manufacturer listed in the Specifications is considered acceptable.

1.13 SHOP DRAWINGS

- A. Refer to individual specification sections for additional submittal information.
- B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed.
- C. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Contract. Refer to the General Conditions and Supplementary General Conditions for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.
- D. Provide shop drawings for all devices specified under equipment specifications for all systems, materials, equipment and/or devices. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures) of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal. Partial submissions shall be rejected.
- E. Equipment shop drawings shall contain full range performance curves, graphs, tables or other pertinent data which clearly indicates operational range of a given unit size. Computer generated/plotted curves, based solely on design performance, will not be accepted.
- F. All specific options and/or alternatives shall be clearly indicated. Failure to do so shall be grounds for rejection.
- G. Submittals shall be marked with the trade involved, i.e., HVAC, plumbing, fire protection, etc. and the specific associated specification section.
- H. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.

- I. Failure to submit shop drawings in ample time for review shall not entitle the Contractor to an extension of Contract time. Contractor must allow for a one week review at the Engineer's office plus normal delivery time to the G.C., Architect, Engineer, and return to the Architect, and G.C. No claim for extension by reason of such default will be allowed, nor shall the Contractor be entitled to purchase, furnish and/or install equipment which has not been reviewed by the Engineer. The Contractor shall incur all costs associated with delay of construction due to equipment and/or materials arriving late due to late or improper shop drawing submittal.
- J. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.
- K. Acceptance rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not indicate that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings.
- L. Acceptance of shop drawings shall not apply to quantity nor relieve Contractor of his responsibility to comply with intent of Drawings and Specifications.
- M. Acceptance of shop drawings is final and no further changes will be allowed without the written consent of the Engineer.
- N. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.
- O. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer at least five (5) working days prior to Bidding to allow for issuance of an Addendum. After the five (5) day deadline, Bidder shall make a decision and qualify the Bid, if the Bidder deems it necessary.
- P. Contractor shall make any corrections required by Engineer and shall resubmit required number of corrected copies of shop drawings or new samples until accepted. Contractor shall direct specific attention in writing or on resubmitted shop drawings to revisions other than corrections requested by Engineer on previous submissions. Engineer shall review no more than one resubmittal of any shop drawing or sample at Owner's expense. The fees for review of additional resubmittals shall be paid by the Contractor at the Engineer's standard rates.

1.14 CHANGES IN WORK

- A. A Change Order is a written order to the Contractor signed by the Owner and the Architect, issued after Contracts have been awarded, authorizing a change in the work or an adjustment in the Contract sum or the Contract time. A Change Order signed by the Contractor indicates his agreement therewith, including the adjustment in the Contract sum or the Contract time.
- B. All changes in the work shall follow the recommendations of the AIA "General Conditions of the Contract for Construction", Article 12.

1.15 MANUFACTURER'S IDENTIFICATION

- A. All component parts of each item of equipment or device shall bear the manufacturer's nameplate giving name of manufacturer, description, size, type, serial and model number, electrical characteristics, etc., in order to facilitate maintenance or replacement. Nameplate data shall not be obstructed. The nameplate of a Contractor or distributor will not be acceptable.
- B. All material and equipment for the electrical portion of the mechanical systems shall bear the label of or be listed by UL, or other accredited authoritative agencies or testing organizations approved by the authority having jurisdiction.

1.16 RECORD DRAWINGS

- A. Maintain at the job site a record set of Mechanical Drawings on which any changes in location or routing of all equipment, materials and access panels shall be recorded.
- B. At the end of construction, the Contractor shall provide the Owner with a complete set of As-Built Drawings, including all updated coordination drawings, ductwork and piping plans. As-Builts shall be drawn on the latest version of Autocad or compatible software, approved in writing, prior to submittal.

1.17 MATERIALS AND WORKMANSHIP

- A. All materials and apparatus required for the work, except as otherwise specifically indicated, shall be new, of first-class quality, and shall be furnished, delivered, erected, connected and finished in every detail and be so selected and arranged as to fit properly into the building spaces. Where no specific type or quality of material is given, a first-class standard article as accepted by industry standards shall be furnished.
- B. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, fitters, metal workers, welders, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.

- C. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.
- D. All labor for installation of mechanical systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.18 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.
- B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.
- C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.
- D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.19 BASES AND SUPPORTS

- A. Unless otherwise specifically noted, the Contractor shall furnish all necessary supports, rails, framing, bases and piers required for all equipment furnished under this Division.
- B. Unless otherwise indicated in individual trade Sections, pumps, fans, air handlers, boilers, chillers, tanks, compressors and other rotating machinery shall be mounted on a minimum of six (6") inch high concrete pads which shall be furnished and installed per Division 3. All pads shall be extended six (6") inches beyond machine base in all directions with top edge chamfered. Shop drawings of all foundations and pads shall be submitted to the Engineer for review before they are constructed. The Mechanical Contractor shall field coordinate all required dimensional and necessary loading information.

- C. Construction of foundations, supports, pads, bases and piers where mounted on the floor shall be of the same finish quality as the adjacent and surrounding flooring material.
- D. Unless otherwise shown, all equipment shall be securely attached to the building structure in an acceptable manner. Attachments shall be of a strong and durable nature; any attachments that are insufficient, in the opinion of the Engineer, shall be replaced as directed without extra cost to the Owner.
- E. All equipment supports shall be designed and constructed such that the equipment will be capable of resisting both vertical and horizontal movement. The equipment shall be positively anchored to the bases or supports to resist vertical movement. The equipment and its supports shall be provided with suitable restraints to resist horizontal movement from any direction as dictated by applicable seismic Codes.

1.20 SLEEVES, INSERTS AND ANCHOR BOLTS

- A. The Contractor shall provide, set in place and be held responsible for the location of all sleeves, inserts and anchor bolts required for the work. In the event that failure to do so requires cutting and patching of finished work, it shall be done at the Contractor's expense.
- B. It is the responsibility of the Contractor to furnish cast-in-place steel sleeves, inserts and anchors in sufficient time to be installed during initial concrete pours. Where job schedules make this impossible, coordinate and obtain acceptance from the Structural Engineer for alternate installation methods.
- C. All pipes and conduits passing through floors, walls or partitions shall be provided with sleeves having an inside diameter one (1") inch larger than the outside diameter of the pipe, conduit or insulation enclosing the pipe.
- D. Piping insulation shall run continuous through sleeve.
- E. Penetrations through fire-rated walls, ceilings and all floors (except slab on grade) in which piping or ducts pass shall be filled solidly with acceptable fire-stopping material. Sleeves shall be steel or a UL / FM listed and approved assembly.
- F. When ducts, piping or conduit penetrate the floor of a mechanical room located above an occupied space, such penetrations shall be made completely watertight, such that a liquid leak shall not pass through the penetration.

1.21 FIRE-STOPS AND SEALS

- A. Refer to Division 07 Specification for additional and more specific information.
- B. Fire-stopping systems shall be submitted as shop drawing.

- C. Penetrations through fire-rated walls, ceiling or floors shall be sealed with a UL approved fire-stop fitting classified for an hourly rating equivalent to the fire rating of the wall, ceiling or floor.
- D. Thruwall and floor seals shall be used to provide a positive means of sealing pipes or ducts which pass through the concrete foundation of a structure below grade or below ground water level. Seals shall also be used at entry points through concrete walls or floors which must be sealed.

1.22 CUTTING AND PATCHING

- A. All cutting and patching shall be done per Division 1 requirements. The Contractor shall furnish sketches showing the location and sizes of all openings, chases, etc., required for the installation of work.
- B. Work under this Division shall include furnishing, locating and setting inserts and/or sleeves required before the floors and walls are built or be responsible for cutting, drilling or chopping where sleeves and inserts were not installed or correctly located. The Contractor shall do all drilling required for the installation of hangers.
- C. Exercise extreme caution when core drilling or punching openings in concrete floor slabs in order to avoid cutting or damaging structural members. No structural members or structural slabs/floors shall be cut without the written acceptance of the Structural Engineer and all such cutting shall be done in a manner directed by him.

1.23 SCAFFOLDING, RIGGING, HOISTING

- A. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises any equipment and apparatus furnished under this Division. Remove same from premises when no longer required.

1.24 EXCAVATION AND BACKFILLING

- A. Excavation and backfilling shall be done per Division 2 of the Specifications.
- B. It is the responsibility of the Contractor to coordinate sizes, depths, fill and bedding requirements and any other excavation work required under this Division per code and local utility requirements.

1.25 WATERPROOFING

- A. Where any work pierces waterproofing, including waterproof concrete and floors in wet areas, the method of installation shall be reviewed by the Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

1.26 ACCESSIBILITY AND ACCESS PANELS

- A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate thickness of partitions, and the adequate clearance in double partitions and hung ceilings for the proper installation of the work.
- B. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Equipment shall include, but not be limited to: motors, controllers, coil, valves, switchgear, drain points, etc. Access doors shall be furnished if required for better accessibility. Minor deviations from the Drawings may be made to allow better accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Engineer.
- C. Access doors in walls, ceilings, floors, etc., shall be field coordinated. It is the responsibility of the Contractor to coordinate and provide information regarding the sizes and quantities of access doors required for his work. The Contractor shall arrange his work in such a manner as to minimize the quantity of access doors required, such as grouping shutoff valves in the same area. Where possible, locate valves in already accessible areas, such as lay-in ceilings, etc.
- D. On a clean set of prints, the Contractor shall mark in red pencil the location of each required access door, including its size and fire rating (if any), and shall submit the print to the Architect for review before access doors are purchased or installed.
- E. Upon completion of the Project, the Contractor shall physically demonstrate that all equipment and devices installed have been located and/or provided with adequate access panels for repair, maintenance and/or operation. Any equipment not so furnished shall be relocated or provided with additional access panels by the installing Contractor at no additional cost to the Owner. All access panel or door locations shall be indicated on Owner's final as-built record drawings.
- F. Permanent ladders for access to equipment when shown on Plans shall be furnished and installed. Coordinate exact requirements in field.

1.27 TEMPORARY OPENINGS

- A. The Contractor shall ascertain from an examination of the Drawings whether any special temporary openings in the building will be required for the admission of apparatus provided under this Division and shall coordinate the requirements accordingly. In the event of failure of the Contractor to give sufficient notice in time to arrange for these openings during construction, the Contractor shall assume all costs of providing such openings thereafter.

1.28 SHUTDOWNS

- A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner's representative.

- B. The Engineer and the Owner shall be notified of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.
- C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.29 TAGS AND CHARTS

- A. Each valve and piece of apparatus under this Division shall be provided with suitable brass or laminated plastic tags securely fastened with brass chains, screws or rivets. Equipment shall be numbered with laminated plastic tags or neatly stenciled letters two (2") inches high using designations in equipment schedules and/or shall conform to a directory indicating number, location and use of each item. Directories shall be prepared under each Section and shall be glass framed.
- B. Directory shall indicate valve tag number and the unit number, floor/area branch line, main line, service or other pertinent data to quickly and easily identify the valve's purpose.

1.30 ESCUTCHEONS

- A. The Contractor shall provide escutcheons on pipes wherever they pass through floors, ceilings, walls or partitions in finished visible locations.

1.31 PAINTING

- A. All finish painting in completed areas shall be performed per Division 9 of the Specifications.
- B. All materials shipped to the job site under this Division, such as grilles, registers and/or radiation covers, shall have standard manufacturer's finish, unless otherwise specified by Architect.
- C. The Contractor shall paint the interior of all ducts wherever the interior of the duct can be seen through a register or louver. Paint shall be flat black, rust preventative type.
- D. All outdoor piping, fittings and hangers shall be properly primed with zinc-rich primer and finished with a minimum of two (2) coats of high grade exterior enamel.

1.32 PIPE EXPANSION

- A. All pipe connections shall be installed to allow for freedom of movement of the piping during expansion and contraction without springing. Provide engineered design, layout, details and fabrication, submitted with registered professional engineer sign and seal, of swing joints, expansion loops and expansion joints with proper anchors and guides. Pay particular attention to plastic piping with high coefficients of expansion.

- B. Consideration of required seismic lateral restraints shall be given when anchoring piping and making provision for expansion.

1.33 ELECTRICAL CONNECTIONS

- A. Unless otherwise specified, all wiring shall be furnished and installed per Division 26 Specifications.
- B. All motor controllers not factory mounted on mechanical equipment shall be furnished, mounted, and installed by the Division 26 contractor, and shall be coordinated with this contractor. Provide properly sized overload heaters and all required accessories with all motor controllers. See Division 26 Motor Controllers for motor controller requirements.
- C. All power wiring shall be furnished and installed per Division 26 complete from power source to motor or equipment junction box including power wiring through the motor controller and proper means of disconnect per NEC and Division 26. The Division 26 Contractor shall provide all disconnects, unless noted otherwise.

1.34 QUIET OPERATION

- A. If noise level is deemed objectionable by the Owner/Engineer, the Contractor shall test and record sound levels in the presence of the Owner/Engineer. The sound level shall be observed on the "A" weighting network of a sound level or sound survey meter. The ASHRAE "Guide and Data Book" provides a means to determine sound level of mechanical equipment when the total of background plus equipment sound levels exceeds the minimum acceptable equipment sound level.
- B. If objectionable noises or vibrations of any magnitude are produced and transmitted to occupied portions of the building by apparatus, piping, ducts or other parts of the mechanical work, the Contractor shall make such changes or additions as necessary without extra cost to the Owner.

1.35 MAINTENANCE

- A. The Contractor shall provide the necessary skilled labor to assure the proper operation and to provide all required current and preventative maintenance for all equipment and controls provided under this Division until final acceptance of the building by the Owner. The Contractor shall not assume acceptance of the building by the Owner until he receives written notification.
- B. The Contractor shall receive calls for any and all problems experienced in the operation of the equipment provided under this Division and he shall take steps to immediately correct any deficiencies that may exist.
- C. The Contractor shall provide a check list and shall put a copy of it in the boiler or main mechanical room. The check list shall itemize each piece of equipment furnished under his Section.

- D. The Contractor shall certify on this check list that he has examined each piece of equipment and that, in his opinion, it is operating as intended by the manufacturer, it has been properly lubricated, and that all necessary current and preventative maintenance has been performed as recommended by the manufacturer and by good and accepted practice.
- E. The Contractor shall check all controls in the building to ascertain that they are functioning as designed. This shall apply to all thermostats, aquastats, humidistats, freezestats and firestats, etc. This portion of the work shall be performed by the Contractor who installed the controls.
- F. During construction, the Contractor shall ensure that all filters are in place on all equipment. If the equipment is operated during construction (see restrictions section of this specification), strict attention shall be paid to maintaining clean and effective filters and cleaning ductwork and equipment. Filters shall be new and/or clean when the system testing and balancing takes place. The Contractor shall bear the cost of all filters and media during construction until final acceptance by the Owner. This requirement shall apply equally to fluid filters and strainers.
- G. Where normal preventative maintenance for any piece of equipment requires special tools, the Contractor shall furnish the appropriate tools for that piece of equipment (i.e., special filter removal hooks, valve wrenches, etc.).

1.36 AIR ELIMINATION

- A. The Contractor shall be responsible for bleeding all air from closed hydronic piping systems after the system has been filled, and thereafter rebleeding as often as required to completely eliminate all air from the system.
- B. Where work on an existing piping system has allowed air to enter that system, the Contractor shall also bleed that system even if no piping work was done in the area where air has developed.
- C. Where air cannot be bled from any piping due to the absence of an air vent, the Contractor shall install a manual air vent in locations required to successfully bleed such air.
- D. Where the piping layout would require an air vent in an inaccessible location, the Contractor shall install an extended 1/4-inch copper bleed line and petcock to an accessible location such as a closet, mechanical room, above lay-in ceiling, etc.

1.37 LUBRICATION

- A. All equipment installed under this Contract having moving parts and requiring lubrication shall be properly lubricated according to manufacturer's recommendations prior to testing and operation. Any such equipment discovered to have been operated before lubrication by the Contractor is subject to rejection and replacement at no additional cost to the Owner. Units furnished with sealed bearings are exempted.

- B. The Contractor shall furnish and install, as appropriate on all equipment requiring lubrication, Zerk pressure gun grease fittings or sight gravity-feed oilers equipped with shutoff and needle valve adjustment. Units furnished with sealed bearings and lifetime lubrication are exempted. All fittings and oilers are to be fully accessible for lubrication with equipment which does not require special adapters. Where fittings would be otherwise inaccessible, furnish and install extended grease lines.

1.38 CLEANING

- A. The Contractor shall be responsible for keeping the jobsite clean, safe and neat throughout the duration of construction. The Contractor shall clean up his own debris daily and shall coordinate removal of rubbish and debris with the General Contractor/Construction Manager.
- B. No debris, construction materials, cigarette butts, coffee cups, etc., shall be left above suspended ceilings.
- C. Terminal equipment and plumbing fixtures shall be cleaned at substantial completion.
- D. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.
- E. During the course of construction, all ducts and pipes shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.
- F. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work. Any oil or grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.

1.39 OPERATING INSTRUCTIONS

- A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period of 4 hours unless specified otherwise under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner's representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least 72 hours notice to the Owner and the Engineer in advance of this period.
- B. The Contractor shall formally submit for delivery to the Engineer three (3) complete bound sets of typewritten or blueprinted instructions for operating and maintaining all systems and equipment included in this Division. All instructions shall be submitted in draft for review prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instruction.

- C. The Contractor, in the above-mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this Division.
- D. The appropriate Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.
- E. An authorized manufacturer's representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: pumps; air conditioning equipment, controls, air handling equipment, boilers. These letters will be bound into the operating and maintenance books.
- F. Refer to individual trade Sections for any other particular requirements related to operating instructions.

1.40 ADJUSTING AND TESTING

- A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment, the control operate as described in the sequence of operation and all systems are in satisfactory, permanent operating condition.
- B. Where requested by the Engineer, a factory-trained service engineering representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service engineering representative shall supervise the initial operation of the equipment and instruct the personnel responsible for operation and maintenance of the equipment. The service engineering representative shall notify the Contractor in writing that the equipment was installed according to manufacturer's recommendations and is operating as intended by the manufacturer.

1.41 COMMISSIONING

- A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service.
- B. Complete installation, startup checks and functional tests according to manufacturers written instructions.
- C. Operational Test: After electrical system has been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new ones and repeat the start up procedure.
- D. Verify that equipment is installed and commissioned as per manufacturers written instructions/requirements.
- E. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

- F. Contractor shall replace all damaged components and components that failed the inspections at no additional charge.
- G. Inspections by the Commissioning Agent shall be on “spot check basis”. Commissioning process does not reduce responsibility of installing contractors to provide a finished and fully functioning product.
- H. This section shall in no way diminish the responsibility of the Contractors, Sub-contractors and Suppliers in performing all aspects of work and testing as outlined in the Contract Documents. Any requirements outlined in this section are in addition to requirements outlined in related specifications.

1.42 GUARANTEES

- A. The Contractor shall guarantee all equipment, material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner, unless otherwise noted.
- B. All refrigeration compressors shall have five (5) year guarantee from the date of final acceptance by the Owner unless otherwise noted.
- C. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by the Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.

1.43 RESTRICTIONS

- A. Mechanical equipment provided under this Division may not be used for temporary heating/cooling requirements due to premature wear and dirt/dust infiltration. Equipment shall be protected from dust and debris during construction. Duct opening shall be protected during construction to prevent dust and debris from being transported through ductwork to equipment or other spaces and to ensure ductwork is clean and ready for use at the time of equipment start-up. Written approval may be obtained from the Owner only after submission of a written cleaning plan and guarantee/warranty extension.
- B. Piping shall not be run in any concrete floor slab. Written approval from the Structural Engineer may be obtained only after submission and approval of a layout shop drawing.

PART 2 PRODUCTS - NOT USED.

PART 3 EXECUTION - NOT USED.

END OF SECTION 230500

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SECTION 230505 - MECHANICAL DEMOLITION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Removal and disposal of existing heating system as shown on the Drawings.
- B. Removal and disposal of existing plumbing system as shown on the Drawings.
- C. Mechanical demolition.
 - 1. Existing plumbing fixtures, water piping, sanitary/waste piping, storm piping as indicated on the plans, described in notes or implied by nature of the work.
 - a. All plumbing water piping removed from active lines to remain shall be capped watertight.
 - b. All sanitary branch piping removed from active systems to remain shall either have a new cleanout provided at termination or the branch line shall be removed to within 24" of the active main and capped.
 - c. Removal shall be complete to behind finished surfaces.
- D. Demolition shall include the removal of all hangers and supports, anchors and other items not required for the new work.

1.3 SEQUENCING AND SCHEDULING OF WORK

- A. All piping to be completely drained prior to commencing demolition.
- B. All power to equipment being removed shall be disconnected by electrical contractor prior to commencing demolition.
- C. Schedule and coordinate demolition with new construction to minimize frequency and duration of work in occupied areas.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions in the field. Note which items are to remain and which items are to be removed as indicated on drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents.
- D. Report discrepancies to Engineer before disturbing existing installation.
- E. Where asbestos materials are deemed to be part of the equipment, the abatement contractor shall be responsible for demolition and proper removal and disposal of equipment.
- F. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Drain systems to be removed.
- C. Provide temporary piping, ductwork, control wiring, and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or piping, coordinate shut-down time with owner.
- D. Existing Domestic Cold Water System: Maintain existing systems in service. Disable systems only to make switchovers and/or connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
- E. Existing Sanitary System: Maintain existing system in service. Disable system only to make switchovers and/or connections. Minimize outage duration.

3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

- A. All demolition work shall be scheduled and coordinated in order to accommodate construction phasing schedule.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned piping to source of supply, provide isolation valve and cap at mains.
- D. Contractor shall make safe all work associated with this division.

- E. Disconnect and remove mechanical piping and fittings serving equipment that has been removed .
- F. Disconnect and remove existing equipment, piping and fittings as indicated on the drawings.
- G. Premature or excessive demolition or failure to retain components of the existing heating and plumbing systems shall result in the Contractor providing replacement at no additional cost to Owner.

3.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused in accordance with manufacturer's recommended maintenance procedures.

END OF SECTION 230505

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SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General construction and requirements.
- B. Applications.
- C. Single phase electric motors.
- D. Electronically Commutated Motors (ECM).

1.2 RELATED REQUIREMENTS

- A. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.
- B. Section 262913 - Enclosed Controllers.

1.3 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 1 - Motors and Generators 2021.
- D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

- A. See Section 013000 - 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.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of high efficiency motors.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Baldor Electric Company/ABB Group; [____]: www.baldor.com/#sle.
- B. Leeson Electric Corporation; [____]: www.leeson.com/#sle.
- C. Regal-Beloit Corporation (Century); [____]: www.centuryelectricmotor.com/#sle.

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service: Refer to Section 260583 for required electrical characteristics.
- B. 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.
- C. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 104 degrees F environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

- D. 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.
- E. 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.

2.3 APPLICATIONS

- A. Single phase motors for fans, pumps, blowers, and air compressors: Capacitor start type.
- B. Single phase motors for fans, blowers, and pumps: Capacitor start, capacitor run type.

2.4 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Starting Torque: Three times full load torque.
- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350 percent of full load torque.
- D. Breakdown Torque: Approximately 250 percent of full load torque.
- E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
- G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.5 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. Manufacturers:
 - 1. US Motors, a brand of NIDEC Motor Corporation; [_____]:
www.usmotors.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Applications:
 - 1. Commercial:
 - a. Hydronic Pump:
 - 1) Operating Mode: Constant speed.

- 2) Input: Motor manufacturer to coordinate control requirements with the control board of the hydronic pump and/or specified sequence of operation.
- 3) Flange Configuration: "C".

PART 3 EXECUTION

3.1 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 230513

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

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.
- B. LEED BUILDING GENERAL REQUIREMENTS

1.2 SECTION INCLUDES

- A. Flexible pipe connectors.
- B. Flexible- hose packless expansion joints.
- C. Alignment guides and anchors
- D. Expansion joints and compensators.
- E. Pipe loops, offsets, and swing joints.

1.3 RELATED REQUIREMENTS

- A. Section 230548 - Vibration and Seismic Controls for HVAC Systems.
- B. Section 232113 - Hydronic Piping.
- C. Section 232300 - Refrigerant Piping.

1.4 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. UL (DIR) - Online Certifications Directory Current Edition.

1.5 SUBMITTALS

- A. See Section 013000 - 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 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. Delegated Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for the preparation.
 - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
 - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
 - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
 - D. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
 - E. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
 - F. Maintenance Data: Include adjustment instructions.
- 1.6 WARRANTY
- A. 3 Year full replacement warranty from the date of final acceptance by Owner, unless otherwise noted. .

1.7

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Comply with UL (DIR) requirements.

2.2 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

- A. Manufacturers:
 - 1. The Metraflex Company: www.metraflex.com/#sle.
 - 2. Flex-hose, Inc. : www.flexhose.com
 - 3. Victaulic Company: www.victaulic.com

4. Substitutions: See Section 016000 - Product Requirements.

- B. General: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by center section of flexible hose.
- C. Flexible Hose: Corrugated stainless steel (or bronze) close-pitch hose with stainless steel (or bronze) overbraid.
- D. Pressure Rating: Design for testing to 1.5 times the maximum rated working pressure and a minimum 4:1 (burst to working) safety factor.
- E. Rating: Operating temperatures up to 850 Deg. F for stainless steel and 400 Deg. F for bronze.
- F. Size: Use pipe sized units.
- G. Three Victaulic flexible type couplings may be used in lieu of a flexible connector for vibration attenuation at equipment connections. The couplings shall be placed in close proximity to the source of the vibration.

2.3 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

- A. Manufacturer:
 - 1. Mercer Rubber Company; [____]: www.mercer-rubber.com/#sle.
 - 2. The Metraflex Company; [____]: www.metraflex.com/#sle.
- B. Inner Hose: Bronze.
- C. Pressure Rating: 125 psi and 450 degrees F.
- D. Joint: Flanged.
- E. Application: Copper piping.

2.4 ACCESSORIES

- A. Stainless Steel Pipe: ASTM A269/A269M, seamless type, Grade TP304.
- B. Pipe alignment guides and anchors as required by manufacturer.
- C. Pipe Alignment Guides:
 - 1. Manufacturers:
 - a. Flex-Weld, Inc; [____]: www.flex-weld.com/#sle.
 - b. The Metraflex Company; PGQ Glide Riser Guide: www.metraflex.com/#sle.
 - 2. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.
- D. Engineered Riser Anchor Clamps:

1. Manufacturers:
 - a. The Metraflex Company; Engineered Riser Anchor Clamp:
www.metraflex.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
2. 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.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
- C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
- D. 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.
- E. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- F. 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 230516

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

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 SECTION INCLUDES

- A. Pipe sleeves.
- B. Manufactured sleeve-seal systems.

1.3 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 099113 - Exterior Painting: Preparation and painting of exterior piping systems.
- C. Section 099123 - Interior Painting: Preparation and painting of interior piping systems.
- D. Section 230523 - General-Duty Valves for HVAC Piping.
- E. Section 230553 - Identification for HVAC Piping and Equipment: Piping identification.
- F. Section 230716 - HVAC Equipment Insulation.
- G. Section 230719 - HVAC Piping Insulation.

1.4 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).

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Valve Stem Packings: Two for each type and size of valve.

1.6 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.

1.7 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.

1.8 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 PIPE SLEEVES

- A. Manufacturers:
 - 1. Flexicraft Industries; Pipe Wall Sleeve: www.flexicraft.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.
 - 3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
 - 4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

- C. Plastic or Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- D. Pipe Passing Through Below Grade Exterior Walls:
 - 1. Zinc coated or cast iron pipe.
 - 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- E. 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. Penetrations in concrete beam flanges are permitted but are prohibited through ribs or beams without prior approval from the Engineer.
- H. Clearances:
 - 1. Provide allowance for insulated piping.
 - 2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
 - 3. All Rated Openings: Caulked tight with fire stopping material in compliance with ASTM E814 in accordance with Section 078400 to prevent the spread of fire, smoke, and gases.

2.2 MANUFACTURED SLEEVE-SEAL SYSTEMS

- A. Manufacturers:
 - 1. Flexicraft Industries; PipeSeal: www.flexicraft.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Modular/Mechanical Seal:
 - 1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
 - 2. Provide watertight seal between pipe and wall/casing opening.
 - 3. Elastomer element size and material in accordance with manufacturer's recommendations.
 - 4. Glass reinforced plastic pressure end plates.

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

- A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B. Install piping to conserve building space, to not interfere with use of space and other work.
- C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- E. Structural Considerations:
 - 1. Do not penetrate building structural members unless indicated.
- F. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
 - 1. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.
 - 2. Aboveground Piping:
 - a. Pack solid using mineral fiber in compliance with ASTM C592.
 - b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
 - 3. All Rated Openings: Caulk tight with fire stopping material in compliance with ASTM E814 in accordance with Section 078400 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.

3.3 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 017419 - Construction Waste Management and Disposal, for additional requirements.

END OF SECTION 230517

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SECTION 230519 - METERS AND GAUGES FOR HVAC PIPING

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 SECTION INCLUDES

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

1.3 RELATED REQUIREMENTS

- A. Section 230923 - Direct-Digital Control System for HVAC.
- B. Section 230993 - Sequence of Operations for HVAC Controls.
- C. Section 232113 - Hydronic Piping.

1.4 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 M6 - Water Meters -- Selection, Installation, Testing, and Maintenance 2012, with Addendum (2018).
- G. UL 393 - Indicating Pressure Gauges for Fire-Protection Service Current Edition, Including All Revisions.

1.5 SUBMITTALS

- A. See Section 013000 - 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 016000 - Product Requirements, for additional provisions.
 - 2. Extra Pressure Gauges: One of each type and size.

1.6 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

2.1 POSITIVE DISPLACEMENT METERS (LIQUID)

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com.
 - 2. FMC Technologies: www.fmctechnologies.com.
 - 3. Venture Measurement, a Danaher Corporation Company: www.venturemeasurement.com.
- B. AWWA C700, positive displacement disc type suitable for fluid with metal alloy main case and cast iron frost-proof, breakaway bottom cap, hermetically sealed register, remote reading.
- C. Meter: Brass body turbine meter with magnetic drive register.
 - 1. Service: Hot water, 200 degrees F.

2.2 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.
- 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 inserted through welded threaded couplet, 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.
 - a. Pressure rating: 275 psi.
 - b. Maximum temperature: 400 degrees F.
 - c. Accuracy: Plus 0.55 percent to minus 2.30 percent.
 2. Portable Meter Set: Dry single diaphragm type pressure gauge with 6 inch dial pointer, stainless steel wetted metal parts, variable pulsation damper, equalizing valve, two bleed valves, and master chart for direct conversion of meter readings to flow rate, mounted in rust-proof carrying case with two ten foot long rubber test hoses with brass valves or quick connections for measuring stations.

2.3 PRESSURE GAUGES

- A. Manufacturers:
 1. Dwyer Instruments, Inc: www.dwyer-inst.com.
 2. Moeller Instrument Company, Inc: www.moellerinstrument.com.
 3. Omega Engineering, Inc: www.omega.com.
- B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 1. Case: Steel with brass bourdon tube.
 2. Size: 4-1/2 inch diameter.
 3. Mid-Scale Accuracy: One percent.
 4. Scale: Psi.

2.4 PRESSURE GAUGE TAPPINGS

- A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.
- B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.
- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.
- D. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.

2.5 STEM TYPE THERMOMETERS

- A. Manufacturers:

1. Dwyer Instruments, Inc: www.dwyer-inst.com.
2. Omega Engineering, Inc: www.omega.com.
3. Weksler Glass Thermometer Corp: www.wekslerglass.com.

B. Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.

1. Size: 9 inch scale.
2. Window: Clear Lexan.
3. Stem: 3/4 inch NPT brass.
4. Accuracy: 2 percentper ASTM E77.
5. Calibration: Degrees F.

C. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

1. Size: 9 inch scale.
2. Window: Clear Lexan.
3. Stem: 3/4 inch NPT brass.
4. Accuracy: 2 percentper ASTM E77.
5. Calibration: Degrees F.

2.6 DIAL THERMOMETERS

A. Manufacturers:

1. Dwyer Instruments, Inc: www.dwyer-inst.com.
2. Omega Engineering, Inc: www.omega.com.
3. Weksler Glass Thermometer Corp: www.wekslerglass.com.

B. Thermometer: ASTM E1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.

1. Size: 3 inch diameter dial.

C. Thermometers: Dial type vapor or liquid actuated; ASTM E1; stainless steel case, with brass or copper bulb, copper or bronze braided capillary, white with black markings and black pointer, glass lens.

1. Size: 4-1/2 inch diameter dial.
2. Lens: Clear glass.
3. Length of Capillary: Minimum 5 feet.
4. Accuracy: 2 percent.
5. Calibration: Degrees F.

2.7 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.8 TEST PLUGS

- A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.
- B. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gauges, one gauge adapters with 1/8 inch probes, two 1 inch dial thermometers.

2.9 STATIC PRESSURE GAUGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com.
 - 2. Omega Engineering, Inc: www.omega.com.
 - 3. Weksler Glass Thermometer Corp: www.wekslerglass.com.
- B. 3-1/2 inch 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.
- D. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.
- C. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- E. Provide instruments with scale ranges selected according to service so that normal operating setpoint is at mid-range of instrument.

- 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 230519

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

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 SECTION INCLUDES

- A. Applications.
- B. General requirements.
- C. Ball valves.
- D. Butterfly valves.
- E. Check valves.
- F. Gate valves.
- G. Chainwheels.

1.3 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 083100 - Access Doors and Panels.
- C. Section 230548 - Vibration and Seismic Controls for HVAC.
- D. Section 230553 - Identification for HVAC Piping and Equipment.
- E. Section 230716 - HVAC Equipment Insulation.
- F. Section 230719 - HVAC Piping Insulation.
- G. Section 232113 - Hydronic Piping.
- H. Section 232213 - Steam and Condensate Heating Piping.

1.4 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. SWP: Steam working pressure.
- I. TFE: Tetrafluoroethylene.

1.5 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 A48/A48M - Standard Specification for Gray Iron Castings 2022.
- K. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).
- L. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service 2021.

- M. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures 1999 (Reapproved 2018).
 - N. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).
 - O. ASTM A582/A582M - Standard Specification for Free-Machining Stainless Steel Bars 2021.
 - P. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings 2015 (Reapproved 2021).
 - Q. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.
 - R. AWWA C606 - Grooved and Shouldered Joints 2015.
 - S. MSS SP-45 - Drain and Bypass Connections 2020.
 - T. MSS SP-67 - Butterfly Valves 2022.
 - U. MSS SP-68 - High Pressure Butterfly Valves with Offset Design 2021.
 - V. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends 2011.
 - W. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends 2018.
 - X. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service 2010a.
 - Y. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends 2011.
 - Z. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves 2019.
 - AA. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends 2011.
 - BB. MSS SP-108 - Resilient-Seated Cast Iron Eccentric Plug Valves 2020.
 - CC. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .
 - DD. MSS SP-125 - Check Valves: Gray Iron and Ductile Iron, In-Line, Spring-Loaded, Center-Guided 2018.
- 1.6 SUBMITTALS
- A. See Section 013000 - 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.

1.7 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.

1.8 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.
- C. Exercise the following precautions for handling:
 - 1. Handle large valves with sling, modified to avoid damage to exposed parts.
 - 2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.1 APPLICATIONS

- A. Provide the following valves for the applications if not indicated on drawings:
 - 1. Throttling (Hydronic): Butterfly, Ball, and Globe.
 - 2. Isolation (Shutoff): Butterfly, Gate, and Ball.

3. Swing Check (Pump Outlet):
 - a. 2 NPS and Smaller: Bronze with bronze disc.
 - b. 2-1/2 NPS and Larger: Iron with lever and weight, lever and spring, center-guided metal, or center-guided with resilient seat.
 4. Dead-End: Butterfly, single-flange (lug) type.
- B. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.
- C. Required Valve End Connections for Non-Wafer Types:
1. Steel Pipe:
 - a. 2 NPS and Smaller: Threaded ends.
 - b. 2-1/2 NPS and Larger: Flanged ends.
 - c. For Grooved-End Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.
- D. Chilled Water Valves:
1. 2 NPS and Smaller, Brass and Bronze Valves:
 - a. Solder-joint ends.
 - b. Ball: Full port, two piece, brass trim.
 - c. Swing Check: Bronze disc, Class.
 - d. Globe: Bronze disc, Class 125.
 2. 2-1/2 NPS and Larger, Iron Valves:
 - a. Single-Flange Butterfly: 2-1/2 NPS to 12 NPS, ductile iron disc, EPDM seat, 200 CWP.
 - b. Grooved-End Butterfly: 2-1/2 NPS to 12 NPS, 300 CWP.
 - c. Swing Check: Metal seats, Class 125.
 - d. Grooved-End Check: 3 NPS to 12 NPS, 300 CWP.
 - e. Globe: Class 125.
- E. Condenser Water Valves:
1. 2 NPS 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. Globe: Bronze disc, Class 125.
 2. 2-1/2 NPS and Larger, Iron Valves:
 - a. Single-Flange Butterfly: 2-1/2 NPS to 12 NPS, ductile iron disc, EPDM seat, 200 CWP.
 - b. Grooved-End Butterfly: 2-1/2 NPS to 12 NPS, 300 CWP.
 - c. Swing Check: Metal seats, Class 125.
 - d. Grooved-End Swing Check: 3 NPS to 12 NPS, 300 CWP.
- F. Heating Hot Water Valves:
1. 2 NPS and Smaller, Brass and Bronze Valves:
 - a. Threaded ends.

- b. Ball: Full port, two piece, brass trim.
- c. Swing Check: Bronze disc, Class 125.
- 2. 2-1/2 NPS and Larger, Iron Valves:
 - a. Single-Flange Butterfly: 2-1/2 NPS to 12 NPS, ductile iron disc, EPDM seat, 200 CWP.
 - b. Grooved-End Butterfly: 2-1/2 NPS to 12 NPS, 300 CWP.
 - c. Swing Check: Metal seats, Class 125.
 - d. Grooved-End Swing Check: 3 NPS to 12 NPS, 300 CWP.

2.2 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 NPS and larger.
 - 2. Handwheel: Valves other than quarter-turn types.
 - 3. Hand Lever: Quarter-turn valves 6 NPS and smaller.
 - 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. Valves in Insulated Piping: Provide 2 NPS 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. 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 NPS through 24 NPS: ASME B16.5.
 - 4. Solder Joint Connections: ASME B16.18.
 - 5. Grooved End Connections: AWWA C606.
- F. General ASME Compliance:
 - 1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
 - 2. Building Services Piping Valves: ASME B31.9.
- G. Bronze Valves:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- H. Valve Bypass and Drain Connections: MSS SP-45.

- I. Source Limitations: Obtain each valve type from a single manufacturer.

2.3 MANUFACTURERS:

- A. Conbraco Industries, Inc.; Apollo Valves; www.apollovalves.com
- B. Nibco, Inc: www.nibco.com
- C. Milwaukee Valve Company; www.milwaukeevalve.com
- D. Hammond Valve: www.hammondvalve.com
- E. Crane Co.: www.cranevalve.com
- F. Victaulic Company; www.victaulic.com.
- G. Substitutions: See Section 01 6000 - Product Requirements.

2.4 BRASS BALL VALVES

- A. Two Piece, Full Port with Brass Trim:
 - 1. Comply with MSS SP-110.
 - 2. CWP Rating: 400 psig.
 - 3. Body: Forged brass.
 - 4. Ends: Threaded.
 - 5. Seats: PTFE or TFE.
 - 6. Stem: Brass.
 - 7. Ball: Chrome-plated brass.
 - 8. Manufacturers:
 - a. Conbraco Industries, Inc.; Apollo Valves; www.apollovalves.com
 - b. Nibco, Inc: www.nibco.com
 - c. Milwaukee Valve Company; www.milwaukeevalve.com
 - d. Victaulic Company; www.victaulic.com.
 - e. Substitutions: See Section 016000 - Product Requirements.

2.5 BRONZE BALL VALVES

- A. One Piece, Reduced Port with Bronze Trim:
 - 1. Comply with MSS SP-110.
 - 2. CWP Rating: 400 psig.
 - 3. CWP Rating: 600 psig.
 - 4. Ends: Threaded.
 - 5. Seats: PTFE.

2.6 STAINLESS STEEL BALL VALVES

- A. One-Piece, Standard Port with Stainless-Steel Trim:

1. Comply with MSS SP-110.
2. SWP Rating: 150 psig.
3. CWP Rating: 800 psig.
4. Body: Stainless steel.
5. Ends: Threaded.
6. Seats: PTFE.
7. Stem: Stainless steel.
8. Ball: Stainless steel.

2.7 IRON, SINGLE FLANGE BUTTERFLY VALVES

- A. Lug type: Bi-directional dead end service without downstream flange.
1. Comply with MSS SP-67, Type I.
 2. CWP Rating: 150 psig and 200 psig.
 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: Coated ductile iron.

2.8 IRON, GROOVED-END BUTTERFLY VALVES

- A. CWP Rating: 175 psig (1200 kPa), 300 psig (2070 kPa): 8 NPS (50 DN) or smaller, 200 psig (1389 kPa): 10 NPS (250 DN) or larger, and [_____].
1. Comply with MSS SP-67, Type I.
 2. Body: Coated ductile iron.
 3. Stem: Stainless steel.
 4. Disc: Coated ductile iron.
 5. Disc Seal: EPDM.

2.9 BRONZE SWING CHECK VALVES

- A. Class 125: CWP Rating: 200 psig (1380 kPa), Class 150: CWP Rating: 300 psig (2070 kPa), and [_____].
1. Comply with MSS SP-80, Type 3.
 2. Body Design: Horizontal flow.
 3. Body Material: Bronze, ASTM B62.
 4. Ends: Threaded.
 5. Disc: Bronze.

2.10 IRON, FLANGED END SWING CHECK VALVES

- A. Class 125: CWP Rating: 200 psig (1380 kPa) with Metal Seats, Class 125: CWP Rating: 150 psig (1035 kPa) with Metal Seats, Class 250: CWP Rating: 500 psig (3450 kPa) with Metal Seats, Class 250: CWP Rating: 300 psig (2070 kPa) with Metal Seats, Class 125: CWP Rating: 200 psig (1380 kPa) with Nonmetallic-to-Metal Seats, and [_____].
1. Comply with MSS SP-71, Type I.

2. Design: Clear or full waterway with flanged ends.
3. Body: Gray iron with bolted bonnet in accordance with ASTM A126.
4. Trim: Bronze.
5. Disc Holder: Bronze.
6. Disc: PTFE, TFE, or [_____].
7. Gasket: Asbestos free.

2.11 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

2.12 IRON, GROOVED-END SWING CHECK VALVES

A. 300 CWP:

1. 10 NPS to 12 NPS.
2. CWP Rating: 300 psig.
3. Body Material: ASTM A536, Grade 65-45-12 ductile iron.
4. Seal: EPDM, Nitrile, or [_____].
5. Disc: Ductile iron.
6. Coating: Black, non-lead paint.

2.13 IRON, CENTER-GUIDED CHECK VALVES

2.14 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, butterfly, plug, and [_____] valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

B. Manufacturers:

PART 3 EXECUTION

3.1 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.

3.2 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. Locate Valves for easy access.
- D. Install valves in position to allow full stem movement.
- E. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- F. Install chainwheels on operators for butterfly, gate and globe valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor. Chains shall not interfere with normal access and shall be restrained to wall or column if necessary.
- G. Install check valves where necessary to maintain direction of flow as follows:
 - 1. Swing Check: Install horizontal maintaining hinge pin level.
- H. Provide chainwheels on operators for valves 4 NPS and larger where located 96 NPS or more above finished floor, terminating 60 NPS above finished floor.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment components for equipment, piping, and other HVAC/hydronic work.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 055000 - Metal Fabrications: Materials and requirements for fabricated metal supports.
- C. Section 230548 - Vibration and Seismic Controls for HVAC.

1.3 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 A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- D. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2018).
- E. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2019.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- G. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022.
- H. MFMA-4 - Metal Framing Standards Publication 2004.
- I. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).
- J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 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 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 033000.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating 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.
- D. Installer's Qualifications: Include evidence of compliance with specified requirements.
- E. 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.

1.6 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. Installer Qualifications for Field-Welding: As specified in Section 055000.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 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. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation; [____]: www.cooperindustries.com/#sle.
 - b. Ferguson Enterprises Inc; [____]: www.fnw.com/#sle.
 - c. Unistrut, a brand of Atkore International Inc; [____]: www.unistrut.com/#sle.
 - 2. Provide factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 3. Comply with MFMA-4.
 - 4. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 - 5. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
- C. Fiberglass Channel (Strut) Framing Systems: Factory-fabricated continuous-slot fiberglass channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Manufacturers:
 - 2. Channel Material: Use polyester resin or vinyl ester resin.

3. Minimum Channel Dimensions: 1-5/8 inch width by 1 inch height.
- D. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Piping up to 1 inch (27 mm) nominal: 1/4 inch diameter.
 - c. Piping larger than 1 inch (27 mm) nominal: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.
- E. Steel Cable:
 1. Manufacturers:
 - a. Ductmate Industries, Inc, a DMI Company; Clutcher Cable Hanging System:
www.ductmate.com/#sle.
- F. Thermal Insulated Pipe Supports:
 1. Manufacturers:
 2. General Construction and 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 inch to 30 inch iron pipes.
 - d. Insulation inserts to consist of rigid polyisocyanurate (urethane) insulation surrounded by a 360 degree, PVC jacketing.
 3. PVC Jacket:
 - a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.
 - b. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
 - c. Thickness: 60 mil.
- G. Pipe Supports:
 1. Manufacturers:
 2. Liquid Temperatures Up To 122 degrees F:
 - a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
 - b. Support From Below: MSS SP-58 Types 35 through 38.
 3. Operating Temperatures from 122 to 446 degrees F:
 - a. Overhead Support: MSS SP-58 Type 1 or 3 through 12, with appropriate saddle of MSS SP-58 Type 40 for insulated pipe.
- H. Pipe Stanchions: For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.
 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.
- I. Beam Clamps: MSS SP-58 Types 19 through 23, 25 or 27 through 30 based on required load.

1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
- J. Riser Clamps:
1. Provide copper plated clamps for copper tubing support.
 2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
- K. Offset Pipe Clamps: Double-leg design two-piece pipe clamp.
- L. Strut Clamps: Two-piece pipe clamp.
- M. Insulation Clamps: Two bolt-type clamps designed for installation under insulation.
- N. Pipe Hangers: For a given pipe run use hangers of the same type and material.
1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 2. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- O. 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.
- P. Non-Penetrating Rooftop Supports for Low-Slope Roofs:
1. Manufacturers:
 - a. Anvil International; H-Block: www.anvilintl.com/#sle.
 - b. Cooper B-Line, a division of Eaton Corporation; [____]: www.cooperindustries.com/#sle.
 - c. Erico International Corporation, a brand of Pentair; [____]: www.erico.com/#sle.
 - d. PHP Systems/Design; [____]: www.phpsd.com/#sle.
 2. 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.
 3. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
- Q. Pipe Shields for Insulated Piping:
1. General Construction and Requirements:
 - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
 - b. Shields Material: UV-resistant polypropylene with glass fill.
 - c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
 - d. Minimum Service Temperature: Minus 40 degrees F.
 - e. Maximum Service Temperature: 178 degrees F.
 - f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

R. Anchors and Fasteners:

1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Wood: Use wood screws.
9. Plastic and lead anchors are not permitted.
10. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

PART 3 EXECUTION

3.1 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.

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

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - 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 230529

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SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

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 SECTION INCLUDES

- A. Vibration isolation requirements.
- B. Seismic control requirements.
- C. Vibration-isolated equipment support bases.
- D. Vibration isolators.
- E. Seismic restraint systems.
- F. Vibration-isolated and/or seismically engineered roof curbs.

1.3 RELATED REQUIREMENTS

- A. Section 23 05 00 - Mechanical General Conditions.
- B. Section 014533 - Code-Required Special Inspections and Procedures.
- C. Section 033000 - Cast-in-Place Concrete.

1.4 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.

1.5 REFERENCE STANDARDS

- A. ASCE 19 - Structural Applications of Steel Cables for Buildings 2016.
- B. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications Most Recent Edition Cited by Referring Code or Reference Standard.

- C. MFMA-4 - Metal Framing Standards Publication 2004.
- D. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems 2008.

1.6 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. 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 033000.

1.7 SUBMITTALS

- A. See Section 013000 - 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.
- 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.
- 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. Seismic Design Data:
- 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. Field quality control test reports.
- L. Product Data:
 - 1. Provide manufacturer's product literature documenting compliance with PART 2 PRODUCTS.
 - 2. Include seismic rating documentation for each isolator and restraint component accounting for horizontal, vertical, and combined loads.
- M. Shop Drawings:
 - 1. Provide schedule of vibration isolator type with location and load on each.
 - 2. Fully dimensioned fabrication drawings and installation details for vibration isolation bases, member sizes, attachments to isolators, and supported equipment.
 - 3. Include selections from prescriptive design tables that indicate compliance with the applicable building code and the vibration isolator manufacturer's requirements.
 - 4. Include the calculations that indicate compliance with the applicable building code for seismic controls and the vibration isolator manufacturer's requirements.
 - 5. Include the seal of the Professional Structural Engineer registered in the State of Connecticut in which the Project is located, on drawings and calculations which at a minimum include the following:
 - a. Seismic Restraint Details: Detailed drawings of seismic restraints and snubbers including anchorage details that indicate quantity, diameter, and depth of penetration, edge distance, and spacing of anchors.
 - b. Equipment Seismic Qualification Certification: Certification by the manufacturer or responsible party that each piece of equipment provided will withstand seismic force levels as specified in the applicable building code for seismic controls.
 - c. Detailed description of the equipment anchorage devices on which the certifications are based.
- N. Coordination Drawings:
 - 1. Drawings showing equipment base construction for each machine, including dimensions, structural member sizes and support point locations.
 - 2. Drawings showing methods of suspension, support guides for conduit, piping and ductwork.
 - 3. Drawings showing methods for isolation of conduits, pipes and ductwork penetrating walls and floor slabs.
 - 4. Concrete and steel details for bases including anchor bolt locations.

5. Number and location of seismic restraint/expansion and anchors for each piece of equipment and piping system. Coordination drawings shall be reviewed by the seismic engineer of record, detailing restraint/expansion locations. Each coordination drawing shall bear the seismic engineer's stamp certifying review of the designed systems.
 6. Specific details of restraint/expansion including anchor bolts for mounting and maximum loading at each location, for each piece of equipment and/or raceway.
 7. Submitted drawings shall detail location and construction details of raceway expansion fittings at building seismic joints to accommodate 4" displacement.
 8. Refer to the Architectural and/or Structural drawings for locations of seismic joints.
- O. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

1.8 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Perform design and installation in accordance with applicable codes.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- D. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience.

PART 2 PRODUCTS

2.1 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 (HVAC), 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.
- D. Equipment Isolation: As indicated on drawings.

2.2 MANUFACTURERS

- A. Kinetics Noise Control, Inc; [____]: www.kineticsnoise.com/#sle.

- B. Mason Industries; [____]: www.mason-ind.com/#sle.
- C. Vibration Eliminator Company, Inc: www.veco-nyc.com/#sle.

2.3 PERFORMANCE REQUIREMENTS

- A. General:
 - 1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.
 - 2. Steel springs to function without undue stress or overloading.

2.4 VIBRATION-ISOLATED EQUIPMENT SUPPORT BASES

- A. Structural Bases:
 - 1. Construction: Engineered, structural steel frames with welded brackets for side mounting of the isolators.
 - 2. Frames: Square, rectangular or T-shaped.
 - 3. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
- B. Concrete Inertia Bases:
 - 1. Construction: Engineered, steel forms, with integrated isolator brackets and anchor bolts, welded or tied reinforcing bars running both ways in a single layer.
 - 2. Size: 6 inches minimum depth and sized to accommodate elbow supports.
 - 3. Mass: Minimum of 1.5 times weight of isolated equipment.
 - 4. Connecting Point: Reinforced to connect isolators and snubbers to base including template and fastening devices for equipment.
 - 5. Concrete: Filled on site with minimum 3000 psi concrete. See Section 033000 for additional requirements.

2.5 VIBRATION ISOLATORS

- A. General Requirements:
 - 1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.
- B. Vibration Isolators for Nonseismic Applications:
- C. Seismic Type:
 - 1. Coil Springs Consisting of Single Elements:
 - a. Housing: Manufactured from cast iron material.
 - b. Ductile Material: Designed and rated for seismic applications.
 - c. Spring: Restrained by housing without significant degradation of vibration isolation capabilities during normal equipment operating conditions.
 - d. Resilient Snubbing Grommet System: Incorporated and designed with clearances of no more than 0.25 inch in any direction preventing direct metal-to-metal contact between supported member and fixed restraint housing.

- e. Resilient Pad: Located in series with spring.
- f. Coil Springs: Color coded elements to have a lateral stiffness greater than 0.8 times the rated vertical stiffness with 50 percent overload capacity.
- g. Finish: Suitable for the application.
- 2. All Directional Elastomeric:
 - a. Material: Molded from oil, ozone, and oxidant resistant compounds.
 - b. Operating Parameters: Designed to operate within the isolator strain limits providing maximum performance and service life.
 - c. Attachment Method: Encapsulated load transfer plate bolted to equipment and base plate with anchor hole bolted to supporting structure.
 - d. Rating: Cast iron and aluminum housings rated for seismic restraint applications.
 - e. Minimum Operating Static Deflections: Deflections indicated in project documents are not to exceed published load capacities.

2.6 ACOUSTICAL AND VIBRATION ISOLATORS

- A. Manufacturers:
 - 1. Acoustical and Vibration Isolators:
 - 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.

2.7 SEISMIC RESTRAINT SYSTEMS

- A. Description: System components and accessories specifically designed for field assembly and attachment of seismic restraints.
- B. 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.
- C. Rigid Restraints: Use MFMA-4 steel channel (strut), steel angle, or steel pipe for structural element; suitable for both compressive and tensile design loads.
- D. Comply with:
 - 1. ASHRAE (HVACA) Handbook - HVAC Applications.
 - 2. SMACNA (SRM).
- E. Rigid Restraints:
 - 1. Structural Element: Sized to resist seismic loads in all lateral directions and carry both compressive and tensile loading.

2. Size: Based on the lesser of cable capacity or anchor load taking into account bracket geometry.
3. Connections: Internally brace clevis hanger bracket cross bolt to prevent deformation.
4. Static Support System: Anchorage capable of carrying additional tension loads generated by the vertical component of the rigid brace compression which is additive to any static load requirements on the system.
5. Vertical Suspension Rods: Attached required bracing of sufficient strength to prevent rod buckling from vertical compression forces utilizing series of attachment clips.

2.8 VIBRATION-ISOLATED AND/OR SEISMICALLY ENGINEERED ROOF CURBS

- A. Seismic Type Non-Isolated Curb and Fabricated Equipment Piers:
 1. Location: Between structure and rooftop equipment.
 2. Height: 18" Above finish roof
 3. Construction: Aluminum.
 4. Weather exposed components consist of corrosion resistant materials.

PART 3 EXECUTION

3.1 EXAMINATION

- A. 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.

3.2 CODE-REQUIRED SPECIAL INSPECTIONS

- A. Arrange work to accommodate tests and/or inspections performed by Special Inspection Agency employed by Owner or Engineer in accordance with Section 014533 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. 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.

- D. Special Inspection Agency services do not relieve Contractor from performing inspections and testing specified elsewhere.

3.3 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. Vibration-Isolated Equipment Support Bases:
 - a. Provide specified minimum clearance beneath base.
 - 2. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
 - 3. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
 - 4. Adjust isolators to be free of isolation short circuits during normal operation.
 - 5. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.

3.4 INSTALLATION - GENERAL

- A. Install in accordance with manufacturer's instructions.
- B. Bases:
 - 1. Adjust equipment level.

3.5 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect vibration isolation and/or seismic control components for damage and defects.
- C. Vibration Isolation Systems:
 - 1. Verify isolator static deflections.
 - 2. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.

- D. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.

END OF SECTION 230548

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SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Pipe markers.

1.2 RELATED REQUIREMENTS

- A. Section 099123 - Interior Painting: Identification painting.

1.3 REFERENCE STANDARDS

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

1.4 SUBMITTALS

- A. See Section 013000 - 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.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- F. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.

- B. Air Terminal Units: Tags.
- C. Automatic Controls: Tags. Key to control schematic.
- D. Control Panels: Nameplates.
- E. Ductwork: Adhesive backed duct markers.
- F. Heat Transfer Equipment: Nameplates.
- G. Major Control Components: Nameplates.
- H. Piping: Pipe markers.
- I. Pumps: Nameplates.
- J. Small-sized Equipment: Tags.
- K. Tanks: Nameplates.
- L. Valves: Tags.
- M. Water Treatment Devices: Nameplates.

2.2 NAMEPLATES

- A. Manufacturers:
 - 1. Advanced Graphic Engraving, LLC: www.advancedgraphicengraving.com.
 - 2. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
 - 4. Seton Identification Products, a Tricor Direct Company: www.seton.com.
- B. Letter Color: White.
- C. Letter Height: 1/2 inch.
- D. Background Color: Black.
- E. Plastic: Comply with ASTM D709.

2.3 TAGS

- A. Manufacturers:
 - 1. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
 - 2. Brady Corporation: www.bradycorp.com.
 - 3. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
 - 5. Seton Identification Products, a Tricor Company: www.seton.com.

- B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.4 ADHESIVE-BACKED DUCT MARKERS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.pipemarker.com/#sle.
- B. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- C. Style: Individual Label.
- D. Color: Green for cold-air supply ducts; yellow for hot air supply ducts; blue for exhaust, outside, relief, return and mixed air ducts..
- E. Size: 16" x 2-1/4".

2.5 PIPE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com.
 - 2. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
 - 4. MIFAB, Inc: www.mifab.com.
 - 5. Seton Identification Products, a Tricor Company: www.seton.com.
- 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 wide by 4 mil thick, manufactured for direct burial service.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

- B. Prepare surfaces in accordance with Section 099123 for stencil painting.

3.2 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 below finished grade, directly above buried pipe.
- F. Use tags on piping 3/4 inch diameter and smaller.
 - 1. Install in clear view and align with axis of piping.
 - 2. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- G. Install ductwork with adhesive-backed duct markers. Identify with system, i.e., supply, exhaust, outdoor air. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 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.
- D. Commissioning activities.

1.2 RELATED REQUIREMENTS

- A. Section 014000 - Quality Requirements: Employment of testing agency and payment for services.
- B. Section 019113 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.
- C. Section 230800 - Commissioning of HVAC.

1.3 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 2008, with Errata (2019).
- C. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems 2015, with Errata (2017).
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing 2002.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to Engineer.
 - 2. Submit six weeks prior to starting the testing, adjusting, and balancing work.

3. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Engineer and other installers to sufficiently understand the design intent for each system.
4. 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. Identification and types of measurement instruments to be used and their most recent calibration date.
 - d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - e. Final test report forms to be used.
 - f. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - 1) Terminal flow calibration (for each terminal type).
 - 2) Diffuser proportioning.
 - 3) Branch/submain proportioning.
 - 4) Total flow calculations.
 - 5) Rechecking.
 - 6) Diversity issues.
 - g. Expected problems and solutions, etc.
 - h. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
 - i. Details of how TOTAL flow will be determined; for example:
 - 1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - 2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
 - j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
 - k. Confirmation of understanding of the outside air ventilation criteria under all conditions.
 - l. Time schedule for TAB work to be done in phases (by floor, etc.).
 - m. Description of TAB work for areas to be built out later, if any.
 - n. Time schedule for deferred or seasonal TAB work, if specified.
 - o. False loading of systems to complete TAB work, if specified.
 - p. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.

- q. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - r. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Field Logs: Submit at least twice a week to the Commissioning Authority.
- E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- F. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Submit under provisions of Section 014000.
 - 2. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Engineer and for inclusion in operating and maintenance manuals.
 - 4. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
 - 5. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 6. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 7. Units of Measure: Report data in I-P (inch-pound) units only.
 - 8. 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. Project Engineer.
 - g. Project Contractor.
 - h. Report date.
- G. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 - 3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
 - 4. 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.

3.2 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.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
 1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Engineer to facilitate spot checks during testing.

3.4 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
 1. Running log of events and issues.
 2. Discrepancies, deficient or uncompleted work by others.
 3. Contract interpretation requests.
 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

- D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

3.6 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.
- 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. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. 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.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure air flow across outside air, return air, and exhaust dampers to check leakage.
- K. 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.

- L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.02 inches positive static pressure near the building entries.
- M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
- N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.
- O. On fan powered VAV boxes, adjust air flow switches for proper operation.

3.7 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 gages 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. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. 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.

3.8 COMMISSIONING

- A. See Sections 019113 - General Commissioning Requirements and 230800 for additional requirements.
- B. Perform prerequisites prior to starting commissioning activities.
- C. Fill out Prefunctional Checklists for:
 - 1. Air side systems.
 - 2. Water side systems.
- D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.

- E. Re-check a random sample equivalent to 10 percent of the final TAB report data as directed by Commissioning Authority.
 - 1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
 - 2. Use the same test instruments as used in the original TAB work.
 - 3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
 - 4. For purposes of re-check, failure is defined as follows:
 - a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
 - b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
 - c. Temperatures: Deviation of more than one degree F.
 - d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
 - 5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.
- F. In the presence of the Commissioning Authority, verify that:
 - 1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
 - 2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
 - 3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

3.9 SCOPE

- A. Test, adjust, and balance the following:
 - 1. Plumbing Pumps.
 - 2. HVAC Pumps.
 - 3. Packaged Steel Water Tube Boilers.
 - 4. Packaged Terminal Air Conditioning Units.
 - 5. Air Handling Units.

6. Fans.
7. Air Terminal Units.
8. Air Inlets and Outlets.

3.10 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 1. Manufacturer.
 2. Model/Frame.
 3. HP/BHP.
 4. Phase, voltage, amperage; nameplate, actual, no load.
 5. RPM.
 6. Service factor.
 7. Starter size, rating, heater elements.
 8. Sheave Make/Size/Bore.
- B. V-Belt Drives:
 1. Identification/location.
 2. Required driven RPM.
 3. Driven sheave, diameter and RPM.
 4. Belt, size and quantity.
 5. Motor sheave diameter and RPM.
 6. Center to center distance, maximum, minimum, and actual.
- C. Pumps:
 1. Identification/number.
 2. Manufacturer.
 3. Size/model.
 4. Impeller.
 5. Service.
 6. Design flow rate, pressure drop, BHP.
 7. Actual flow rate, pressure drop, BHP.
 8. Discharge pressure.
 9. Suction pressure.
 10. Total operating head pressure.
 11. Shut off, discharge and suction pressures.
 12. Shut off, total head pressure.
- D. Combustion Equipment:
 1. Boiler manufacturer.
 2. Model number.
 3. Serial number.
 4. Firing rate.
 5. Overfire draft.
 6. Gas meter timing dial size.
 7. Gas meter time per revolution.

8. Gas pressure at meter outlet.
9. Gas flow rate.
10. Heat input.
11. Burner manifold gas pressure.
12. Percent carbon monoxide (CO).
13. Percent carbon dioxide (CO₂).
14. Percent oxygen (O₂).
15. Percent excess air.
16. Flue gas temperature at outlet.
17. Ambient temperature.
18. Net stack temperature.
19. Percent stack loss.
20. Percent combustion efficiency.
21. Heat output.

E. Air Moving Equipment:

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. Sheave Make/Size/Bore.
13. Number of Belts/Make/Size.
14. Fan RPM.

F. Return Air/Outside Air:

1. Identification/location.
2. Design air flow.
3. Actual air flow.
4. Design return air flow.
5. Actual return air flow.
6. Design outside air flow.
7. Actual outside air flow.
8. Return air temperature.
9. Outside air temperature.
10. Required mixed air temperature.
11. Actual mixed air temperature.
12. Design outside/return air ratio.
13. Actual outside/return air ratio.

- G. Exhaust Fans:
 - 1. Location.
 - 2. Manufacturer.
 - 3. Model number.
 - 4. Serial number.
 - 5. Air flow, specified and actual.
 - 6. Total static pressure (total external), specified and actual.
 - 7. Inlet pressure.
 - 8. Discharge pressure.
 - 9. Sheave Make/Size/Bore.
 - 10. Number of Belts/Make/Size.
 - 11. Fan RPM.

- H. Duct Traverses:
 - 1. System zone/branch.
 - 2. Duct size.
 - 3. Area.
 - 4. Design velocity.
 - 5. Design air flow.
 - 6. Test velocity.
 - 7. Test air flow.
 - 8. Duct static pressure.
 - 9. Air temperature.
 - 10. Air correction factor.

- I. Duct Leak Tests:
 - 1. Description of ductwork under test.
 - 2. Duct design operating pressure.
 - 3. Duct design test static pressure.
 - 4. Duct capacity, air flow.
 - 5. Maximum allowable leakage duct capacity times leak factor.
 - 6. Test apparatus:
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
 - 7. Test static pressure.
 - 8. Test orifice differential pressure.
 - 9. Leakage.

- J. Air Monitoring Stations:
 - 1. Identification/location.
 - 2. System.
 - 3. Size.
 - 4. Area.

5. Design velocity.
6. Design air flow.
7. Test velocity.
8. Test air flow.

K. Flow Measuring Stations:

1. Identification/number.
2. Location.
3. Size.
4. Manufacturer.
5. Model number.
6. Serial number.
7. Design Flow rate.
8. Design pressure drop.
9. Actual/final pressure drop.
10. Actual/final flow rate.
11. Station calibrated setting.

L. Terminal Unit Data:

1. Manufacturer.
2. Type, constant, variable, single, dual duct.
3. Identification/number.
4. Location.
5. Model number.
6. Size.
7. Minimum static pressure.
8. Minimum design air flow.
9. Maximum design air flow.
10. Maximum actual air flow.
11. Inlet static pressure.

M. Air Distribution Tests:

1. Air terminal number.
2. Room number/location.
3. Terminal type.
4. Terminal size.
5. Area factor.
6. Design velocity.
7. Design air flow.
8. Test (final) velocity.
9. Test (final) air flow.
10. Percent of design air flow.

N. Sound Level Reports:

1. Location.
2. Octave bands - equipment off.

3. Octave bands - equipment on.

END OF SECTION 230593

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SECTION 230713 - DUCT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Duct insulation.
- B. Duct liner.
- C. Insulation jackets.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section [_____]: Installation and finishing outdoor insulation jacket over roofing system.
- C. Section 099113 - Exterior Painting: Painting insulation jackets.
- D. Section 099123 - Interior Painting: Painting insulation jackets.
- E. Section 220553 - Identification for Plumbing Piping and Equipment.
- F. Section 230553 - Identification for HVAC Piping and Equipment.
- G. Section 233100 - HVAC Ducts and Casings: Glass fiber ducts.

1.3 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) 2014.
- C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2020a.
- E. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).
- F. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).

- G. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation 2020.
- H. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material) 2019.
- I. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings 2019.
- J. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers 2015.
- K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- L. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022.
- M. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- N. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.
- O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013000 - 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 necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum 3 years of experience and approved by manufacturer.

1.6 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.

1.7 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

2.1 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.

2.2 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. Knauf Insulation: www.knaufinsulation.com.
 - 2. Johns Manville: www.jm.com.
 - 3. Knauf Insulation; Atmosphere Duct Wrap: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation: www.ocbuildingspec.com.
 - 5. CertainTeed Corporation: www.certainteed.com.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. 'K' value: 0.27 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 250 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
 - 4. Density: 0.75 lb/cuft
 - 5. Equal to Johns Manville Microlite XG.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- E. Outdoor Vapor Barrier Mastic:
 - 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

- F. Tie Wire: Annealed steel, 16 gage, 0.0508 inch diameter.

2.3 GLASS FIBER, RIGID

- A. Manufacturer:
1. Knauf Insulation: www.knaufinsulation.com.
 2. Johns Manville: www.jm.com.
 3. Owens Corning Corporation: www.ocbuildingspec.com.
 4. CertainTeed Corporation: www.certainteed.com.
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
1. 'K' Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 2. Maximum Service Temperature: 450 degrees F.
 3. Maximum Water Vapor Absorption: 5.0 percent.
 4. Maximum Density: 8.0 lb/cu ft.
- C. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 3. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- E. Indoor Vapor Barrier Finish:
1. Cloth: Untreated; 9 oz/sq yd weight, glass fabric.
 2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.4 OUTDOOR DUCT INSULATION

- A. Closed cell expanded polystyrene foam insulation (minimum R-value of 5 per inch thickness) covered with self-adhering modified bitumen weather barrier.

2.5 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
1. Aeroflex USA, Inc; Aerocel Sheet & Roll with PSA: www.aeroflexusa.com/#sle.
 2. Armacell LLC; AP Armaflex ; []: www.armacell.us/#sle.
 3. K-Flex USA LLC; Insul-Sheet: www.kflexusa.com/#sle.
 4. Substitutions: See Section 016000 - Product Requirements
- 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.

2. Maximum Service Temperature: 180 degrees F.
 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 Polymeric; DP 5050 Water Based, Zero VOC, High Strength, Weather Barrier Coating: www.designpoly.com/#sle.

2.6 JACKETS

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
1. Lagging Adhesive:
 - a. Compatible with insulation.
- B. Mineral Fiber (Outdoor) Jacket: Asphalt impregnated and coated sheet, 50 lb/square.
- C. Aluminum Jacket: ASTM B209 (ASTM B209M).
1. Thickness: 0.016 inch sheet.
 2. Finish: Smooth.
 3. Joining: Longitudinal slip joints and 2 inch laps.
 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
- D. 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 mils.
 3. Finish: Embossed.
 4. Color: Silver.
 5. Water Vapor Transmission: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 6. Mold Resistance: Pass when tested in accordance with ASTM C1338.
 7. Emissivity: 0.30 when tested in accordance with ASTM C1371.
 8. Manufacturers:
 - a. Polyguard Products; Alumaguard: www.polyguardproducts.com.com/#sle.

2.7 DUCT LINER

- A. Manufacturers:
1. Armacell LLC; AP Coilflex: www.armacell.us/#sle.
 2. Ductmate Industries, Inc, a DMI Company; [____]: www.ductmate.com/#sle.
 3. Knauf Insulation: www.knaufinsulation.com.
 4. Johns Manville: www.jm.com.

5. Owens Corning Corporation: www.ocbuildingspec.com.
6. CertainTeed Corporation: www.certainteed.com.

- B. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; Greenguard certified, flexible blanket; impregnated surface and edges coated with poly vinyl acetate polymer or acrylic polymer shown to be fungus and bacteria resistant by testing to ASTM G21 and G22.
1. Equal to Johns Manville Linacoustic RC.
 2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
 3. Service Temperature: Up to 250 degrees F.
 4. Rated Velocity on Coated Air Side for Air Erosion: 6,000 fpm, minimum.
 5. Minimum Noise Reduction Coefficients:
 - a. 1 inch Thickness: 0.45.
- C. Adhesive: Waterproof, fire-retardant type, ASTM C916.
- D. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

2.8 FIRE-RATED INSULATION SYSTEMS

- A. Manufacturers:
1. Fyre Wrap: www.firewrap.com
 2. Fire Master Duct Wrap: www.thermalceramics.com
 3. Johns Manville, Firetemp-wrap: www.jm.com
- B. High temperature, flexible blanket insulation with FSK jacket, 1-1/2" thick, 6 pcf, tested and certified to provide a 1 hour fire rating and zero clearance to combustible material.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that ducts have been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 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, up to and including diffuser and grille box adapters.
 5. All longitudinal and butt seams shall be properly taped.
- D. Insulated ducts conveying air above ambient temperature:
1. Provide with or without standard vapor barrier jacket.
 2. Continue insulation through walls, sleeves, hangers and other duct penetrations.
 3. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
 4. All longitudinal and butt seams shall be properly taped.
- E. 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.
- F. 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. Increase duct size to allow for insulation thickness.
 6. If duct liner is called out or specified, it does not eliminate the need to externally insulate the ductwork as specified.
- 3.3 SCHEDULES
- A. Exhaust Ducts Within 10 ft of Exterior Openings: 2 inch thick
- B. Exhaust Ducts: None required
- C. Supply and Return Ducts: 2" thick (minimum installed R-6)
- D. Supply and Return Ducts Exposed to Outdoors: 2" thick polystyrene (minimum installed R-8)
- E. Outside Air Intake Ducts: 2" thick (minimum installed R-6)
- F. Kitchen Hood Exhaust Ducts: 1-1/2" thick fire-rated insulation, 2 layers
- G. Duct Liner: 1" thick

H. Supply ducts After Terminal Boxes:

END OF SECTION 230713

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Equipment insulation.
- B. Covering.

1.2 RELATED REQUIREMENTS

- A. Section 230553 - Identification for HVAC Piping and Equipment.
- B. Section 232113 - Hydronic Piping: Placement of hangers and hanger inserts.
- C. Section 232114 - Hydronic Specialties.

1.3 REFERENCE STANDARDS

- A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019.
- B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement 2007 (Reapproved 2019).
- C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2020a.
- E. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).
- F. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2022a.
- G. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).
- H. ASTM C1695 - Standard Specification for Fabrication of Flexible Removable and Reusable Blanket Insulation for Hot Service 2020.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.

J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022.

K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

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

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 3 years of experience.

1.6 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.

1.7 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

2.1 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.

2.2 GLASS FIBER, FLEXIBLE

- A. Manufacturers:
 - 1. CertainTeed Corporation; []: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation; []: www.jm.com/#sle.
 - 3. Knauf Insulation; Atmosphere Duct Wrap: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation; []: www.ocbuildingspec.com/#sle.
- B. Insulation: ASTM C553; flexible, noncombustible.
 - 1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 450 degrees F.
 - 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, 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 stainless steel with twisted ends on maximum 12 inch centers.
- E. Vapor Barrier Lap Adhesive: Compatible with insulation.
- F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.3 FLEXIBLE REMOVABLE AND REUSABLE BLANKET INSULATION

- A. Manufacturers:
 - 1. Auburn Manufacturing Inc; Ever Green Cut 'n Wrap: www.auburnmfg.com/#sle.
 - 2. [].
- B. Insulation: ASTM C553 Type V; flexible, noncombustible.
 - 1. Comply with ASTM C1695.
 - 2. K Value: 0.37 at 100 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 3. Minimum Service Temperature: 32 degrees F.
 - 4. Maximum Service Temperature: 500 degrees F.
 - 5. Maximum Water Vapor Absorption: Less than 5.0 percent by weight.
 - 6. Weight: 7.65 oz per sq ft.
 - 7. Effective Thickness: 1.25 plus/minus 0.25 inch.

2.4 GLASS FIBER, RIGID

- A. Manufacturer:

1. CertainTeed Corporation: www.certainteed.com.
2. Johns Manville Corporation: www.jm.com.
3. Knauf Insulation: www.knaufusa.com.
4. Owens Corning Corp: www.owenscorning.com.
5. [_____].
6. [_____].
7. Substitutions: See Section 016000 - Product Requirements.

B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.

1. K Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
2. Maximum Service Temperature: 850 degrees F.
3. Maximum Water Vapor Absorption: 5.0 percent by weight.
4. Maximum Density: 8.0 lb/cu ft.

C. Vapor Barrier Jacket:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with self-sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

D. Facing: 1 inch galvanized steel hexagonal wire mesh stitched on one face of insulation.

E. Vapor Barrier Lap Adhesive: Compatible with insulation.

F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.5 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:

1. Aeroflex USA, Inc; [_____]: www.aeroflexusa.com/#sle.
2. Armacell LLC; AP Armaflex FS: www.armacell.us/#sle.
3. K-Flex USA LLC; Insul-Sheet: www.kflexusa.com/#sle.

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.
2. Maximum Service Temperature: 220 degrees F.
3. Connection: Waterproof vapor barrier adhesive.

2.6 JACKETS

A. PVC Plastic:

1. Manufacturers:
 - a. Johns Manville Corporation: www.jm.com.
 - b. Substitutions: See Section 016000 - Product Requirements.

2. Jacket: Sheet material, off-white color.
 - a. Minimum Service Temperature: Minus 40 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.
3. Covering Adhesive Mastic: Compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that equipment has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 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 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, insulate flanges and unions with removable sections and jackets.
- J. Fiber glass insulated equipment containing fluids above ambient temperature; provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.

- K. Inserts and Shields:
 - 1. Application: Equipment 1-1/2 inches 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 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 canvas jacket sized for finish painting or PVC jacket and fitting covers.
- N. Exterior Applications:
 - 1. Provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement.
 - 2. Cover with aluminum.
- O. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.
- P. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- Q. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

3.3 SCHEDULE

- A. Heating Systems:
 - 1. Pump Bodies: 2" Glass Fiber
 - 2. Heat Exchangers/Converters: 2" Glass Fiber
 - 3. Air Separators: 2" Glass Fiber
- B. Cooling Systems:
 - 1. Pump Bodies: 1-1/2" Glass Fiber
 - 2. Air Separators: 1-1/2" Glass Fiber
 - 3. Chiller Cold Surfaces (Not Factory Insulated): 1-1/2" Armaflex

END OF SECTION 230716

SECTION 230719 - HVAC PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Jackets and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 232113 - Hydronic Piping: Placement of hangers and hanger inserts.
- B. Section 232300 - Refrigerant Piping: Placement of inserts.

1.3 REFERENCE STANDARDS

- A. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus 2019.
- 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 C195 - Standard Specification for Mineral Fiber Thermal Insulating 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 C547 - Standard Specification for Mineral Fiber Pipe Insulation 2022.
- F. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation 2022.
- G. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).
- H. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2018).
- I. ASTM C1695 - Standard Specification for Fabrication of Flexible Removable and Reusable Blanket Insulation for Hot Service 2020.
- J. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension 2016 (Reapproved 2021).

- K. ASTM D610 - Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces 2008 (Reapproved 2019).
- L. ASTM D1056 - Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber 2020.
- M. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- N. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022.
- O. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen 2004 (Reapproved 2012).
- P. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference 2000 (Reapproved 2016).
- Q. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials 2021a.
- R. ASTM G153 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials 2013 (Reapproved 2021).
- S. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.7 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

2.1 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.

2.2 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. JP Lamborn Co; Thermal Sleeve MT: www.jpflex.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. K value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 1200 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 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. Outdoor Vapor Barrier Mastic:
 - 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.3 GLASS FIBER, RIGID

- A. Manufacturers:

1. CertainTeed Corporation: www.certainteed.com.
 2. Johns Manville Corporation: www.jm.com.
 3. Knauf Insulation: www.knaufinsulation.com.
 4. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, Greenguard certified.
1. K Value: ASTM C177, 0.24 at 75 degrees F.
 2. Maximum Service Temperature: 850 degrees F.
 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.
- E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- 2.4 FLEXIBLE REMOVABLE AND REUSABLE BLANKET INSULATION

- A. Manufacturers:
1. Auburn Manufacturing Inc; Ever Green Cut 'n Wrap: www.auburnmfg.com/#sle.
- B. Insulation: ASTM C553 Type V; flexible, noncombustible.
1. Comply with ASTM C1695.
 2. K Value: 0.37 at 100 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 3. Minimum Service Temperature: 32 degrees F.
 4. Maximum Service Temperature: 500 degrees F.
 5. Maximum Water Vapor Absorption: 5.0 percent by weight.
 6. Color: Green.
 7. Weight: 7.65 oz/sq ft.
 8. Effective Thickness: 1.25 +/- 0.25 inch.

2.5 CELLULAR GLASS

- A. Manufacturers:
- B. Pipe and Tubing Insulation: ASTM C552, Type II, Grade 6.
1. K Value: 0.35 at 100 degrees F.
 2. Service Temperature Range: From 250 degrees F to 800 degrees F.
 3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
 4. Water Absorption: 0.5 percent by volume, maximum.
 5. Density: A minimum of 6.12 lb/cu ft.

2.6 POLYETHYLENE

- A. Manufacturers:
- B. Insulation: Flexible closed-cell polyethylene tubing, slit lengthwise for installation, complying with applicable requirements of ASTM D1056.
 - 1. K Value: ASTM C177; 0.25 at 75 degrees F.
 - 2. Maximum Service Temperature: 300 degrees F.
 - 3. Density: 2 lb/cu ft.
 - 4. Maximum Moisture Absorption: 1.0 percent by volume.
 - 5. Connection: Contact adhesive.

2.7 JACKETS

- A. PVC Plastic.
 - 1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.
- B. ABS Plastic:
 - 1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: Minus 40 degrees F.
 - b. Maximum Service Temperature: 180 degrees F.
 - c. Moisture Vapor Permeability: 0.012 perm inch, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 30 mil.
 - e. Connections: Brush on welding adhesive.

2.8 ENGINEERED WALL OUTLET SEALS AND REFRIGERANT PIPING INSULATION PROTECTION

- A. Manufacturers:
- B. Basis of Design: Airex Manufacturing, Inc; www.airexmfg.com/#sle.
- C. Pipe Penetration Wall Seal: Seals HVAC piping wall penetrations with compression gasket wall mounted rigid plastic outlet cover.
 - 1. Wall Outlet Size, Stucco and Masonry Applications: 7-1/2 inch wide by 10 inch high.
 - a. Elastomeric Sleeve Diameter: 1-11/16 inch.
 - 2. Wall Outlet Size, Siding and Compact Applications: 6-7/8 inch wide by 3-7/8 inch high.
 - a. Elastomeric Sleeve Diameter: 1-11/16 inch.
 - 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.

- D. Insulation Protection System: Refrigerant piping insulation PVC protective cover.
1. PVC Insulation Cover Color: Black with full-length velcro fastener.
 2. Weatherization and Ultraviolet Exposure Protection: Comply with ASTM G153.
 3. Water/Vapor Permeability: Comply with ASTM E96/E96M.
 4. Flame Spread and Smoke Development Rating of 24/450: Comply with ASTM E84 or UL 723.
 5. Tensile Strength After UV Exposure and Water Immersion: Comply with ASTM D412.

2.9 ACCESSORIES

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

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated pipes conveying fluids below ambient temperature; insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. Glass fiber insulated pipes conveying fluids below ambient temperature:
- F. For hot piping conveying fluids over 140 degrees F, 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 1/2" inches diameter and larger on clevis hanger.
 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 3. Insert location: Between support shield and piping and under the finish jacket.
 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 078400.
- J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- 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.

3.3 SCHEDULE

- A. Heating Systems:
 1. Glycol Heating Supply and Return:
 2. Low Pressure Steam Condensate:
 3. Boiler Feed Water:
- B. Other Systems:
 1. Humidifier Piping:

END OF SECTION 230719

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SECTION 230800 - COMMISSIONING OF HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. See Section 019113 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 019113.
- B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.
- C. The Commissioning Authority (CA) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.
- D. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
 - 1. Control system.
 - 2. Major and minor equipment items.
 - 3. Piping systems and equipment.
 - 4. Ductwork and accessories.
 - 5. Terminal units.
 - 6. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.
- E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.2 RELATED REQUIREMENTS

- A. Section 015719 - Temporary Environmental Controls: Precautions and procedures; smoking room testing; building flush-out.
- B. Section 017800 - Closeout Submittals: Scope and procedures for operation and maintenance manuals and project record documents.
- C. Section 019113 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.
- D. Section 230923 - Direct-Digital Control System for HVAC.
- E. Section 230913 - Instrumentation and Control Devices for HVAC.
- F. Section 230993 - Sequence of Operations for HVAC Controls.

- G. Section 250800 - Commissioning of Integrated Automation.

1.3 REFERENCE STANDARDS

- A. ASHRAE Guideline 1.1 - HVAC&R Technical Requirements for the Commissioning Process 2007, with Errata (2012).

1.4 SUBMITTALS

- A. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
- B. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.
- C. HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
 - 1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.
 - 2. Full as-built set of control drawings.
 - 3. Full as-built sequence of operations for each piece of equipment.
 - 4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
 - a. Floor.
 - b. Room number.
 - c. Room name.
 - d. Air handler unit ID.
 - e. Reference drawing number.
 - f. Air terminal unit tag ID.
 - g. Heating and/or cooling valve tag ID.
 - h. Minimum air flow rate.
 - i. Maximum air flow rate.
 - 5. Full print out of all schedules and set points after testing and acceptance of the system.
 - 6. Full as-built print out of software program.
 - 7. Electronic copy on disk of the entire program for this facility.
 - 8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
 - 9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
 - 10. Control equipment component submittals, parts lists, etc.
 - 11. Warranty requirements.
 - 12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).

13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
 - a. Sequences of operation.
 - b. Control drawings.
 - c. Points lists.
 - d. Controller and/or module data.
 - e. Thermostats and timers.
 - f. Sensors and DP switches.
 - g. Valves and valve actuators.
 - h. Dampers and damper actuators.
 - i. Program setups (software program printouts).
- D. Project Record Documents: See Section 017800 for additional requirements.
 1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
 2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.
- E. Draft Training Plan: In addition to requirements specified in Section 017900, include:
 1. Follow the recommendations of ASHRAE Guideline 1.1.
 2. Control system manufacturer's recommended training.
 3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.
- F. Training Manuals: See Section 017900 for additional requirements.
 1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.
- B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

PART 3 EXECUTION

3.1 PREPARATION

- A. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.
- B. Furnish additional information requested by the Commissioning Authority.
- C. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update the schedule as appropriate.
- D. Notify the Commissioning Authority when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.
- E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.
- F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.
- G. Provide temperature and pressure taps in accordance with Contract Documents.

3.2 INSPECTING AND TESTING - GENERAL

- A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.
- B. Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.
- C. Provide two-way radios for use during the testing.
- D. Valve/Damper Stroke Setup and Check:
 - 1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
 - 2. Set pump/fan to normal operating mode.
 - 3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
 - 4. Command valve/damper open; verify position is full open and adjust output signal as required.

5. Command valve/damper to a few intermediate positions.
6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

- E. Isolation Valve or System Valve Leak Check: For valves not by coils.
1. With full pressure in the system, command valve closed.
 2. Use an ultra-sonic flow meter to detect flow or leakage.
- F. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.3 TAB COORDINATION

- A. TAB: Testing, adjusting, and balancing of HVAC.
- B. Coordinate commissioning schedule with TAB schedule.
- C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.
- D. Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.
- E. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Authority prior to starting TAB.
- F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

3.4 CONTROL SYSTEM FUNCTIONAL TESTING

- A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.
- B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.
- C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.
- D. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.

2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.
- E. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.
- F. Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
 1. Setpoint changing features and functions.
 2. Sensor calibrations.
- G. Demonstrate to the Commissioning Authority:
 1. That all specified functions and features are set up, debugged and fully operable.
 2. That scheduling features are fully functional and setup, including holidays.
 3. That all graphic screens and value readouts are completed.
 4. Correct date and time setting in central computer.
 5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
 6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
 7. Power failure and battery backup and power-up restart functions.
 8. Global commands features.
 9. Security and access codes.
 10. Occupant over-rides (manual, telephone, key, keypad, etc.).
 11. O&M schedules and alarms.
 12. Occupancy sensors and controls.
 13. Fire alarm interlocks and response.
 14. All control strategies and sequences not tested during controlled equipment testing.
- H. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.5 OPERATION AND MAINTENANCE MANUALS

- A. See Section 017800 for additional requirements.
- B. Add design intent documentation furnished by Engineer to manuals prior to submission to Owner.

- C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

3.6 DEMONSTRATION AND TRAINING

- A. See Section 017900 for additional requirements.
- B. Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.
- C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.
- D. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:
- E. TAB Review: Instruct Owner's personnel for minimum [____] hours, after completion of TAB, on the following:
 - 1. Review final TAB report, explaining the layout and meanings of each data type.
 - 2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
 - 3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
 - 4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
 - 5. Other salient information that may be useful for facility operations, relative to TAB.
- F. HVAC Control System Training: Perform training in at least three phases:
 - 1. Phase 1 - Basic Control System: Provide minimum of [____]2 hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
 - a. This training may be held on-site or at the manufacturer's facility.
 - b. If held off-site, the training may occur prior to final completion of the system installation.
 - c. For off-site training, Contractor shall pay expenses of up to two attendees.
 - 2. Phase 2 - Integrating with HVAC Systems: Provide minimum of 2 hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:

- a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
 - b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
 - c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
 - d. Every display screen, allowing time for questions.
 - e. Point database entry and modifications.
3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of [_____]2 hours of training. Tailor training session to questions and topics solicited beforehand from Owner. Also be prepared to address topics brought up and answer questions concerning operation of the system.
- G. Provide the services of manufacturer representatives to assist instructors where necessary.
- H. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION 230800

SECTION 230913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air Supply System:
 - 1. Compressor and receivers.
 - 2. Pressure relief valves.
- B. Control panels.
- C. Control Valves:
 - 1. Ball valves and actuators.
 - 2. Radiation valves.
- D. Pressure independent valves and actuators.
- E. Dampers.
- F. Damper Operators:
 - 1. Electric operators.
- G. Humidistats:
 - 1. Room humidistats.
- H. Input/Output Sensors:
 - 1. Temperature sensors.
 - 2. Humidity sensors.
 - 3. Static pressure (air pressure) sensors.
 - 4. Carbon dioxide sensors.
- I. Thermostats:
 - 1. Electric room thermostats.
 - 2. Room thermostat accessories.
 - 3. Airstream thermostats.
- J. Time clocks.
- K. Transmitters:
- L. Transducers:
- M. Level Instruments:
- N. Level Switches:

1.2 CONTROLS ELECTRICAL POWER

- A. 120V and low voltage power for controls shall be installed by the Temperature Controls Contractor.

1.3 RELATED REQUIREMENTS

- A. Section 230519 - Meters and Gauges for HVAC Piping: Thermometer sockets and gauge taps.
- B. Section 230923 - Direct-Digital Control System for HVAC.
- C. Section 230993 - Sequence of Operations for HVAC Controls.
- D. Section 232114 - Hydronic Specialties.
- E. Section 233300 - Air Duct Accessories: Installation of automatic dampers.
- F. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.4 REFERENCE STANDARDS

- A. ANSI/FCI 70-2 - Control Valve Seat Leakage 2021.
- B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.
- C. ASTM B32 - Standard Specification for Solder Metal 2020.
- D. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2020.
- E. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.
- F. ASTM B819 - Standard Specification for Seamless Copper Tube for Medical Gas Systems 2019.
- G. ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics 2021.
- H. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding 2019.
- I. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- J. NEMA DC 3 - Residential Controls - Electrical Wall-Mounted Room Thermostats 2013.
- K. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.6 SUBMITTALS

- A. 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.
- B. 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.
- C. Design Data: Provide design data for sizing and selection of compressor.
- D. Manufacturer's Instructions: Provide for all manufactured components.
- E. Designer's Qualification Statement.
- F. Manufacturer's Qualification Statement.
- G. Installer's Qualification Statement.
- H. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
- I. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
- J. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1.7 QUALITY ASSURANCE

- A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State in which the Project is located.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective work within a five year period after Substantial Completion.
- C. Provide five year manufacturer's warranty for control air compressors.

PART 2 PRODUCTS

2.1 MANUFACTURERS

2.2 EQUIPMENT - GENERAL

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

2.3 AIR SUPPLY SYSTEM

- A. Compressor and Receivers:
 - 1. Simplex belt driven air compressor and tank unit with belt guard, silencers, flexible connections, air filter, automatic and manual drain assemblies, oil and particle filter for minimum 0.5 micron particles, pressure reducing valves, and pressure relief valves.
 - 2. Size compressor and storage tank to limit compressor starts to maximum 10 per hour and 50 percent running time.
 - 3. Pressure Control: Zinc or aluminum castings, rated for service with elastomeric diaphragm, adjustable electric contacts.
 - a. Set to start and stop compressor at 50 and 60 psig.
 - b. Set to start and stop second compressor at 50 and 60 psig.
 - 4. Electrical Alternation Set: With motor starters to operate compressors alternately.
- B. Pressure Regulators:
 - 1. Zinc or aluminum castings, rated for service with elastomeric diaphragm, balanced construction to automatically prevent pressure build up, and producing flat, reduced pressure curve for system capacity demand.
- C. Pressure Relief Valves:
 - 1. ASME Code Rated and labeled for high pressure side and sized for installed capacity of pressure regulators at low pressure. Set at maximum 20 percent above low pressure.
- D. Control and Instrumentation Tubing:
 - 1. Copper Tube: ASTM B819 Type K, or ASTM B88 (ASTM B88M) Type K (A), seamless, H or O temper (drawn or annealed).
 - a. Fittings: ASME B16.22, wrought copper.
 - b. Joints: Solder, lead free, ASTM B32 HB alloy (95-5 tin-antimony), or tin and silver.

- c. Fittings: UL listed, rod or forged brass rated to 200 psig at 100 degrees F.
- d. Joints: Ball sleeve compression type.
- 2. Polyethylene Tubing: Black, flame retardant, virgin polyethylene, resistant to environmental stress-cracking when tested in accordance with ASTM D1693.
 - a. Fittings: UL labeled, rod or forged brass rated to 200 psig at 100 degrees F.
 - b. Joints: Compression or barbed type.

2.4 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with enameled finished face panel.
- C. Provide common keying for all panels.

2.5 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, hot water, or steam at 15 to 25 psig (104.4 to 172.4).
 - 3. Flow Characteristic: Include 2-way and 3-way diverting operation configured to fail normally closed (NC).
 - 4. Replacements in Kind: Provide pressure-independent type.
 - 5. ANSI Rating: Class 150.
 - 6. Leakage: Class IV (0.1 percent of rated capacity) per ANSI/FCI 70-2.
 - 7. Body Size:
 - a. Service Temperature:
 - 1) Fluid Side: 0 to 284 degrees F liquid or 25 psig steam.
 - 8. Actuator Requirements:
 - a. Assembly: Factory-mounted.
 - b. Input: 0 to 5 VDC configured for proportional control.
 - c. Accessories: Provide with valve position indicator and manual override.
- B. Radiation Valves:
 - 1. Bronze body, bronze trim, 2 or 3 port as indicated, replaceable plugs and seats, union and threaded ends.
 - 2. Rate for service pressure of 125 psig at 250 degrees F.
 - 3. Size for 3 psig maximum pressure drop at design flow rate.
 - 4. two-way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two-way valve operators to close valves against pump shut off head.

5. Operators (Modulating): Self-contained, linear motorized actuator with approximately 3/4 inch stroke, 60 second full travel with transformer and SPDT contacts: 24 v DC, 6 watt maximum input.

2.6 PRESSURE INDEPENDENT VALVES AND ACTUATORS

- A. Size 2 inch and Smaller:
 1. Provide ball, globe, or [] style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded, soldered, or [] connections.
 2. Metal construction materials consist of bronze, brass, or [].
 3. Non-metal construction materials consist of Teflon, EPDM, engineered resin, or [].
- B. Size 2.5 inch and Larger:
 1. Provide ball, globe, butterfly, or [] style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, weld end, or [] connections.
 2. Valve body construction materials consist of cast iron, carbon steel, ductile iron, or [].
 3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORLYL, engineered resin, or [].
- C. Actuator Requirements:
 1. Assembly: Factory-mounted.
 2. Input: 0 to 5 VDC configured for proportional control.

2.7 DAMPERS

- A. Performance: Test in accordance with AMCA 500-D.
- B. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gage, 0.1046 inch.
- C. Blades: Galvanized steel, maximum blade size 8 inches wide, 48 inches long, minimum 22 gage, 0.0299 inch, attached to minimum 1/2 inch shafts with set screws.
- D. Blade Seals: Synthetic elastomeric, inflatable, mechanically attached, field replaceable.
- E. Jamb Seals: Spring stainless steel.
- F. Shaft Bearings: Oil impregnated sintered bronze.
- G. Linkage Bearings: Oil impregnated sintered bronze.
- H. Leakage: Less than one percent based on approach velocity of 2000 ft per min and 4 inches wg.

- I. Maximum Pressure Differential: 6 inches wg.
- J. Temperature Limits: Minus 40 to 200 degrees F.

2.8 DAMPER OPERATORS

- A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
 - 1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
 - 2. Provide one operator for maximum 36 sq ft damper section.
- B. Electric Operators:
 - 1. Manufacturers:
 - 2. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

2.9 HUMIDISTATS

- A. Room Humidistats:
 - 1. Wall mounted, proportioning type.
 - 2. Throttling Range: Adjustable 2 percent relative humidity.
 - 3. Operating Range: 30 to 80 percent.
 - 4. Maximum Temperature: 110 degrees F.
 - 5. Cover: Set point indication.

2.10 INPUT/OUTPUT SENSORS

- A. Temperature Sensors:
 - 1. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
 - 2. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F.
 - 3. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
 - 4. Temperature Sensing Device: Compatible with project DDC controllers.
 - 5. Performance Characteristics:
 - a. RTD:
 - 1) Room Sensor Accuracy: Plus/minus 0.50 degrees F minimum.
 - 2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F minimum.
 - 3) Chilled Water Accuracy: Plus/minus 0.50 degrees F minimum.
 - b. Thermistor:
 - 1) Accuracy (All): Plus/minus 0.36 degrees F minimum.

- 2) Range: Minus 25 degrees F through 122 degrees F minimum.
- 3) Heat Dissipation Constant: 2.7 mW per degree C.
- c. Temperature Transmitter:
 - 1) Accuracy: 0.10 degree F minimum or plus/minus 0.20 percent of span.
 - 2) Output: 4 to 20 mA.
- d. Sensing Range:
 - 1) Provide limited range sensors if required to sense the range expected for a respective point.
 - 2) Use RTD type sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.
 - 3) Use temperature transmitters in conjunction with RTD's when RTD's are incompatible with DDC controller direct temperature input.
- e. Wire Resistance:
 - 1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.
 - 2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.
- f. Room Sensors: Locking cover matching the pneumatic thermostats used.
- g. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
- h. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.
- i. Ceiling and Recessed Mount Temperature Sensors: Ceiling-mounted sensor in a low-profile housing.
- j. Room Security Sensors: Stainless steel cover plate with insulated back and security screws.
- k. Room Temperature Sensors:
 - 1) Construct for surface, wall box, or [] mounting.
 - 2) Provide the following:
 - (a) Setpoint reset slide switch with an adjustable temperature range.
 - (b) Individual heating/cooling setpoint slide switches.
 - (c) Momentary override request push button for activation of after-hours operation.
 - (d) Analog thermometer.
- l. Room Temperature Sensors with Integral Digital Display:

- 1) Provide a four button keypad with the following capabilities:
 - (a) Controller mode status.
 - (b) Password enabled setpoint and override modes.
 - B. Humidity Sensors:
 1. Manufacturers:
 - C. Static Pressure (Air Pressure) Sensors:
 1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
 2. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
 3. Accuracy: One percent of full scale with repeatability 0.3 percent.
 4. Output: 0 to 5 vdc with power at 12 to 28 vdc.
 - D. Carbon Dioxide Sensors, Duct and Wall:
 1. Air Temperature: Range of 32 to 122 degrees F.
 2. Relative Humidity: Range of 0 to 95 percent (non-condensing).
 3. Calibration Characteristics:
 - a. Automatically compensating algorithm for sensor drift due to sensor degradation.
 - b. Maximum Drift: 2 percent.
 4. Construction:
 - a. Sensor Chamber: Non-corrosive 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.
 5. Optional Equipment
- 2.11 THERMOSTATS
- A. Electric Room Thermostats:
 1. Type: NEMA DC 3, 24 volts, with setback/setup temperature control.
 - B. Room Thermostat Accessories:
 1. Thermostat Covers: Brushed aluminum.
 2. Insulating Bases: For thermostats located on exterior walls.
 3. Thermostat Guards: Metal mounted on separate base.
 4. Adjusting Key: As required for device.
 5. Aspirating Boxes: Where indicated for thermostats requiring flush installation.
 - C. Airstream Thermostats:
 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
 2. Averaging service remote bulb element: 7.5 feet.

2.12 TIME CLOCKS

- A. Seven day programming switch timer with synchronous timing motor and seven day dial, continuously charged Ni-cad battery driven power failure 8 hour carry over and multiple switch trippers to control systems for minimum of two and maximum of eight signals per day with two normally open and two normally closed output switches.
- B. Solid state programmable time control with [] separate programs, 24 hour battery carry over, duty cycling.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Ensure installation of components is complementary to installation of similar components.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mount compressor and tank unit on vibration isolation consisting of springs, with minimum 1 inch static deflection and 1 inch clearance to floor. Isolate air supply with wire-braid reinforced rubber hose or polyethylene tubing. Pipe manual and automatic drains to nearest floor drain.
- C. Supply instrument air from compressor units through filter, pressure reducing valve, pressure relief valve, with pressure gauges, and shutoff and bypass valves.
- D. Install pressure reducing stations consisting of pressure reducing valve, particle filter, valve bypass, pressure gauge on inlet and outlet, and pressure relief valve.
- E. Locate refrigerated air dryer in discharge air line from tank. Mount dryer on wall on rubber in shear mounts. Install pressure regulator downstream of dryer. Pipe automatic drain to nearest floor drain.

- F. Use copper tubing in mechanical rooms, where subject to damage or temperatures in excess of 200 degrees F, where adjacent to heating pipes passing through common sleeve, and where not readily accessible. In mechanical rooms bundled plastic tubing with suitable junction boxes or single plastic tubing with tray or raceway may be used.
- G. Solder copper tubing except at instruments or equipment where compression fittings may be used.
- H. Conceal tubing. Run exposed only in mechanical rooms, storage rooms and like, in neat manner and properly supported.
- I. Mechanically attached tubing to supporting surfaces. Sleeve through concrete surfaces in minimum one inch sleeves, extended 6 inches above floors and one inch below bottom surface of slabs.
- J. Purge tubing with dry, oil-free compressed air before connecting control instruments.
- K. Provide instrument air tubing with check and hand valves to expansion tanks with Schrader fittings and hose; refer to Section 232114.
- L. Provide instrument air tubing with check and hand valves to chiller.
- M. Check and verify location of thermostats with plans and room details before installation. Locate 60 inches above floor. Align with lighting switches and humidistats. Refer to Section 262726.
- N. Mount freeze protection thermostats using flanges and element holders.
- O. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- P. Provide separable sockets for liquids and flanges for air bulb elements.
- Q. Provide thermostats in aspirating boxes in front entrances.
- R. Provide guards on thermostats in entrances.
- S. Provide valves with position indicators and with pilot positioners where sequenced with other controls.
- T. Provide separate steam valves for each bank of coils. Provide two valves in parallel where steam load exceeds 1500 lb per hr with 1/3 to 2/3 load capacities sequenced with smaller valve opening first.
- U. Provide mixing dampers of opposed blade construction arranged to mix streams. Provide pilot positioners on mixed air damper motors. [_____] .

- V. Provide isolation (two position) dampers of parallel blade construction.
- W. Provide pilot positioners on pneumatic damper operators sequenced with other controls.
- X. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
- Y. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- Z. Provide conduit and electrical wiring in accordance with Section 260583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.3 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide a separate maintenance contract for specified maintenance service.
- C. Provide service and maintenance of control system for one year from Date of Substantial Completion.
- D. Provide complete service of controls systems, including call backs, and submit written report of each service call.
- E. In addition to normal service calls, make minimum of [] complete normal inspections of approximately [] hours duration to inspect, calibrate, and adjust controls.

END OF SECTION 230913

SECTION 230923 - DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. System description.
- B. Operator interface.
- C. Controllers.
- D. Power supplies and line filtering.
- E. System software.
- F. Controller software.
- G. HVAC control programs.

1.2 **CONTROLS ELECTRICAL POWER**

- A. 120V and low voltage power for controls shall be installed by the Temperature Controls Contractor.

1.3 RELATED REQUIREMENTS

- A. Section 230913 - Instrumentation and Control Devices for HVAC.
- B. Section 230993 - Sequence of Operations for HVAC Controls.
- C. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.4 REFERENCE STANDARDS

- A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks 2020, with Errata and Amendments (2022).
- B. ASHRAE Std 147 - Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment and Systems 2019, with Addendum (2021).
- 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.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.6 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for each system component and software module.
- C. Shop Drawings:
 - 1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 - 2. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
 - 3. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 - 4. Indicate description and sequence of operation of operating, user, and application software.
- D. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
 - 2. Include submittals data in final "Record Documents" form.
- E. Operation and Maintenance Data:
 - 1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 - 2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. Designer Qualifications: Perform design of system using manufacturer's software 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.

- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- D. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.
- E. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.

1.8 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Substantial Completion.
- C. Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.9 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
 - 1. Limiting use of software to equipment provided under these specifications.
 - 2. Limiting copying.
 - 3. Preserving confidentiality.
 - 4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Niagra/Tridium.

2.2 SYSTEM DESCRIPTION

- A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.
- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

- D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 230913.
- E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.3 OPERATOR INTERFACE

- A. PC Based Work Station:
 - 1. Resides on high speed network with building controllers.
 - 2. Connected to server for full access to all system information.
- B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.
- C. Hardware:
 - 1. Laptop:
 - a. Laptop(s) to be provided by DDC controls manufacturer.
 - b. Quantity: As indicated on the Drawings.
 - c. Minimum RAM: [_____].
 - d. Minimum Processing Speed: [_____].
 - e. Minimum Hard Drive Memory: [_____].
 - f. Drives: [_____].
 - g. Ports: [_____].
 - h. Display: [_____].
 - i. Network Connection:
 - 1) Ethernet interface card.
 - 2) Minimum Speed: [_____].
 - 2. Hand Held Device:
 - a. Provide remote system access via PDA with browser agnostic connectivity, including controller point monitor and control access to the following data:
 - 1) Alarm.
 - 2) Summary.
 - 3) Schedule.
 - 4) Trend.
 - b. Provide the capability to view in text list based format.

- c. Minimum Functionality:
 - 1) Set point adjustment.
 - 2) Alarm acknowledgement.
 - 3) Scheduling.

2.4 CONTROLLERS

A. Building Controllers:

- 1. General:
 - a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - c. Share data between networked controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - h. Communication with other network devices to be based on assigned protocol.
- 2. Communication:
 - a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
 - b. Perform routing when connected to a network of custom application and application specific controllers.
 - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
- 3. External Input-Output (I-O) Data Bus:
 - a. Input only modules.
 - b. Output only modules.
 - c. Variable frequency drives (VFD's).
 - d. Universal I-O module (configurable).
 - e. Specific wired and wireless data integration modules.
 - f. DALI (Digital addressable lighting interface) modules.
 - g. Motor control of devices like blinds, roller shutters, and sun protection systems.
 - h. Multiple Input Output (I-O) Module:
 - 1) IAQ: Temperature, humidity, and CO₂.
 - 2) Audio: Microphone, tone generator, and speaker.
 - 3) Occupancy: Light and thermal sensing with multi-colored LED feedback.
- 4. Anticipated Environmental Ambient Conditions:

- a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
- b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
- 5. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
- 6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
- 7. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- B. Input/Output Interface:
 - 1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
 - 2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
 - 3. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.
 - b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.
 - 4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
 - 5. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
 - 6. Binary Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Outputs provided with three position (On/Off/Auto) override switches.

- c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
- 7. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
 - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
 - c. Drift to not exceed 0.4 percent of range per year.
- 8. Tri State Outputs:
 - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
 - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
 - c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
- 9. System Object Capacity:
 - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
 - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.5 SYSTEM SOFTWARE

- A. Operating System:
 - 1. Concurrent, multi-tasking capability.
 - a. Common Software Applications Supported: Microsoft Excel.
 - b. Acceptable Operating Systems: [_____].
 - 2. System Graphics:
 - a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
 - b. Animation displayed by shifting image files based on object status.
 - c. Provide method for operator with password to perform the following:
 - 1) Move between, change size, and change location of graphic displays.
 - 2) Modify on-line.
 - 3) Add, delete, or change dynamic objects consisting of:
 - (a) Analog and binary values.
 - (b) Dynamic text.
 - (c) Static text.
 - (d) Animation files.
 - 3. Custom Graphics Generation Package:

- a. Create, modify, and save graphic files and visio format graphics in PCX formats.
- b. HTML graphics to support web browser compatible formats.
- c. Capture or convert graphics from AutoCAD.
- 4. Standard HVAC Graphics Library:
 - a. HVAC Equipment:
 - 1) Boilers.
 - 2) Air Handlers.
 - 3) Terminal HVAC Units.
 - b. Ancillary Equipment:
 - 1) Fans.
 - 2) Pumps.
 - 3) Valves.
 - 4) Dampers.

B. Workstation System Applications:

- 1. Automatic System Database Save and Restore Functions:
 - a. Current database copy of each Building Controller is automatically stored on hard disk.
 - b. Automatic update occurs upon change in any system panel.
 - c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
- 2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
 - a. Save database from any system panel.
 - b. Clear a panel database.
 - c. Initiate a download of a specified database to any system panel.
- 3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
- 4. On-line Help:
 - a. Context-sensitive system assists operator in operation and editing.
 - b. Available for all applications.
 - c. Relevant screen data provided for particular screen display.
 - d. Additional help available via hypertext.
- 5. Security:
 - a. Operator log-on requires user name and password to view, edit, add, or delete data.
 - b. System security selectable for each operator.
 - c. System supervisor sets passwords and security levels for all other operators.
 - d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
 - e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
 - f. All system security data stored in encrypted format.

6. System Diagnostics:
 - a. Operations Automatically Monitored:
 - 1) Workstations.
 - 2) Printers.
 - 3) Modems.
 - 4) Network connections.
 - 5) Building management panels.
 - 6) Controllers.
 - b. Device failure is annunciated to the operator.
7. Alarm Processing:
 - a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
 - b. Configurable Objects:
 - 1) Alarm limits.
 - 2) Alarm limit differentials.
 - 3) States.
 - 4) Reactions for each object.
8. Alarm Messages:
 - a. Descriptor: English language.
 - b. Recognizable Features:
 - 1) Source.
 - 2) Location.
 - 3) Nature.
9. Configurable Alarm Reactions by Workstation and Time of Day:
 - a. Logging.
 - b. Printing.
 - c. Starting programs.
 - d. Displaying messages.
 - e. Dialing out to remote locations.
 - f. Paging.
 - g. Providing audible annunciation.
 - h. Displaying specific system graphics.
10. Custom Trend Logs:
 - a. Definable for any data object in the system including interval, start time, and stop time.
 - b. Trend Data:
 - 1) Sampled and stored on the building controller panel.

- 2) Archivable on hard disk.
 - 3) Retrievable for use in reports, spreadsheets and standard database programs.
 - 4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
 - 5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
11. Alarm and Event Log:
 - a. View all system alarms and change of states from any system location.
 - b. Events listed chronologically.
 - c. Operator with proper security acknowledges and clears alarms.
 - d. Alarms not cleared by operator are archived to the workstation hard disk.
 12. Object, Property Status and Control:
 - a. Provide a method to view, edit if applicable, the status of any object and property in the system.
 - b. Status Available by the Following Methods:
 - 1) Menu.
 - 2) Graphics.
 - 3) Custom Programs.
 13. Reports and Logs:
 - a. Reporting Package:
 - 1) Allows operator to select, modify, or create reports.
 - 2) Definable as to data content, format, interval, and date.
 - 3) Archivable to hard disk.
 - b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
 - c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
 - d. Set to be printed on operator command or specific time(s).
 14. Reports:
 - a. Standard:
 - 1) Objects with current values.
 - 2) Current alarms not locked out.
 - 3) Disabled and overridden objects, points and SNVTs.
 - 4) Objects in manual or automatic alarm lockout.
 - 5) Objects in alarm lockout currently in alarm.
 - 6) Logs:

- (a) Alarm History.
 - (b) System messages.
 - (c) System events.
 - (d) Trends.
- b. Custom:
 - 1) Daily.
 - 2) Weekly.
 - 3) Monthly.
 - 4) Annual.
 - 5) Time and date stamped.
 - 6) Title.
 - 7) Facility name.
- c. Tenant Override:
 - 1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
 - 2) Annual report showing override usage on a monthly basis.
- d. Electrical, Fuel, and Weather:
 - 1) Electrical Meter(s):
 - (a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - (b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
 - 2) Fuel Meter(s):
 - (a) Monthly showing daily natural gas consumption for each meter.
 - (b) Annual summary showing monthly consumption for each meter.
 - 3) Weather:
 - (a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.
- C. Workstation Applications Editors:
 - 1. Provide editing software for each system application at PC workstation.
 - 2. Downloaded application is executed at controller panel.

3. Full screen editor for each application allows operator to view and change:
 - a. Configuration.
 - b. Name.
 - c. Control parameters.
 - d. Set-points.
4. Scheduling:
 - a. Monthly calendar indicates schedules, holidays, and exceptions.
 - b. Allows several related objects to be scheduled and copied to other objects or dates.
 - c. Start and stop times adjustable from master schedule.
5. Custom Application Programming:
 - a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
 - b. Programming Features:
 - 1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
 - 2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
 - 3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
 - 4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
 - 5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
 - 6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - 7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
 - 8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.
 - 9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

PART 3 EXECUTION

3.1 INSTALLERS

- A. Installer List:

3.2 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.3 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 230993.
- C. Provide with 120v AC, 15 amp dedicated emergency power circuit to each programmable control unit.
- D. Provide conduit and electrical wiring in accordance with Section 260583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 3 day period.
- C. Provide basic operator training for 2 persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time. Provide training on site.

3.5 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate complete and operating system to Owner.

3.6 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.
- C. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
- D. Provide complete service of systems, including call backs. Make minimum of [____] complete normal inspections of approximately [____] hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

3.7 SCHEDULES

- A. Input/Output Schedule:
 - 1. Point Description:
 - 2. Digital Input:
 - 3. Digital Output:

END OF SECTION 230923

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.
- B. Sequence of operation for:
 - 1. Air terminal units.
 - 2. Cabinet heaters.
 - 3. Central fan systems.
 - 4. Unit heaters.

1.2 CONTROLS ELECTRICAL POWER

- A. 120V and low voltage power for controls shall be installed by the Temperature Controls Contractor.

1.3 RELATED REQUIREMENTS

- A. Section 230913 - Instrumentation and Control Devices for HVAC.
- B. Section 230923 - Direct-Digital Control System for HVAC.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Sequence of Operation Documentation: Submit written sequence of operation for entire HVAC system and each piece of equipment.
 - 1. State each sequence in small segments and give each segment a unique number for referencing in Functional Test procedures; provide a complete description regardless of the completeness and clarity of the sequences specified in Contract Documents.
- C. Control System Diagrams: Submit graphic schematic of the control system showing each control component and each component controlled, monitored, or enabled.
 - 1. Label with settings, adjustable range of control and limits.
 - 2. Include flow diagrams for each control system, graphically depicting control logic.
- D. Points List: Submit list of all control points indicating at least the following for each point.
 - 1. Name of controlled system.
 - 2. Point abbreviation.
 - 3. Point description; such as dry bulb temperature, airflow, etc.

4. Display unit.
5. Control point or setpoint (Yes / No); i.e. a point that controls equipment and can have its setpoint changed.
6. Monitoring point (Yes / No); i.e. a point that does not control or contribute to the control of equipment but is used for operation, maintenance, or performance verification.
7. Calculated point (Yes / No); i.e. a “virtual” point generated from calculations of other point values.

E. Designer's Qualification Statement.

F. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

1.5 QUALITY ASSURANCE

A. Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed at the State in which the Project is located.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 AIR TERMINAL UNITS

A. Single-duct Variable Volume:

1. Cooling Only:
 - a. On a rise in space temperature, the damper will modulate to provide maximum airflow.
 - b. As space temperature decreases, the damper will modulate down to its minimum airflow.
2. Cooling with Reheat:
 - a. On a rise in space temperature above the cooling set-point, the unit modulates to its maximum airflow.
 - b. As the space temperature falls below the cooling set-point, the unit modulates to its minimum airflow.
 - c. As the space temperature continues to fall to the heating set-point, the terminal modulates to its heating minimum airflow. At this point, the heat will be staged on as follows:

3.2 CABINET HEATERS

A. Single temperature room thermostat set at 68 degrees F maintains constant space temperature by cycling unit fan motor and electric heating elements.

1. Integral thermostat continues fan operation until element temperature falls below 100 degrees F.

3.3 CENTRAL FAN SYSTEMS

- A. Time Schedule: Start and stop supply and return fans. Determine fan status through auxiliary contactors in motor starter. If fan fails to start as commanded, signal alarm.
- B. Safety Devices:
 1. Freeze Protection: Stop fans and close outside air dampers if temperature before supply fan is below 37 degrees F; signal alarm.
 2. High Temperature Protection: Stop fans and close outside dampers if temperature in return air is above 300 degrees F; signal alarm.
 3. Smoke Detector: Stop fans, close outside dampers, and close smoke dampers if smoke is detected; signal alarm.
- C. Outside Air Damper: When supply fan is running, open outside air damper to minimum position. Prevent supply fan starting until outside air damper is open and position is verified.
- D. Outside, Return, and Relief Dampers:
 1. When supply fan is not running, outside and relief dampers are closed and return damper is open.
- E. Display:
 1. System graphic.
 2. System on/off indication.
 3. System day/night mode.
 4. System fan on/off indication.
 5. Return fan on/off indication.
 6. Preheat coil pump on/off indication.
 7. Supply static pressure indication.
 8. System on/off auto switch.
 9. System day/night/auto switch.

3.4 UNIT HEATERS

- A. Single temperature room thermostat set at 68 degrees F maintains constant space temperature by cycling unit fan motor and energizing electric heating elements.

END OF SECTION 230993

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SECTION 232113 - HYDRONIC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section "Summary."

1.2 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water and glycol piping, above grade.
- C. Equipment drains and overflows.
- D. Pipe hangers and supports.
- E. Unions, flanges, mechanical couplings, and dielectric connections.
- F. Valves:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.
 - 4. Pressure independent temperature control valves and balancing valves.

1.3 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 083100 - Access Doors and Panels.
- C. Section 230516 - Expansion Fittings and Loops for HVAC Piping.
- D. Section 230523 - General-Duty Valves for HVAC Piping.
- E. Section 230548 - Vibration and Seismic Controls for HVAC.
- F. Section 230553 - Identification for HVAC Piping and Equipment.
- G. Section 230719 - HVAC Piping Insulation.
- H. Section 232114 - Hydronic Specialties.
- I. Section 232500 - HVAC Water Treatment: Pipe cleaning.

1.4 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 B16.15 - Cast Copper Alloy Threaded Fittings: Classes 125 and 250 2018.
- E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
- F. ASME B16.22 - Wrought Copper and 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. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
- J. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service 2019a.
- K. ASTM A183 - Standard Specification for Carbon Steel Track Bolts and Nuts 2014 (Reapproved 2020).
- 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 D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series) 2020.

- S. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 2021.
- T. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 2020.
- U. 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.
- V. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers 1992, with Editorial Revision (2018).
- W. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications 2007 (Reapproved 2019).
- X. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding 2019.
- Y. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2022).
- Z. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings 2017.
- AA. AWWA C606 - Grooved and Shouldered Joints 2015.
- BB. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of piping 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.

1.6 SUBMITTALS

- A. See Section 013000 - 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 catalogue 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. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- E. Project Record Documents: Record actual locations of valves.
- F. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 016000 - Product Requirements, for additional provisions.

1.7 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 10 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. Periodic job site visits by factory-trained representative to ensure best practices in grooved joint installation.
 3. A distributor's representative is not considered qualified to perform the training.
- F. Welder Qualifications: Certify in accordance with ASME BPVC-IX.
 1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.8 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

2.1 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 jointing dissimilar metals.
 - 3. Grooved mechanical joints may be used in accessible locations only.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Engineer.
 - b. Grooved mechanical connections and joints comply with AWWA C606.
 - 1) Ductile Iron: Comply with ASTM A536, Grade 65-45-12.
 - 2) Steel: Comply with ASTM A106/A106M, Grade B or ASTM A53/A53M.
 - c. Use rigid joints unless otherwise indicated.
 - d. Provide steel coupling nuts and bolts complying with ASTM A183.
 - 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 gate valves with cap; pipe to nearest floor drain.
 - 2. On discharge of condenser water pumps, use spring loaded check valves.
 - 3. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
 - 4. For throttling, bypass, or manual flow control services, use globe, ball, or butterfly valves.

2.2 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.
3. 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.
 - 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.
 - a. Manufacturers:
 - 1) Apollo Valves; [____]: www.apollovalves.com/#sle.
 - 2) Grinnell Products; [____]: www.grinnell.com/#sle.
 - 3) Viega LLC; [____]: www.viega.us/#sle.

2.3 EQUIPMENT DRAINS AND OVERFLOWS

A. 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.

B. 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.

2.4 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.

1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

8. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

- 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.

2.5 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe 2 Inches and Less:
1. Ferrous Piping: 150 psig malleable iron, threaded.
 2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe 2 Inches and Greater:
1. Ferrous Piping: 150 psig forged steel, slip-on.
 2. Copper Piping: Bronze.
 3. Gaskets: 1/16 inch thick, preformed neoprene.
- 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. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 4. When pipe is field grooved, provide coupling manufacturer's grooving tools.

2.6 BALL VALVES

- A. Manufacturers:
1. Anvil International; [____]: www.anvilintl.com/#sle.
 2. Apollo Valves; [____]: www.apollovalves.com/#sle.
 3. Grinnell Products; [____]: www.grinnell.com/#sle.
 4. Shurjoint Piping Products, Inc; [____]: www.shurjoint.com/#sle.
 5. Victaulic Company; [____]: www.victaulic.com/#sle.
 6. Viega LLC; [____]: www.viega.us/#sle.
- B. Over 2 Inches:
1. Ductile iron body, chrome plated stainless steel ball, teflon, Virgin TFE, or [____] seat and stuffing box seals, lever handle, gear operated, or [____], flanged ends, rated to 800 psi.

2.7 BUTTERFLY VALVES

- A. Manufacturers:
1. Anvil International; [____]: www.anvilintl.com/#sle.
 2. Apollo Valves; [____]: www.apollovalves.com/#sle.
 3. Grinnell Products; [____]: www.grinnell.com/#sle.
 4. Shurjoint Piping Products, Inc; [____]: www.shurjoint.com/#sle.

5. Victaulic Company; [____]: www.victaulic.com/#sle.
 - B. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, grooved, or [____] ends, extended neck.
 - C. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, Buna-N encapsulation, or [_____].
 - D. Operator: 10 position lever handle.
- 2.8 PRESSURE INDEPENDENT TEMPERATURE CONTROL VALVES AND BALANCING VALVES
- A. Manufacturers:
 1. Danfoss; AB-QM Valve: www.danfoss.com/#sle.
 2. Schneider Electric; [____]: www.schneider-electric.us/#sle.
 - B. Control Valves: Factory-fabricated pressure independent with internal differential pressure regulator (DPRV), which automatically adjusts to normal changes in system pressure and provides 100 percent control valve authority at all positions of the valve.
 1. PICV to accurately control the flow from 0 to 100 percent full rated flow with an operating pressure differential range of 3 to 60 psig.
 2. Provide ANSI/FCI 70-2 Class 4 shut-off on all sizes and field serviceable.
 3. Provide control valve to incorporate control, balancing, and flow limiting. Hydronic system pressure independent control valve bodies to comply with ASME B16.34 or ASME B16.15 pressure and temperature class ratings based on the design operating temperature and 150 percent of the system design operating pressure and have the following characteristics:
 - a. 2 NPS and Smaller: Class 150 bronze or brass body with union connections, stainless steel trim, stainless steel rising stem, stainless steel disc or ball, and screwed ends with backseating capacity repackable under pressure.
 - b. 2-1/2 NPS and Larger: Class 125 iron or ductile iron body, stainless steel trim, stainless steel rising stem, stainless steel disc or ball, flanged ends with backseating capacity repackable under pressure.
 - c. Pressure Control Seat: Brass construction with vulcanized EPDM.
 - d. Sizing: Line-size.
 - e. Fittings and Components: All fittings and components to meet ANSI standards and be compatible with readily available components. 8-inch valves and above to be provided with proper companion flanges.
 - f. Close-Off (Differential) Pressure Rating: Combination of actuator, DPRV action, and trim to provide a minimum close-off pressure rating of 150 percent of total system (pump) head. Provide actuator from the same manufacturer as the pressure independent control valve.
 - C. Electronic Actuators: Direct-mounted, self-calibrating type designed for minimum 60,000 full-stroke cycles at rated force.

- D. Provide actuator with visible position indication. Fail positions on power failure to include in-place, open or closed as indicated in the controls specifications.

PART 3 EXECUTION

3.1 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.

3.2 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. Slope piping and arrange to drain at low points.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 220516.
- J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 230516.
 - 1. Flexible couplings may be used in header piping to accommodate thermal growth, thermal contraction in lieu of expansion loops.
- K. Grooved Joints:

1. Install in accordance with the manufacturer's latest published installation instructions.

L. Inserts:

1. Provide inserts for placement in concrete formwork.
2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

M. Pipe Hangers and Supports:

1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
3. Place hangers within 12 inches of each horizontal elbow.
4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
5. Support vertical piping at every other 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. Refer to Section 09 9123. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

- N. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 220719.

- O. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 230719.

- P. Install valves with stems upright or horizontal, not inverted.

3.3 SCHEDULES

A. Hanger Spacing for Copper Tubing.

1. 1/2 Inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. 1 Inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. 1-1/2 Inches and 2 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. 2-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
5. 3 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.

B. Hanger Spacing for Steel Piping.

1. 1/2 Inch, 3/4 Inch, and 1 Inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.

2. 1-1/4 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
3. 1-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2 Inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3 Inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.

C. Hanger Spacing for Plastic Piping.

1. 1/2 Inch: Maximum span, 42 inches; minimum rod size, 1/4 inch.
2. 3/4 Inch: Maximum span, 45 inches; minimum rod size, 1/4 inch.
3. 1 Inch: Maximum span, 51 inches; minimum rod size, 1/4 inch.
4. 1-1/4 Inches: Maximum span, 57 inches; minimum rod size, 3/8 inch.
5. 1-1/2 Inches: Maximum span, 63 inches; minimum rod size, 3/8 inch.
6. 2 Inches: Maximum span, 69 inches; minimum rod size, 3/8 inch.

END OF SECTION 232113

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SECTION 232114 - HYDRONIC SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Expansion tanks.
- B. Air vents.
- C. Air separators.
- D. Strainers.
- E. Suction diffusers.
- F. Pump connectors.
- G. Balancing valves.
- H. Pressure reducing valves.
- I. Glycol system.

1.2 RELATED REQUIREMENTS

- A. Section 232113 - Hydronic Piping.
- B. Section 232500 - HVAC Water Treatment: Pipe cleaning.

1.3 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.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of hydronic system with size, location and installation of service utilities.

- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.5 SUBMITTALS

- A. 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.
- B. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- D. Maintenance Contract.
- E. Project Record Documents: Record actual locations of flow controls.
- F. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Glycol Solution: One container, 1 gallon size.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.7 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

2.1 EXPANSION TANKS

- A. Manufacturers:
 - 1. Amtrol Inc; [_____]: www.amtrol.com/#sle.

2. ITT Bell & Gossett; [____]: 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 psi, with flexible EPDM diaphragm or bladder sealed into tank, and steel support stand.
- C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psi.
- D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.2 AIR VENTS

- A. Manufacturers:
 1. Armstrong International, Inc; [____]: www.armstronginternational.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 diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

2.3 AIR SEPARATORS

- A. Dip Tube Fitting (Where Not Provided By Boiler Manufacturer):
 1. For 125 psi operating pressure; to prevent free air collected in boiler from rising into system.
- B. In-line Air Separators:
 1. Manufacturers:
 - a. Armstrong International, Inc; [____]: www.armstronginternational.com/#sle.
 - b. ITT Bell & Gossett; [____]: www.bellgossett.com/#sle.
 - c. Taco, Inc; [____]: www.taco-hvac.com/#sle.
 2. Cast iron for sizes 1-1/2 inch and smaller, or steel for sizes 2 inch and larger; tested and stamped in accordance with ASME BPVC-VIII-1; for 125 psi operating pressure.

2.4 STRAINERS

- A. Manufacturers:
 1. Armstrong International, Inc; [____]: www.armstronginternational.com/#sle.
 2. Flexicraft Industries; [____]: www.flexicraft.com/#sle.
 3. Grinnell Products; [____]: www.grinnell.com/#sle.
 4. The Metraflex Company; LPD Y Strainer: www.metraflex.com/#sle.
- B. Size 2 inch and Under:
 1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:

1. Provide flanged, grooved, or [] iron body for 175 psi working pressure, Y pattern with 1/16 inch, 3/64 inch, or [] inch stainless steel perforated screen.

2.5 SUCTION DIFFUSERS

A. Manufacturers:

1. Anvil International; []: www.anvilintl.com/#sle.
2. Grinnell Products; []: www.grinnell.com/#sle.
3. ITT Bell & Gossett; []: www.bellgossett.com/#sle.
4. Shurjoint Piping Products, Inc; []: www.shurjoint.com/#sle.
5. Victaulic Company of America; []: www.victaulic.com/#sle.

- B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.

2.6 PUMP CONNECTORS

A. Manufacturers:

1. Anvil International; AnviFlex: www.anvilintl.com/#sle.
2. Ferguson Enterprises Inc; []: www.fnw.com/#sle.

- B. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.

1. Maximum Allowable Working Pressure: 150 psig at 120 degrees F.
2. End Connections: Same as specified for pipe jointing.
3. End Connections: Flanged ductile iron; complying with ASME B16.1 Class 125.
4. End Connections: Threaded; complying with ASME B16.11.
5. Provide pump connector with integral vanes to reduce turbulent flow.
6. Provide necessary accessories including, but not limited to, swivel joints.

2.7 PRESSURE-TEMPERATURE TEST PLUGS

A. Manufacturers:

1. Ferguson Enterprises Inc; []: www.fnw.com/#sle.
2. Peterson Equipment Company Inc; []: www.petesplug.com/#sle.

- B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.

- C. Application: Use extended length plugs to clear insulated piping.

2.8 BALANCING VALVES

A. Manufacturers:

1. Armstrong International, Inc; [____]: www.armstronginternational.com/#sle.
2. Ferguson Enterprises Inc; [____]: www.fnw.com/#sle.
3. Hays Fluid Controls; [____]: www.haysfluidcontrols.com/#sle.
4. ITT Bell & Gossett; [____]: www.bellgossett.com/#sle.
5. Oventrop Corporation; Hydrocontrol F: www.ventrop.com/#sle.
6. Taco, Inc; [____]: www.taco-hvac.com/#sle.

B. Size 2 inch and Smaller:

1. Provide ball, globe, or [____] style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded, soldered, or [____] connections.
2. Metal construction materials consist of bronze, brass, or [____].
3. Non-metal construction materials consist of Teflon, EPDM, engineered resin, or [____].

C. Size 2.5 inch and Larger:

1. Provide ball, globe, butterfly, or [____] style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, weld end, or [____] connections.
2. Valve body construction materials consist of cast iron, carbon steel, ductile iron, or [____].
3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, engineered resin, or [____].

2.9 RELIEF VALVES

A. Manufacturers:

1. Apollo Valves; [____]: www.apollovalves.com/#sle.
2. Armstrong International, Inc; [____]: www.armstronginternational.com/#sle.
3. 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.

2.10 GLYCOL SYSTEM

- A. Mixing Tank: 55 gallon steel drum with fittings suitable for filling and hand pump for charging, rubber hose for connection of hand pump to system.
- B. Storage Tank: Closed type, welded-steel construction, tested and stamped in accordance with ASME BPVC-VIII-1; 100 psi rating; cleaned, prime coated, and supplied with steel support saddles. Construct with tapings for installation of accessories.
- C. Expansion Tank: Diaphragm type with vent fitting with air separator, and automatic air vent.
- D. Air Pressure Reducing Station: Pressure reducing valve with shut-off valves, strainer, check valve, and needle valve bypass.

E. Glycol Solution:

1. Inhibited propylene glycol and water solution mixed [_____]40 percent glycol - [_____] 60 percent water, suitable for operating temperatures from minus 40 degrees F to 250 degrees F.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- C. Provide manual air vents at system high points and as indicated.
- D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- E. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- F. Provide valved drain and hose connection on strainer blowdown connection.
- G. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
- H. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.
- I. Support pump fittings with floor-mounted pipe and flange supports.
- J. Provide radiator valves on water inlet to terminal heating units such as radiation, unit heaters, and fan coil units.
- K. Provide radiator balancing valves on water outlet from terminal heating units such as radiation, unit heaters, and fan coil units.
- L. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- M. 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.
- N. Pipe relief valve outlet to nearest floor drain.
- O. Where one line vents several relief valves, make cross-sectional area equal to sum of individual vent areas.

- P. Clean and flush glycol system before adding glycol solution. Refer to Section 232500.
- Q. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.
- R. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill at 12 psi.
- S. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Pressure system cold at 5 psi.
- T. Perform tests determining strength of glycol and water solution and submit written test results.

3.2 MAINTENANCE

- A. See Section 017000 - Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide a separate maintenance contract for specified maintenance service.
- C. Provide service and maintenance of glycol system for one year from date of Substantial Completion at no extra charge to Owner.
- D. Perform monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Report findings in detail in writing, including analysis and amounts of glycol or water added.
- E. Explain corrective actions to Owner's maintenance personnel in person.

3.3 EXPANSION TANK SCHEDULE

END OF SECTION 232114

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SECTION 232123 - HYDRONIC PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. System lubricated circulators.
- B. In-line circulators.
- C. Vertical in-line pumps.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete.
- B. Section 230716 - HVAC Equipment Insulation.
- C. Section 230719 - HVAC Piping Insulation.
- D. Section 232113 - Hydronic Piping.
- E. Section 232114 - Hydronic Specialties.
- F. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. NEMA MG 1 - Motors and Generators 2021.
- B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 778 - Standard for Motor-Operated Water Pumps Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013000 - 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. Millwright's Certificate: Certify that base mounted pumps have been aligned.
- D. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.

- E. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Armstrong Pumps Inc: www.armstrongpumps.com.
- B. Bell & Gossett, a Xylem Inc. brand: www.bellgossett.com.
- C. Wilo USA LLC: www.wilo-usa.com.

2.2 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. Minimum Quality Standard: UL 778.
- C. Base Mounted Pumps: Aligned by qualified millwright.
- D. 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.

2.3 SYSTEM LUBRICATED CIRCULATORS

- A. Type: Horizontal shaft, single stage, direct connected with multiple speed wet rotor motor for in-line mounting, for 140 psi maximum working pressure, 230 degrees F maximum water temperature.
- B. Casing: Cast iron with flanged pump connections.
- C. Impeller, Shaft, Rotor: Stainless Steel.
- D. Bearings: Metal Impregnated carbon (graphite) and ceramic.
- E. Motor: Impedance protected, multiple speed, with external speed selector.

2.4 IN-LINE CIRCULATORS

- A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psi maximum working pressure.
- B. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 175 psi maximum working pressure.
- C. Casing: Cast iron, with flanged pump connections.
- D. Impeller: Non-ferrous keyed to shaft.
- E. Bearings: Oil-lubricated bronze sleeve.
- F. Shaft: Alloy steel with bronze sleeve, integral thrust collar.
- G. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.
- H. Drive: Flexible coupling.
- I. Electrical Characteristics:
 - 1. Motor: 1750 rpm unless indicated otherwise; refer to Section 220513.
 - 2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

2.5 VERTICAL IN-LINE PUMPS

- A. Type: Vertical, single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 175 psi working pressure.
- B. Casing: Cast iron, with suction and discharge gauge port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
- C. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
- D. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
- E. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.
- F. Electrical Characteristics:
 - 1. Motor: 1750 rpm unless specified otherwise; refer to Section 220513.
 - 2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.1 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C. 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. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- D. Provide line sized shut-off valve and strainer on pump suction, and line sized shut-off valve and check valve on pump discharge.
- E. Provide air cock and drain connection on horizontal pump casings.
- F. Provide drains for bases and seals, piped to and discharging into floor drains.
- G. Check, align, and certify alignment of base-mounted pumps prior to start-up.
- H. Install close-coupled and base-mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 033000.
- I. Lubricate pumps before start-up.
- J. Provide side-stream filtration system for closed loop systems. Install across pump with flow from pump discharge to pump suction from pump tapings.

END OF SECTION 232123

SECTION 232300 - REFRIGERANT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Filter-driers.

1.2 RELATED REQUIREMENTS

- A. Section 230716 - HVAC Equipment Insulation.
- B. Section 230719 - HVAC Piping Insulation.
- C. Section 236213 - Packaged Air-Cooled Refrigerant Compressor and Condenser Units.

1.3 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. ASHRAE Std 15 - Safety Standard for Refrigeration Systems 2019, with All Amendments and Errata.
- 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 B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.
- G. ASME B31.5 - Refrigeration Piping and Heat Transfer Components 2020.
- H. ASME B31.9 - Building Services Piping 2020.

- I. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- J. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service 2020.
- K. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding 2019.
- L. ICC (IMC)-2018 - International Mechanical Code 2018.
- M. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical Current Edition, Including All Revisions.

1.4 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.
- C. Filter-Driers:
 - 1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.

1.5 SUBMITTALS

- A. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
- B. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
- C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
- D. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Test Reports: Indicate results of leak test, acid test.
- F. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
- G. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.

- H. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.6 QUALITY ASSURANCE

- A. 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.

1.7 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

2.1 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.

2.2 PIPING

- A. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.
 - 3. Mechanical Press Sealed Fittings: Double pressed type complying with UL 207 and ICC (IMC)-2018.
 - a. Manufacturers:
 - 1) RLS, LLC; RLS Cu (Copper): www.rlspressfittings.com/#sle.
 - 2) [_____].
- B. Pipe Supports and Anchors:

1. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron adjustable swivel, split ring.
2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
4. 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 under pipe to top of roofing.

2.3 REFRIGERANT

- A. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.4 VALVES

- A. Manufacturers:
 1. Hansen Technologies Corporation; [____]: www.hantech.com/#sle.
 2. Henry Technologies; [____]: www.henrytech.com/#sle.
 3. Flomatic Valves; [____]: www.flomatic.com/#sle.

2.5 STRAINERS

- A. Manufacturers:
 1. Hansen Technologies Corporation; [____]: www.hantech.com/#sle.
 2. Parker Hannifin/Refrigeration and Air Conditioning; [____]: www.parker.com/#sle.

2.6 FILTER-DRIERS

- A. Manufacturers:
 1. Flow Controls Division of Emerson Electric; [____]: www.emersonflowcontrols.com/#sle.
 2. Parker Hannifin/Refrigeration and Air Conditioning; [____]: www.parker.com/#sle.
 3. Sporlan, a Division of Parker Hannifin; [____]: www.parker.com/#sle.

PART 3 EXECUTION

3.1 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.

3.2 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. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- G. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.5.
 - 2. Support horizontal piping as indicated.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
- H. 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.
- I. Provide clearance for installation of insulation and access to valves and fittings.
- J. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 08 3100.
- K. Flood piping system with nitrogen when brazing.

- L. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
- M. Insulate piping and equipment; refer to Section and Section 220716.
- N. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- O. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- P. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- Q. Fully charge completed system with refrigerant after testing.
- R. Provide electrical connection to solenoid valves. Refer to Section 260583.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - 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. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test to no leakage.

3.4 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 6. 2-5/8 inch OD: Maximum span, 9 feet; minimum rod size, 3/8 inch.
- B. Hanger Spacing for Steel Piping.
 - 1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 - 2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.

END OF SECTION 232300

SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal ductwork.
- B. Casing and plenums.
- C. Kitchen hood ductwork.
- D. Duct cleaning.

1.2 RELATED REQUIREMENTS

- A. Section 230130.51 - HVAC Air-Distribution System Cleaning: Cleaning ducts after completion of installation.
- B. Section 230713 - Duct Insulation: External insulation and duct liner.
- C. Section 233300 - Air Duct Accessories.
- D. Section 233600 - Air Terminal Units.
- E. Section 233700 - Air Outlets and Inlets.

1.3 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- F. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2021.
- G. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.

- H. SMACNA (FGD) - Fibrous Glass Duct Construction Standards 2021.
- I. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines 2001.
- J. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual 2012.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for [] pressure class and higher systems.
- D. Manufacturer's Certificate: Certify that installation of glass fiber ductwork meet or exceed specified requirements.
- E. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).

1.5 QUALITY ASSURANCE

1.6 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

2.1 DUCT ASSEMBLIES

- A. Regulatory Requirements: Construct ductwork to comply with NFPA 90A standards.
- B. Ducts: Galvanized steel, unless otherwise indicated.
- C. Low Pressure Supply (Heating Systems): 1/2 inch w.g. pressure class, galvanized steel.
- D. Low Pressure Supply (System with Cooling Coils): 1/2 inch w.g. pressure class, galvanized steel.
- E. Medium and High Pressure Supply: 1/2 inch w.g. pressure class, galvanized steel.

- F. Return and Relief: 1/2 inch w.g. pressure class, galvanized steel.
- G. General Exhaust: 1/2 inch w.g. pressure class, galvanized steel.
- H. Kitchen Cooking Hood Exhaust: 1/2 inch w.g. pressure class, galvanized steel.
 - 1. Construct of 16 gage, 0.0598 inch sheet steel using continuous external welded joints in rectangular sections.
- I. Outside Air Intake: 1/2 inch w.g. pressure class, galvanized steel.
- J. Transfer Air and Sound Boots: 1/2 inch w.g. pressure class, fibrous glass.

2.2 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
- B. Stainless Steel for Ducts: ASTM A666, Type 304.
- C. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. VOC Content: Not more than 250 g/L, excluding water.
 - 3. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
 - 4. For Use With Flexible Ducts: UL labeled.
 - 5. Manufacturers:
 - a. Carlisle HVAC Products; Hardcast Iron-Grip 601 Water Based Duct Sealant: www.carlislehvac.com/#sle.
 - b. Design Polymerics; DP 1010 Water Based Smooth Duct Sealant, Zero VOC, Premium Quality: www.designpoly.com/#sle.
 - c. Ductmate Industries, Inc, a DMI Company; [____]: www.ductmate.com/#sle.
- D. Gasket Tape: Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle rings connections.
 - 1. Manufacturers:
 - a. Design Polymerics; DP 1040 100 Percent Solids, Zero VOC, High Pressure/High-Velocity Butyl Gasket Tape: www.designpoly.com/#sle.
- E. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.3 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.

- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Construct T'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.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).
- F. 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.

2.4 MANUFACTURED DUCTWORK AND FITTINGS

- A. Flat Oval Ducts: Machine made from round spiral lockseam duct.
 - 1. Manufacture in accordance with SMACNA (DCS).
 - 2. Fittings: Manufacture at least two gages heavier metal than duct.
 - 3. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
 - 4. Manufacturers:
 - a. EHG, a DMI Company; [____]: www.ehgduct.com/#sle.
- B. Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
 - 1. Manufacture in accordance with SMACNA (DCS).
 - 2. Manufacturers:
 - a. EHG, a DMI Company; [____]: www.ehgduct.com/#sle.
 - b. GSI, a DMI Company; [____]: www.green seamind.com/#sle.
 - c. Linx Industries, Inc, a DMI Company; [____]: www.li-hvac.com/#sle.
 - d. MKT Metal Manufacturing; [____]: www.mktduct.com/#sle.
- C. Round Ducts: Round lockseam duct with galvanized steel outer wall.
 - 1. Manufacture in accordance with SMACNA (DCS).
 - 2. Manufacturers:
 - a. EHG, a DMI Company; [____]: www.ehgduct.com/#sle.
 - b. Linx Industries, Inc, a DMI Company; [____]: www.li-hvac.com/#sle.
 - c. MKT Metal Manufacturing; [____]: www.mktduct.com/#sle.
- D. Flexible Ducts: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
 - 1. Insulation: None.
 - 2. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
 - 3. Maximum Velocity: 4000 fpm.

4. Temperature Range: Minus 20 degrees F to 210 degrees F.
5. Manufacturers:
 - a. JP Lamborn Co; Non-Insulated MNI: www.jpflex.com/#sle.
- E. Round Duct Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).
 1. Manufacturers:
 - a. Ductmate Industries, Inc, a DMI Company; [____]: www.ductmate.com/#sle.
- F. Kitchen Cooking Hood and Grease Exhaust: Nominal 3 inches thick ceramic fiber insulation between 20 gage, 0.0375 inch, Type 304 stainless steel liner and 24 gage, 0.0239 inch aluminized steel sheet outer jacket.
 1. Tested and UL listed for use with commercial cooking equipment in accordance with NFPA 96.
 2. Certified for zero clearance to combustible material in accordance with:
 3. Materials and construction of the modular sections and accessories to be in accordance with the terms of the following listings:

2.5 CASINGS

- A. Fabricate casings in accordance with SMACNA (DCS) and construct for operating pressures indicated.
- B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18 gage, 0.0478 inch expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
- D. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gage, 0.0598 inch sheet steel back facing and 22 gage, 0.0299 inch perforated sheet steel front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb/cu ft minimum glass fiber insulation media, on inverted channels of 16 gage, 0.0598 inch sheet steel.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install in accordance with manufacturer's instructions.

- C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- D. Fibrous Glass Ducts: Install in accordance with SMACNA (FGD). Obtain manufacturer's inspection and acceptance of fabrication and installation at beginning of installation.
- E. Flexible Ducts: Connect to metal ducts with adhesive.
- F. Kitchen Hood Exhaust: Provide residue traps at base of vertical risers with provisions for clean out.
- G. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- H. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- I. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- J. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- K. Use double nuts and lock washers on threaded rod supports.
- L. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
- M. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.
- N. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

3.2 CLEANING

- A. See Section 017419 - Construction Waste Management and Disposal, for additional requirements.
- B. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment that could be harmed by excessive dirt with temporary filters, or bypass during cleaning.

END OF SECTION 233100

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Backdraft dampers - fabric.
- D. Combination fire and smoke dampers.
- E. Combination fire and smoke dampers - corridor dampers.
- F. Duct access doors.
- G. Duct test holes.
- H. Fire dampers.
- I. Flexible duct connectors.
- J. Smoke dampers.
- K. Volume control dampers.
- L. Low leakage (Class 1A) control dampers.
- M. Miscellaneous products:
 - 1. Damper operators.
 - 2. Damper position switch.
 - 3. Duct opening closure film.

1.2 RELATED REQUIREMENTS

- A. Section 233100 - HVAC Ducts and Casings.
- B. Section 233600 - Air Terminal Units: Pressure regulating damper assemblies.
- C. Section 253513 - Integrated Automation Actuators and Operators: Damper operators.
- D. Section 253516 - Integrated Automation Sensors and Transmitters: Damper position switch.
- E. Section 253523 - Integrated Automation Control Dampers: Product furnishing.

1.3 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- B. NFPA 92 - Standard for Smoke Control Systems 2021.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2021.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.
- 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 555S - Standard for Smoke Dampers Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
- D. Manufacturer's Installation Instructions: Provide instructions for fire dampers.
- E. Project Record Drawings: Record actual locations of access doors and test holes.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.1 AIR TURNING DEVICES/EXTRACTORS

- A. Manufacturers:
 - 1. Carlisle HVAC Products; Dynair Hollow Vane and Rail (Double Wall Vane): www.carlislehvac.com/#sle.
 - 2. Elgen Manufacturing, Inc; [____]: www.elgenmfg.com/#sle.
 - 3. Krueger-HVAC, Division of Air System Components; [____]: www.krueger-hvac.com/#sle.
 - 4. Titus HVAC, a brand of Johnson Controls; [____]: www.titus-hvac.com/#sle.

- B. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.
- C. Multi-blade device with radius blades attached to pivoting frame and bracket, steel construction, with push-pull operator strap.

2.2 BACKDRAFT DAMPERS - METAL

- A. Manufacturers:
 - 1. Louvers & Dampers, Inc, a brand of Mestek, Inc; [____]: www.louvers-dampers.com/#sle.
 - 2. Nailor Industries, Inc; [____]: www.nailor.com/#sle.
 - 3. Ruskin Company; [____]: www.ruskin.com/#sle.
 - 4. United Enertech; [____]: www.unitedenertech.com/#sle.
- B. Gravity Backdraft Dampers, Size 18 by 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.
- C. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.3 BACKDRAFT DAMPERS - FABRIC

- A. Fabric Backdraft Dampers: Factory-fabricated.
 - 1. Blades: Neoprene coated fabric material.
 - 2. Birdscreen: 1/2 inch nominal mesh of galvanized steel or aluminum.
 - 3. Maximum Velocity: 1000 fpm (5 mps) face velocity.

2.4 COMBINATION FIRE AND SMOKE DAMPERS

- A. Products furnished per Section 253523.
- B. Manufacturers:
 - 1. Nailor Industries, Inc; [____]: www.nailor.com/#sle.
 - 2. Pottorff; [____]: www.pottorff.com/#sle.
 - 3. Ruskin Company; [____]: www.ruskin.com/#sle.
- C. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- D. Provide factory sleeve and collar for each damper.
- E. Multiple Blade Dampers: Fabricate with 16 gage, 0.0598 inch 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 plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.

- F. Operators: UL listed and labelled spring return pneumatic type suitable for operation on 0-20 psig instrument air. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.
- G. Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally.

2.5 COMBINATION FIRE AND SMOKE DAMPERS - CORRIDOR DAMPERS

- A. Products furnished per Section 253523.
- B. Manufacturers:
 - 1. Ruskin Company; [____]: www.ruskin.com/#sle.
- C. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- D. Multiple Blade Dampers: Fabricate with 16 gage, 0.0598 inch 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 plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.
- E. Operators: UL listed and labelled spring return pneumatic type suitable for operation on 0-20 psig instrument air. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.
- F. Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally.

2.6 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. Ductmate Industries, Inc, a DMI Company; [____]: www.ductmate.com/#sle.
 - 2. Elgen Manufacturing, Inc; [____]: www.elgenmfg.com/#sle.
 - 3. MKT Metal Manufacturing; [____]: www.mktduct.com/#sle.
 - 4. Nailor Industries, Inc; [____]: www.nailor.com/#sle.
 - 5. Ruskin Company; [____]: www.ruskin.com/#sle.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
 - 1. Less Than 12 inches Square: Secure with sash locks.

2. Up to 18 inches Square: Provide two hinges and two sash locks.

2.7 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.
 1. Manufacturers:
 - a. Carlisle HVAC Products; Dynair Test Port with Red Cap with O-Ring Seal: www.carlislehvac.com/#sle.

2.8 FIRE DAMPERS

- A. Manufacturers:
 1. AireTechnologies, Inc, a DMI Company; [____]: www.airetechnologies.com/#sle.
 2. Lloyd Industries, Inc; [____]: www.firedamper.com/#sle.
 3. Louvers & Dampers, Inc, a brand of Mestek, Inc; [____]: www.louvers-dampers.com/#sle.
 4. Nailor Industries, Inc; [____]: www.nailor.com/#sle.
 5. Ruskin Company; [____]: www.ruskin.com/#sle.
 6. Substitutions: See Section 016000 - Product Requirements.
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C. All fire dampers shall be dynamic rated.
- D. Horizontal Dampers: Galvanized steel, 22 gage, 0.0299 inch 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 pressure class ducts up to 12 inches in height.
- F. Multiple Blade Dampers: 16 gage, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- G. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.9 FLEXIBLE DUCT CONNECTORS

- A. Manufacturers:
 1. Carlisle HVAC Products; Dynair Connector Plus G90 Steel Offset Seam Neoprene Fabric: www.carlislehvac.com/#sle.
 2. Ductmate Industries, Inc, a DMI Company; [____]: www.ductmate.com/#sle.

- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Flexible Duct Connections: Fabric crimped into metal edging strip.

2.10 SMOKE DAMPERS

- A. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.
- B. Dampers: UL Class 1 airfoil blade type smoke damper, normally open automatically operated by pneumatic actuator.
- C. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.11 VOLUME CONTROL DAMPERS

- A. Products furnished per Section 253523.
- B. Manufacturers:
 - 1. AireTechnologies, Inc, a DMI Company; [____]: www.airetechnologies.com/#sle.
 - 2. MKT Metal Manufacturing; [____]: www.mktduct.com/#sle.
 - 3. Nailor Industries, Inc; [____]: www.nailor.com/#sle.
 - 4. NCA, a brand of Metal Industries Inc; [____]: www.ncamfg.com/#sle.
 - 5. Ruskin Company; [____]: www.ruskin.com/#sle.
 - 6. United Enertech; [____]: www.unitedenertech.com/#sle.
- C. Fabricate in accordance with SMACNA (DCS) and as indicated.
- D. Single Blade Dampers:
 - 1. Fabricate for duct sizes up to 6 by 30 inch.
 - 2. Blade: 24 gage, 0.0239 inch, minimum.

2.12 MISCELLANEOUS PRODUCTS

- A. Damper manual operators furnished per Section 253513.
- B. Damper position switch furnished per Section 253516.
- C. Duct Opening Closure Film: Mold-resistant, self-adhesive film to keep debris out of ducts during construction.
 - 1. Thickness: 2 mils.
 - 2. High tack water based adhesive.
 - 3. UV stable light blue color.
 - 4. Elongation Before Break: 325 percent, minimum.
 - 5. Manufacturers:

PART 3 EXECUTION

3.1 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 233100 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 size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch 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 233300

SECTION 233416 - CENTRIFUGAL HVAC FANS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Backward inclined centrifugal fans.
- B. Bearings and drives.
- C. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 230513 - Common Motor Requirements for HVAC Equipment.
- B. Section 230548 - Vibration and Seismic Controls for HVAC.
- C. Section 230713 - Duct Insulation.
- D. Section 233300 - Air Duct Accessories: Backdraft dampers.

1.3 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings 2015 (Reaffirmed 2020).
- B. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program 2015.
- C. AMCA 99 - Standards Handbook 2016.
- D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating 2016.
- E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans 2014.
- F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data 2014.
- G. NEMA MG 1 - Motors and Generators 2021.
- H. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.

1.4 SUBMITTALS

- A. Product Data: Provide data on centrifugal fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

- B. Shop Drawings: Indicate assembly of centrifugal fans and accessories including fan curves with specified operating point clearly plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- C. Manufacturer's Instructions: Include complete installation instructions.
- D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

1.7 FIELD CONDITIONS

- A. Permanent fans may not be used for ventilation during construction.
- B. Permanent fans may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ACME Engineering and Manufacturing Corporation; [____]: www.acmefan.com/#sle.
- B. Loren Cook Company; [____]: www.lorencook.com/#sle.
- C. Twin City Fan & Blower; [____]: www.tcf.com/#sle.

2.2 MANUFACTURERS BY FAN TYPE

- A. Airfoil Centrifugal Fans:
- B. Backward-Inclined Centrifugal Fans:
 - 1. ACME Engineering and Manufacturing Corporation; [____]: www.acmefan.com/#sle.
 - 2. Loren Cook Company; [____]: www.lorencook.com/#sle.
 - 3. PennBarry, Division of Air Systems Components; [____]: www.pennbarry.com/#sle.

4. Rosenberg USA, Inc; []: www.rosenbergusa.com/#sle.
5. Twin City Fan & Blower; TCBI: www.tcf.com/#sle.

2.3 PERFORMANCE REQUIREMENTS

- A. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. Fabrication: Comply with AMCA 99.
- D. Performance Base: Sea level conditions.
- E. Temperature Limit: Maximum 300 degrees F.
- F. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

2.4 WHEEL AND INLET

- A. Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded or riveted to flange and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.

2.5 HOUSING

- A. Factory finish before assembly to manufacturer's standard. For fans handling air downstream of humidifiers, provide two additional coats of paint. Prime coating on aluminum parts is not required.
- B. Provide bolted construction with horizontal flanged split housing, where indicated.
- C. Fabricate plug fans without volute housing, in lined steel cabinet. Refer to Section 230713.

2.6 BEARINGS AND DRIVES

- A. Bearings: Heavy duty pillow block type, selfgreasing ball bearings, with ABMA STD 9 life at 50,000 hours.
- B. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard.
- C. Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp and under, selected so required rpm is obtained with sheaves set at mid Fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.

- D. Belt Guard: Fabricate to SMACNA (DCS); 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.7 ACCESSORIES

- A. Fixed Inlet Vanes: Steel construction with fixed cantilevered inlet guide vanes welded to inlet bell.
- B. Inlet/Outlet Screens: Galvanized steel welded grid.
- C. Access Doors: Shaped to fit scroll, with quick opening latches and gaskets.
- D. Scroll Drain: 1/2 inch steel pipe coupling welded to low point of fan scroll.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install fans with resilient mountings and flexible electrical leads. Refer to Section 220548.
- C. Install fans with resilient mountings and flexible electrical leads. Refer to Section 230548.
- D. Install flexible connections between fan inlet and discharge ductwork; refer to Section 233300. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- E. Install fan restraining snubbers; refer to Section 220548. Adjust snubbers to prevent tension in flexible connectors when fan is operating.
- F. Install fan restraining snubbers; refer to Section 230548. Adjust snubbers to prevent tension in flexible connectors when fan is operating.
- G. Provide fixed sheaves required for final air balance.
- H. Provide backdraft dampers on discharge of exhaust fans and as indicated; refer to Section 233300.

END OF SECTION 233416

SECTION 233600 - AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single-duct terminal units.
 - 1. Constant-volume units.
 - 2. Variable-volume units.

- B. Controls for terminal units.

1.2 RELATED REQUIREMENTS

- A. Section 230548 - Vibration and Seismic Controls for HVAC.
- B. Section 233100 - HVAC Ducts and Casings.
- C. Section 233300 - Air Duct Accessories.
- D. Section 233700 - Air Outlets and Inlets.
- E. Section 251400 - Integrated Automation Local Control Units: HVAC controllers.
- F. Section 251500 - Integrated Automation Software: BAS or BMS.
- G. Section 253516 - Integrated Automation Sensors and Transmitters: Sensors and switches.

1.3 REFERENCE STANDARDS

- A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils 2001, with Addenda (2011).
- B. AHRI 880 (I-P) - Performance Rating of Air Terminals 2017.
- C. ASHRAE RP-1455 - Seminar 65 - Standardized Best of Class Sequences for HVAC Systems 2016.
- D. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size 2017, with Addendum (2022).
- E. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. ASTM A492 - Standard Specification for Stainless Steel Rope Wire 1995 (Reapproved 2019).
- G. ASTM A603 - Standard Specification for Metallic-Coated Steel Structural Wire Rope 2019.

- H. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems 2008.
- I. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors current edition, including all revisions.
- J. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
 - 1. Include schedules listing discharge and radiated sound power level for each of the second through sixth-octave bands at inlet static pressures of 1 to 4 in-wc.
- D. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.
- E. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.
- F. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.
- G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.
- H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 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. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.6 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.1 SINGLE-DUCT, VARIABLE-VOLUME AND CONSTANT-VOLUME UNITS

- A. Manufacturers:
 - 1. Krueger-HVAC; []: www.krueger-hvac.com/#sle.
 - 2. Price Industries, Inc; []: www.priceindustries.com/#sle.
 - 3. Trane, a brand of Ingersoll Rand; []: www.trane.com/#sle.
 - 4. Titus.
- B. General:
 - 1. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, 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, coil type and coil (right or left hand) connection, where applicable.
- C. Unit Casing:
 - 1. Minimum 22 gauge, 0.0299 inch galvanized steel.
 - 2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes.
 - 3. Unit Discharge: Rectangular, with slip-and-drive connections.
 - 4. Acceptable Liners:
 - a. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.
- D. Damper Assembly:
 - 1. Heavy-gauge, galvanized steel, or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.
 - 2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
 - 3. Incorporate low leak damper blades for tight airflow shutoff.
- E. Controls:
 - 1. Terminal Unit Controls:
 - a. Provide accessories for field interfaced controller including ball valve and thermostat.
 - b. Factory ship DDC controller including airflow sensor, integral airflow transmitter, integral damper actuator, and duct-mounted temperature sensor.

- c. Sequence of Operation: Zone temperature control with airflow and coil discharge monitoring.

2.2 CONTROLS FOR TERMINAL UNITS

- A. Electric, Line Voltage:
 - 1. Zone Thermostat:
 - a. Electromechanical SPDT switch device, direct or reverse acting, see Section 253516.
 - b. Show value and setpoint using built-in thermometer in celsius and fahrenheit units.
- B. Direct or Distributed Digital Controller (DDC), Integrated:
 - 1. Provide application specific controller, see Section 251400 and 251500.
 - 2. Accuracy: Plus/minus five percent of analog input readings and analog outputs.
 - 3. Sequence of Operation: Follow ASHRAE RP-1455 for specific terminal unit.
 - 4. Upstream Flow Sensor: Pitot-tube array, otherwise see Section 253516.
 - 5. Zone Thermostat:
 - a. Temperature sensor based device, see Section 25 3516.
 - b. Wall-mounted with occupancy sensor, setpoint adjust, and service port.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that conditions are suitable for installation.
- B. Verify that field measurements are as indicated on drawings.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.
- C. See drawings for the size(s) and duct location(s) of the air terminal units.
- D. Provide ceiling access doors or locate units above easily removable ceiling components.
- E. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM). See Section 23 0548.
- F. Do not support from ductwork.
- G. Connect to ductwork in accordance with Section 233100.

3.3 ADJUSTING

- A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to zero percent full flow. Set units with heating coils for minimum 50 percent full flow.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Provide manufacturer's field representative to test, inspect, instruct, and observe field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.
 - 1. Leak Test:
 - a. After installation, fill water coils and test for leaks.
 - b. Repair leaks and retest until no leaks exist.
 - 2. Operational Test:
 - a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - b. Test and adjust controls and safeties.
 - c. Replace damaged and malfunctioning controls and other equipment.
 - d. Remove and replace malfunctioning units and retest as specified above.

3.5 CLEANING

- A. Vacuum clean coils and inside of units.
- B. Install new filters.

3.6 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals for closeout submittals.
- B. See Section 017900 - Demonstration and Training for additional requirements.

END OF SECTION 233600

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SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Diffusers:
 - 1. Critical environment diffusers.
 - 2. Perforated ceiling diffusers.
- B. Rectangular ceiling diffusers.
- C. Round ceiling diffusers.
- D. Slot ceiling diffusers.
- E. Registers/grilles:
 - 1. Floor-mounted, linear supply register/grilles.
 - 2. Floor-mounted, supply register/grilles.
 - 3. Ceiling-mounted, egg crate exhaust and return register/grilles.
 - 4. Ceiling-mounted, exhaust and return register/grilles.
 - 5. Ceiling-mounted, linear exhaust and return register/grilles.
 - 6. Ceiling-mounted, supply register/grilles.
 - 7. Wall-mounted, supply register/grilles.
 - 8. Wall-mounted, linear register/grilles.
- F. Duct-mounted supply and return registers/louvers.
- G. Louvers:
- H. Goosenecks.

1.2 REFERENCE STANDARDS

- A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating 2012 (Reapproved 2015).
- B. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Air Inlets 2006 (Reaffirmed 2021).
- C. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels 2019.
- D. SMACNA (ASMM) - Architectural Sheet Metal Manual 2012.
- E. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.

- F. UL 2518 - Standard for Safety Air Dispersion Systems Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. See Section 013000 - 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.

1.4 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B. Test and rate louver performance in accordance with AMCA 500-L.
- C. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Krueger-HVAC; [____]: www.krueger-hvac.com/#sle.
- B. Price Industries; [____]: www.price-hvac.com/#sle.
- C. Titus, a brand of Air Distribution Technologies; [____]: www.titus-hvac.com/#sle.

2.2 ROUND CEILING DIFFUSERS

- A. Manufacturers:
- B. Type: Round, adjustable pattern, stamped or spun, multicore diffuser to discharge air in 360 degree pattern, with sectorizing baffles where indicated. Diffuser collar shall project not more than 1 inch above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque.
- C. Fabrication: Steel with baked enamel finish.
- D. Color: As selected by Engineer from manufacturer's standard range.
- E. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.3 RECTANGULAR CEILING DIFFUSERS

- A. Manufacturers:
 - 1. Krueger-HVAC; [____]: www.krueger-hvac.com/#sle.
 - 2. Titus.
- B. Type: Provide rectangular and square formed adjustable, backpan stamped, core removable, and multi-louvered ceiling diffusers constructed to maintain 360 degree discharge air pattern with sectorizing baffles where indicated.
- C. Connections: Round.
- D. Frame: Provide surface mount, snap-in, inverted T-bar, and spline type. In plaster ceilings, provide plaster frame and ceiling frame.
- E. Fabrication: Steel with baked enamel finish.
- F. Color: As indicated.
- G. Color: As selected by Engineer from manufacturer's standard range.
- H. Accessories: Provide radial opposed blade, butterfly, and combination splitter volume control damper; removable core, sectorizing baffle, safety chain, wire guard, equalizing grid, operating rod extension, anti-smudging device, and gaskets for surface mounted diffusers with damper adjustable from diffuser face.

2.4 PERFORATED FACE CEILING DIFFUSERS

- A. Manufacturers:
 - 1. Krueger-HVAC; [____]: www.krueger-hvac.com/#sle.
 - 2. Metalaire, a brand of Metal Industries Inc; [____]: www.metalair.com/#sle.
 - 3. Titus.
- B. Type: Perforated face with fully adjustable pattern and removable face.
- C. Frame: Surface mount type. In plaster ceilings, provide plaster frame and ceiling frame.
- D. Fabrication: Steel with steel frame and baked enamel finish.
- E. Fabrication: Stainless steel.
- F. Color: As indicated.
- G. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.5 CEILING SLOT DIFFUSERS

- A. Manufacturers:
 - 1. Krueger-HVAC; [____]: www.krueger-hvac.com/#sle.
 - 2. Metalaire, a brand of Metal Industries Inc; [____]: www.metalaire.com/#sle.
 - 3. Titus.
- B. Type: Continuous 1/2 inch wide slot, 1 slots wide, with adjustable vanes for left, right, or vertical discharge; integral ceiling fire damper.
- C. Fabrication: Aluminum extrusions with factory clear lacquer finish.
- D. Color: As indicated.
- E. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket, mitered end border.
- F. Plenum: Integral, galvanized steel, insulated.

2.6 DUCT-MOUNTED SUPPLY AND RETURN REGISTERS/LOUVERS

- A. Manufacturers:
 - 1. Krueger-HVAC; [____]: www.krueger-hvac.com/#sle.
 - 2. Titus.
- B. Type: Duct-mounted, rectangular register for round-spiral duct with adjustable pivot-ended blades, end caps, built-in volume damper, and dual cover flanges to lay flush on duct surface regardless of diameter. Performance to match manufacturer's catalog data.
- C. Material: 22 gauge, 0.0299 inch.
 - 1. Provide crossing spiral fitting-body of matching duct diameter.
- D. Color: As indicated on drawings.

2.7 CEILING SUPPLY REGISTERS/GRILLES

- A. Manufacturers:
 - 1. Krueger-HVAC; [____]: www.krueger-hvac.com/#sle.
 - 2. Metalaire, a brand of Metal Industries Inc; [____]: www.metalaire.com/#sle.
 - 3. Titus.
- B. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, one-way deflection.
- C. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- D. Construction: Made of aluminum extrusions with factory enamel finish.

- E. Color: As indicated.
- F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.8 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Manufacturers:
 - 1. Krueger-HVAC; [____]: www.krueger-hvac.com/#sle.
 - 2. Titus.
- B. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, vertical face.
- C. Frame: 1-1/4 inch margin with countersunk screw mounting.
- D. Fabrication: Steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.
- E. Fabrication: Stainless steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame.
- F. Color: As indicated.
- G. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

2.9 CEILING LINEAR EXHAUST AND RETURN GRILLES

- A. Manufacturers:
 - 1. Krueger-HVAC; [____]: www.krueger-hvac.com/#sle.
 - 2. Metalaire, a brand of Metal Industries Inc; [____]: www.metalair.com/#sle.
- B. Type: Streamlined blades with 90 degree one-way deflection, 1/8 by 3/4 inch on 1/4 inch centers.
- C. Frame: 1-1/4 inch margin, extra heavy for floor mounting, with countersunk screw mounting.
- D. Fabrication: Steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.
- E. Color: As indicated.
- F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.10 CEILING EGG CRATE EXHAUST AND RETURN GRILLES

- A. Manufacturers:
 - 1. Krueger-HVAC; [____]: www.krueger-hvac.com/#sle.
 - 2. Titus.
- B. Basis of Design: Krueger-HVAC; EGCX: www.krueger-hvac.com/#sle.
- C. Type: Egg crate style face consisting of 1/2 by 1/2 by 1/2 inch grid core.
- D. Fabrication: Grid core consists of aluminum with mill aluminum finish.
- E. Color: To be selected by Engineer from manufacturer's standard range.
- F. Accessories: Provide integral gang and face operated opposed blade damper, 2 inch filter frame, plaster frame, square mesh insect screen, square mesh debris screen, prescored molded fiberglass back, and 45 degree angled eggcrate or other similar provisions for visual blocking such as angled louver or 90 degree duct elbow.

2.11 WALL SUPPLY REGISTERS/GRILLES

- A. Manufacturers:
 - 1. Metalaire, a brand of Metal Industries Inc; [____]: www.metalaire.com/#sle.
 - 2. Price.
 - 3. Titus.
- B. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, single deflection.
- C. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille with one-way deflection.
- D. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- E. Fabrication: Steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.
- F. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

2.12 LINEAR WALL REGISTERS/GRILLES

- A. Manufacturers:
 - 1. Krueger-HVAC; [____]: www.krueger-hvac.com/#sle.
 - 2. Metalaire, a brand of Metal Industries Inc; [____]: www.metalaire.com/#sle.
 - 3. Titus.

- B. Type: Streamlined blades with 0 degree deflection, 1/8 by 3/4 inch on 1/4 inch centers.
- C. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- D. Fabrication: Aluminum extrusions, with factory baked enamel finish.
- E. Color: As indicated.
- F. Color: To be selected by Engineer from manufacturer's standard range.
- G. Damper: Integral gang-operated opposed blade damper with removable key operator, operable from face.

2.13 LINEAR FLOOR SUPPLY REGISTERS/GRILLES

- A. Manufacturers:
 - 1. Metalaire, a brand of Metal Industries Inc; [____]: www.metalaire.com/#sle.
 - 2. Titus.
- B. Type: Streamlined blades with 0 degree deflection, 1/8 by 3/4 inch on 1/4 inch centers, assembled on expanded tubes mandrel construction.
- C. Frame: 1-1/4 inch heavy margin frame with countersunk screw mounting, and mounting frame.
- D. Fabrication: Aluminum extrusions with factory baked enamel finish.
- E. Color: As indicated.
- F. Damper: Integral gang-operated opposed blade damper with removable key operator, operable from face.

2.14 FLOOR SUPPLY REGISTERS/GRILLES

- A. Manufacturers:
 - 1. Price.
 - 2. Titus.
- B. Individually adjustable blades, wide stamped border, single or double blade damper with set screw adjustment.
- C. Fabricate of steel, welded construction, with factory baked enamel finish.

2.15 LOUVERS

- A. Manufacturers:
 - 1. NCA, a brand of Metal Industries Inc; [____]: www.ncamfg.com/#sle.
 - 2. Ruskin Company; [____]: www.ruskin.com/#sle.

3. [_____].
- B. Type: 4 inch deep frame with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch square mesh screen over intake or exhaust end.
 - C. Fabrication: 16 gauge, 0.0598 inch (1.52 mm) thick galvanized steel thick galvanized steel welded assembly, with factory prime coat finish.
 - D. Color: As indicated on the drawings.

PART 3 EXECUTION

3.1 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.
- F. Paint ductwork visible behind air outlets and inlets matte black, see Section 099123.

END OF SECTION 233700

SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Manufactured breechings.
- B. Single wall metal stacks.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 230513 - Common Motor Requirements for HVAC Equipment: Induced draft fan motor.
- C. Section 230716 - HVAC Equipment Insulation.

1.3 REFERENCE STANDARDS

- A. NFPA 31 - Standard for the Installation of Oil-Burning Equipment 2020.
- B. NFPA 54 - National Fuel Gas Code 2021.
- C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.
- D. UL 103 - Factory-Built Chimneys for Residential Type and Building Heating Appliances Current Edition, Including All Revisions.
- E. UL 441 - Standard for Gas Vents Current Edition, Including All Revisions.

1.4 DEFINITIONS

- A. Breeching: Vent connector.
- B. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
- C. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.5 DESIGN REQUIREMENTS

- A. Factory built vents and chimneys used for venting natural draft appliances to comply with NFPA 211 and be UL listed and labeled.

1.6 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of [] with size, location and installation of service utilities.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.7 SUBMITTALS

- A. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.
- B. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations where factory built units are used.
- C. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.
- D. Manufacturer's Certificate: Certify that refractory lined metal stacks meet or exceed specified requirements.

1.8 QUALITY ASSURANCE

- A. Designer Qualifications: Design stacks under direct supervision of a Professional Structural Engineer experienced in design of the type of work specified 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 [] years documented experience, and approved by manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. AMPCO by Hart & Cooley, Inc; Model VSI: www.ampcostacks.com/#sle.
- B. DuraVent; DuraStack Pro (DIS2): www.duravent.com/#sle.
- C. Metal-Fab, Inc; []: www.mtlfab.com/#sle.

2.2 BREECHINGS, CHIMNEYS, AND STACKS - GENERAL REQUIREMENTS

- A. Regulatory Requirements:
 - 1. Comply with NFPA 31 for installation of oil burning appliances and equipment.

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

2.3 MANUFACTURED BREECHINGS

- A. Provide factory-built, modular connector and manifold system, tested to UL 103 with positive pressure rating.
- B. Assembly to be UL listed for use with building equipment in compliance with NFPA 211.
- C. Fabricate with 1 inch minimum air space between walls and construct inner liner of 304 stainless steel and outer jacket of 304 stainless steel.
 1. Protect aluminized steel surfaces exposed to the elements with a minimum of one base coat of primer and one finish coat of corrosion resistant paint suitable for outer jacket skin temperatures of the application.
- D. Design, fabricate, and install gas-tight preventing products of combustion leaking into the building.
 1. Securely connect inner joints and seal with factory supplied overlapping V-bands and appropriate sealant in accordance with manufacturer's instructions.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 54
- C. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.
- D. Install concrete inserts for support of breechings, chimneys, and stacks in coordination with formwork.
- E. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.
- F. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- G. Coordinate installation of dampers, and induced draft fans. Refer to Section 260583.
- H. Clean breechings, chimneys, and stacks during installation, removing dust and debris.

- I. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breechings, breeching insulation, chimneys, or stacks.

END OF SECTION 235100

SECTION 235216 - CONDENSING BOILERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Manufactured units.
- B. Boiler construction.
- C. Boiler trim.
- D. Fuel burning system.
- E. Factory installed controls.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete.
- B. Section 230913 - Instrumentation and Control Devices for HVAC.
- C. Section 232114 - Hydronic Specialties.
- D. Section 232123 - Hydronic Pumps.
- E. Section 232500 - HVAC Water Treatment.
- F. Section 235100 - Breechings, Chimneys, and Stacks.
- G. Section 251500 - Integrated Automation Software.
- H. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Current Edition.
- B. 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.
- C. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers 2021.

- D. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI) Current Edition.
- E. NFPA 54 - National Fuel Gas Code 2021.
- F. SCAQMD 1146.1 - Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters 1990, with Amendment (2018).

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Manufacturer's Installation Instructions: Indicate assembly, support details, connection requirements, and include start up instructions.
- C. Manufacturer's Factory Inspection Report: Submit boiler inspection prior to shipment.
- D. Manufacturer's Field Reports: Burner manifold gas pressure, percent carbon monoxide (CO), percent oxygen (O), percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output.
- E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

1.8 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Provide a five year warranty to include coverage for heat exchanger.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Modular Condensing Hot Water Boiler for Indoor Applications:
 - 1. Bosch Thermotechnology; CM Series, Instant Flow: www.bosch-thermotechnology.us/#sle.
 - 2. Lochinvar LLC; []: www.lochinvar.com/#sle.

2.2 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.

2.3 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: Construct with materials that are impervious to corrosion where subject to contact with corrosive condensables.
- 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.

2.4 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. Boiler Pump (where required by boiler design):
 - 1. Primary pump, 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.
 - 3. Pump time delay.

2.5 FUEL BURNING SYSTEM

- A. Provide forced draft automatic burner or pulse combustion, integral to boiler, designed to burn natural gas, propane, and No. 2 fuel oil, and maintain fuel-air ratios automatically.
 - 1. Blower Design: Statically and dynamically balanced to supply combustion air; direct connected to motor.
 - 2. Forced Draft Design: Mixes combustion air and gas to achieve 90 percent combustion efficiency.
 - 3. Pulse Combustion Design: Self-aspirating, not requiring blower for combustion.
 - 4. Combustion Air Filter: Protects fuel burning system from debris.
- B. Gas Train: Plug valve, safety gas valve, gas-air ratio control valve, and pressure regulator controls air and gas mixture.
- 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.

2.6 FACTORY INSTALLED CONTROLS

- A. Option for internal or external (0-10) VDC control.
- B. 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.
- C. Electronic PI setpoint/modulation control system.
- D. Microprocessor-based, fuel/air mixing controls.

2.7 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Provide factory tests to check construction, controls, and operation of unit.
- C. Manufacturer to conduct boiler inspection prior to shipment; submit copy of inspection report to Engineer.
- D. Non-Complying Work: See Section 014000.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install boiler and provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes.
- C. Install boiler on concrete housekeeping base, sized minimum of 4 inches larger than boiler base in accordance with Section 033000.
- D. Coordinate factory installed controls with Section 230913.
- E. Coordinate provisions for water treatment in accordance with Section 232500.
- F. Pipe relief valves to nearest floor drain.

- G. Pipe cooled condensate produced by the combustion process from the boiler condensate connection and/or flue stack with suitable piping material to neutralizer prior to discharging into nearest floor drain.
- H. Install primary boiler pump in accordance with Section 232123.
- I. Provide piping connection and accessories in accordance with Section 232114.
- J. Provide for connection to electrical service in accordance with Section 260583.
- K. Connect vent combustion generated fumes to breeching, chimney or exhaust stack; see Section 235100.
- L. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 25 1500.

3.2 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals for closeout submittals.
- B. Demonstrate proper operation of equipment to Owner's designated representative.
- C. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Conduct walking tour of project.
 - 3. Briefly describe function, operation, and maintenance of each component.
- D. 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 235216

SECTION 237416 - PACKAGED ROOFTOP AIR-CONDITIONING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Packaged, large-capacity, rooftop air-conditioning units.

1.2 RELATED REQUIREMENTS

- A. Section 230548 - Vibration and Seismic Controls for HVAC.
- B. Section 230913 - Instrumentation and Control Devices for HVAC: Control components, time clocks.
- C. Section 234000 - HVAC Air Cleaning Devices.
- D. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment 2023.
- B. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment 2015, with Addendum.
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- C. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up 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 manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from physical damage by storing off site until roof mounting curbs are in place and ready for immediate installation of units.

1.7 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Provide a five year warranty to include coverage for refrigeration compressors.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Carrier Corporation; [____]: www.commercial.carrier.com/#sle.
- B. Johnson Controls International, PLC; [____]: www.johnsoncontrols.com/#sle.
- C. Trane, a brand of Ingersoll Rand; [____]: www.trane.com/#sle.

2.2 PACKAGED, LARGE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

- A. Manufacturers:
 - 1. Carrier Corporation; [____]: www.commercial.carrier.com/#sle.
 - 2. Johnson Controls International, PLC; [____]: www.johnsoncontrols.com/#sle.
 - 3. Trane, a brand of Ingersoll Rand; [____]: www.trane.com/#sle.
- B. General: Roof mounted units having gas burner and electric refrigeration that are 25 tons and larger in capacity.
- C. Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, return fan, heat exchanger and burner, heat recovery coil, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.
- D. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.
- E. Disconnect Switch: Factory mount disconnect switch in control panel.

2.3 CASING

- A. Cabinet: Steel with baked enamel finish, including access panels with screwdriver-operated flush, cam type fasteners. Structural members to be minimum 18 gauge, 0.0478 inch, with access doors or panels of minimum 20 gauge, 0.0359 inch.

2.4 FANS

- A. Supply and Return Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch pulley, and rubber isolated hinge mounted. Provide with high efficiency motor or direct drive as indicated. Isolate complete fan assembly. See Section 230548.

2.5 BURNERS

- A. Gas Burner: Atmospheric type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame-sensing device, and automatic 100 percent shutoff pilot.
- B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after airflow proven and slight delay, allow gas valve to open.
- C. Supply Fan Control: Temperature sensor sensing bonnet temperatures and independent of burner controls, with provisions for continuous fan operation.

2.6 EVAPORATOR COIL

- A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.
- B. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

2.7 CONDENSER COIL

- A. Provide copper tube aluminum fin coil assembly with subcooling rows and coil guard.
- B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors.
- C. Provide refrigerant pressure switches to cycle condenser fans.

2.8 COMPRESSORS

- A. Provide hermetic compressors, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.

2.9 MIXED AIR CASING

- A. Dampers: Provide manual outside and return air dampers for fixed outside air quantity.
- B. Gaskets: Provide tight fitting dampers with edge gaskets.
- C. Gaskets: Provide tight fitting dampers with edge gaskets maximum leakage 5 percent at 2-inch pressure differential.
- D. Mixed Air Controls: Maintain selected supply air temperature and return dampers to minimum position on call for heating and above 75 degrees F ambient, or when ambient air temperature exceeds return air temperature.

2.10 AIR FILTERS:

- A. 2-inch thick, glass fiber disposable media in metal frames.

2.11 OPERATING CONTROLS

- A. Provide low voltage, adjustable room thermostat to control burner operation, compressor and condenser fan, and supply fan to maintain temperature setting.
 - 1. Include system selector switch heat-off-cool and auto-on fan control switch.
- B. Provide remote-mounted auto-on fan control switch.
- C. Provide low-limit thermostat in supply air to close outside air damper and stop supply fan.

2.12 OPERATING CONTROLS - SINGLE ZONE UNITS

- A. Electric solid state microcomputer-based room thermostat, located as indicated in service area with remote sensor located as indicated in service area with remote sensor.
- B. Room thermostat to incorporate:
 - 1. Automatic switching from heating to cooling.
 - 2. Preferential rate control to minimize overshoot and deviation from setpoint.
 - 3. Set up for four separate temperatures per day.
 - 4. Instant override of setpoint for continuous or timed period from one hour to 31 days.
 - 5. Short cycle protection.
 - 6. Programming based on weekdays, Saturday and Sunday.

2.13 OPERATING CONTROLS - VARIABLE VOLUME UNITS

- A. Temperature transmitter located in supply air to signal electronic logic panel to control mixing dampers and cooling in sequence. Mixing section to operate as first stage of cooling and revert to minimum outside air above approximately 75 degrees F as determined by enthalpy of return and outdoor air.
- B. Control cooling by cycling compressors, cylinder unloading, and hot gas bypass.
- C. Control logic to allow supply air reset under low load or airflow conditions.
- D. Seven day time clock with spring carry over or electronic clock with battery backup to control unit on occupied/unoccupied schedule. At night, unit to switch off. Locate clock in remote control panel with status lights.
- E. Provide two stage morning warm-up thermostat to hold outdoor dampers closed and energize heat until return air temperature reaches setpoint.

2.14 ROOF CURBS

- A. Vibration Isolation Curb: [_____].

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that roof is ready to receive work and opening dimensions are as required by manufacturer.
- B. Verify that proper power supply is available.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.3 SYSTEM STARTUP

- A. Prepare and start equipment. Adjust for proper operation.

3.4 CLOSEOUT ACTIVITIES

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

3.5 MAINTENANCE

- A. Provide a separate maintenance contract for specified maintenance service.

- B. Provide service and maintenance of packaged rooftop units for one year from Date of Substantial Completion.
- C. Provide routine maintenance service with a two-month interval as maximum time period between calls.
- D. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.
- E. Provide 24-hour emergency service on breakdowns and malfunctions.
- F. After each service call, submit copy of service call work order or report that includes description of work performed.

END OF SECTION 237416

SECTION 238126.13 - SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air-source heat pumps.
- B. Air cooled condensing units.
- C. Controls.

1.2 RELATED REQUIREMENTS

- A. Section 230913 - Instrumentation and Control Devices for HVAC: Thermostats, humidistats, time clocks.
- B. Section 233100 - HVAC Ducts and Casings.
- C. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.3 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 23.1 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Pressures of the Refrigerant 2019.
- E. NEMA MG 1 - Motors and Generators 2021.
- F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- G. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2021.
- H. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C. Design Data: Indicate refrigerant pipe sizing.
- D. Manufacturer's Instructions: Indicate rigging, assembly, and 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 manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- G. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.6 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Mitsubishi.

2.2 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.
 - 1. Heating and Cooling: Air-source electric heat pump located in outdoor unit with evaporator; auxiliary electric heat.
 - 2. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.
- B. Performance Requirements: See Drawings for additional requirements.

- C. Electrical Characteristics:
 - 1. [] kW.
 - 2. [] volts, single phase, 60 Hz.
 - 3. [] amperes maximum fuse size.
 - 4. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 260583.

2.3 INDOOR UNITS FOR DUCTED SYSTEMS

- A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heating and cooling element(s), controls, and accessories; wired for single power connection with control transformer.
 - 1. Air Flow Configuration: Upflow.
 - 2. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
- B. Supply Fan: Centrifugal type rubber mounted with direct or belt drive with adjustable variable pitch motor pulley.
 - 1. Motor: NEMA MG 1; 1750 rpm single speed, permanently lubricated, hinge mounted.
 - 2. Motor Electrical Characteristics:
- C. 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. Manufacturers: System manufacturer.

2.4 INDOOR UNITS FOR DUCTLESS SYSTEMS

- A. Indoor 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.
 - 1. Fan: Line-flow fan direct driven by a single motor.
 - 2. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.
 - 3. Wall-Mounted Units:
- B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
 - 1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
 - 2. Manufacturer: System manufacturer.

2.5 OUTDOOR UNITS

- A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
 - 1. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.
- B. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
- C. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
 - 1. Provide thermostatic expansion valves.
- D. Operating Controls:
 - 1. Control by room thermostat to maintain room temperature setting.

2.6 ACCESSORY EQUIPMENT

PART 3 EXECUTION

3.1 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.
- D. Verify that water supply is available for humidifier.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.
- B. Install in accordance with NFPA 90A and NFPA 90B.
- C. Install refrigeration systems in accordance with ASHRAE Std 15.
- D. Pipe drain from humidifiers to nearest floor drain.

END OF SECTION 238126.13