Heating System Upgrades
Auburn Public Works Highway Garage
Auburn, Maine

ISSUED FOR BID
NOVEMBER 06, 2013

Allied # 13-090

CORDJIA
Capital Projects Group, LLC

Allied Engineering
Structural Mechanical Electrical Commissioning

SECTION 230500 – COMMON WORK RESULTS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City of Auburn requirements, apply to this Section.

B. This section applies to Division 23.

1.2 GENERAL

A. This Section includes mechanical items common to all of this division specification sections.

B. Provide services, skilled and common labor, and all apparatus and materials required for the complete installation as shown and within the intent of the contract documents, field conditions, and code requirements.

C. The intention of these Contract Documents is to call for finished work, fully tested and ready for operation. Any components or labor not mentioned in the Contract Documents but required for functioning systems shall be provided. Should there appear to be any discrepancies or questions of intent, the Contractor shall refer the matter to the Architect/Engineer for decision before start of any related work.

D. The drawings show the general arrangement of systems and equipment but do not show all required fittings and offsets that may be necessary to connect pipes and ductwork to equipment, and to coordinate with other trades. Provide all necessary fittings, offsets and runs based on field measurements and at no additional cost. Coordinate with other trades for space available and relative location of equipment and accessories. Pipe and duct location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.

1.3 EFFICIENCY MAINE

A. This project intends to pursue Efficient Maine (EM) prescriptive and/or custom incentives. The contractor shall participate in the activities associated with Efficiency Maine incentive approval process including but not limited to; preparation and submission of required incentive applications and the tracking and submission of measure specific invoices to Efficiency Maine within 60 days of the completion of the work.

B. The contractor shall also:

1. Become familiar with the Efficiency Maine Business Program including available incentives and the application and review process.
2. Review plans and specifications for compliance with Efficiency Maine standards for applicable systems and technologies.

3. Review plans and specifications for any and all incentive opportunities, prescriptive and custom.

C. The project schedule shall reflect and accommodate the time required to achieve application preapproval from EM. No equipment shall be purchased until preapproval is received from EM.

D. All invoices shall be forwarded to EM within 60 days of the completion of work. This deliverable shall be shown on the project schedule as a milestone date and coordinated with all contractors to assure compliance with this requirement.

E. Efficiency Maine is available to assist in the application process and can be reached at 866-376-2463. Contractor must contact EM prior to submittals to review the project equipment and scope.

1.4 DEFINITIONS

A. “Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

B. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

C. "Provide": Furnish and install, complete and ready for the intended use.

D. “Shall”: The word shall is used to indicate mandatory requirements strictly to be followed in order to conform to the standard and procedures and from which no deviation is permitted.

E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and attics.

F. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

G. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

H. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

I. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

1.5 SUBMITTALS

A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings shall be dated and contain: Name of project; name of prime professional; name of prime contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Individual piecemeal or incomplete submittals will not be accepted. Similar items, (all types specified) shall be submitted at one time. Number each submittal by trade. Indicate deviations from contract requirements on Letter of Transmittal. Shop Drawings will be given a general review only. Corrections or comments made on the Shop Drawings during the review do not relieve Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for: confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

1.6 SUBSTITUTIONS

A. Timing: Engineer will consider requests for substitution if received within 30 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Engineer.

B. Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:

1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
2. Requested substitution does not require revisions to the Contract Documents.
3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
4. Substitution request is fully documented and properly submitted.
5. Requested substitution will not adversely affect Contractor's Construction Schedule.
6. Requested substitution has received necessary approvals of authorities having jurisdiction.
7. Requested substitution is compatible with other portions of the Work.
8. Requested substitution has been coordinated with other portions of the Work.
9. Requested substitution provides specified warranty.

C. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

1.7 QUALITY ASSURANCE

A. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications.

B. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.

C. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

D. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications." Comply with provisions in ASME B31 Series, "Code for Pressure Piping." Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

E. Electrical Characteristics for Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

F. The Contractor shall hold a license to perform the work as issued by the local jurisdiction.

G. Plumbing work shall be performed by, or under, the direct supervision of a licensed master plumber.

H. Electrical work shall be performed by, or under, the direct supervision of a licensed electrician.

I. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used.

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 1 - Product Requirements.

B. Piping:

1. Pipe and tube required by the applicable standard to be cleaned and capped shall be delivered to the job site with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
2. Protect stored pipe and tube from moisture and dirt. Elevate above grade. When stored inside, do not exceed the structural capacity of the floor.

3. Protect fittings, flanges, and piping specialties from moisture and dirt.
4. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 COORDINATION

A. Coordinate use of project space and sequence of installation of mechanical and electrical work, which is indicated diagrammatically on drawings. Follow routings shown for pipes, ducts, and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

B. Coordinate use of project space and sequence of installation of work.

C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for installations. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

D. Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels and doors are specified in Division 8.

1.10 TEST ADJUST AND BALANCE READINESS

A. The Contractor shall provide and coordinate the services of qualified, responsible sub-contractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the course of this project, including the testing, adjusting, and balancing period.

B. The Drawings and Specifications indicate valves, dampers, and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB Firm. Also, any malfunction encountered by TAB personnel and reported to the Contractor shall be corrected by the Contractor immediately so that the balancing work can proceed with the minimum of delays.

1.11 RENOVATION PROJECTS

A. Project Conditions: Full Owner Occupancy: The Owner intends to occupy the project site during construction. The Contractor shall cooperate with the Owner to minimize conflicts with the Owner's operations.

B. Project Conditions: Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner to minimize conflicts with the Owner's operations.

C. Project Conditions: No Owner Occupancy until final acceptance: The Owner intends to occupy the building only after construction is 100% complete and the building has been accepted.

D. The Contractor shall study all drawings and specifications, visit the site, and get acquainted with the existing conditions and the requirements of the plans and specifications. No claim will be recognized for extra compensation due to the failure of the Contractor to be familiarized with the conditions and extent of the proposed work. The Contractor shall execute all alterations, additions, removals, relocations or new work, etc., as indicated or required to provide a complete installation in accordance with the intent of the drawing and specifications.

E. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of site beyond areas in which the Work is indicated.

F. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize use of driveways and entrances. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

G. Follow the recommended procedures of the SMACNA IAQ Guidelines for Occupied Buildings under Construction.

1. Dust partitions and depressurization of the work are performed under Division 1.
2. The return side of an HVAC system is, by definition, under negative pressure and thus capable of drawing in nearby construction dust and odor. When possible, the entire system shall be shut down during heavy construction or demolition. The system shall be isolated from the surrounding environment as much as possible (e.g., all tiles in place for a ceiling plenum, duct and air handler leaks repaired) to prevent induction of pollutants.
3. Return system openings in (and immediately adjacent to) the construction area shall be sealed with plastic.
4. When the system must remain operational during construction, temporary filters shall be added to return grilles. All filters must receive frequent periodic maintenance and be replaced at end of project.
5. When the general system must remain operational, the heaviest work areas shall be dampered off or otherwise blocked if temporary imbalance of the return air system does not create a greater problem.
6. The mechanical room shall not be used to store construction or waste materials.
7. Diffusers, VAV boxes, and ducts may be adequately protected in most cases where the above measures are implemented. When the system is off for the duration of construction, diffusers shall also be sealed in plastic for further protection. Ducts, diffusers, and window units shall be inspected upon completion of the work for the amount of deposited particulate present and cleaned where needed. If significant dust deposits are observed in the system during construction, some particulate discharge can be expected during start-up. When such a discharge is only minor, delaying re-occupancy long enough to clean up the dust may be sufficient. In more severe cases, installing temporary coarse filters on diffusers or cleaning the ducts may be necessary. The condition of the main filters shall be checked whenever visible particulates are discharged from the system.

H. Continuity of Services: The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to “General Conditions of the Contract for Construction” for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other

trades and with Owner's Representative. Provide, as part of contract, temporary plumbing and mechanical and electrical connections and relocations as required to accomplish the above.

I. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services. Notify Owner at least two days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions. Indicate method of providing temporary utilities. Do not proceed with utility interruptions without Owner's written permission.

J. Cutting And Patching

1. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed. Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.
2. Temporary Support: Provide temporary support of Work to be cut.
3. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
4. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
5. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
6. Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
7. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

    a. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
    b. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
    c. Concrete or Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

8. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.

    a. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
    b. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing. Clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

9. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of

uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

10. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
11. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

PART 2 - PRODUCT

2.1 PRODUCT CRITERIA

A. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. See other specification sections for any exceptions.

B. Equipment Service: Products shall be supported by a service organization that maintains a complete inventory of repair parts and is located reasonably close to the site.

C. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.

D. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.

E. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.

F. Asbestos products or equipment or materials containing asbestos shall not be used.

2.2 PIPE JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods. Refer to individual piping Sections for special joining materials not listed below.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

C. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

D. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

E. Mechanical Coupling Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents and exterior environment. Gasket design shall be such that the entire coupling housing is isolated from the system contents to prevent galvanic action and inhibit galvanic corrosion.

F. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

G. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

H. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

I. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

J. Solvent Cements for Joining Plastic Piping: CPVC Piping: ASTM F 493. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

C. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve; ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.4 DIELECTRIC FITTINGS

A. Provide where copper tubing and ferrous metal pipe are joined.

B. Fittings shall match piping specifications. Threaded dielectric union, ANSI B16.39. Watts Series LF3000 (lead free) or approved equal. Flange union with dielectric gasket and bolt sleeves, ANSI B16.42. Dielectric flange fittings: Watts Series LF3100.

2.5 ESCUTCHEONS

A. Escutcheons shall be manufactured from nonferrous metals and shall be chrome-plated. Metals and finish shall conform to ASME A112.19.2. Escutcheons shall be one-piece type where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. ID shall closely fit around pipe, tube, and insulation of insulated piping and an OD that completely cover the opening.

B. All escutcheons shall have setscrews for maintaining a fixed position against a surface.

2.6 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout. Characteristics: Post-hardening, volume adjusting, non-staining, non-corrosive, nongaseous, and recommended for interior and exterior applications. Design Mix: 5000-psi, 28-day compressive strength. Packaging: Premixed and factory packaged.

2.7 ROOFING

A. Coordinate roofing subcontractor as part of this contract.

2.8 MOTORS

A. Motor Characteristics

1. Motors 1/2 HP and Larger: Three phase.
2. Motors smaller than 1/2 HP: Single phase.
3. Frequency Rating: 60 Hz.
4. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
5. Service Factor: 1.15 for open drip proof motors; 1.0 for totally enclosed motors.
6. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
7. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
8. Enclosure: as specified.

B. Polyphase Motors

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium efficiency ratings shall meet or exceed the NEMA Premium qualifying efficiencies. Efficiencies shall be eligible for utility rebates. For example, 1800-RPM ODP minimum required efficiency for a 7.5 HP motor is 91.0%
3. Stator: Copper windings, unless otherwise indicated. Multispeed motors shall have separate winding for each speed.
4. Rotor: Squirrel cage, unless otherwise indicated.

5. Bearings: Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading.
6. Temperature Rise: Match insulation rating, unless otherwise indicated.
7. Insulation: Class F, unless otherwise indicated.
8. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

C. Single-Phase Motors

1. Type: One of the following, to suit starting torque and requirements of specific motor application: Permanent-split capacitor, Split-phase start, capacitor run, Capacitor start, capacitor run.
2. Shaded-Pole Motors: For motors 1/20 hp and smaller only.
3. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
4. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, pre-lubricated-sleeve type for other single-phase motors.

2.9 VIBRATION ISOLATION

A. All equipment shall be isolated to prevent vibration transmission to the building structure.

PART 3 - EXECUTION

3.1 DEMOLITION AND REMOVALS

A. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 COMMON REQUIREMENTS

A. Install piping, ductwork, and equipment to allow maximum possible headroom unless specific mounting heights are indicated. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

C. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

D. Any structural member weakened or impaired by cutting, notching, or otherwise shall be reinforced, repaired, or replaced so as to be left in safe structural condition in accordance with the local building code requirements.

E. Install piping and ductwork in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

F. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

G. Install systems above accessible ceilings to allow sufficient space for ceiling panel removal.

H. Install piping to permit valve servicing.

I. Install equipment and other components to allow right of way for piping installed at required slope.

J. Install free of sags and bends.

K. Provide unions or flanges at connections to equipment.

L. Install fittings for changes in direction and branch connections.

M. Make allowances for application of insulation.

N. Select system components with pressure rating equal to or greater than system operating pressure.

O. Verify final equipment locations for roughing-in.

P. Protection and Cleaning: Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations. Damaged or defective items shall be replaced. Protect all finished parts of equipment. Close duct and pipe openings with caps or plugs during installation.

Tightly cover and protect fixtures and equipment against dirt, water, chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and the relevant specification section specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel or groove plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8. Only brazing alloys having a liquid temperature above 1000°F shall be used.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows: Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Non-pressure Piping: Join according to ASTM D 2855.

J. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.4 PIPE PENETRATIONS

A. Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed.

B. Refer to Section 230700 “Mechanical Insulation”.

C. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation.

D. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install steel pipe sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
4. Sleeves are not required in drywall construction.
5. Sleeves are not required for core-drilled holes. Piping through concrete or masonry shall not be subject to any load from the building construction.

E. To prevent accidental liquid spills from passing to a lower level, provide the following:

1. For sleeves: Extend sleeve 1-1/2 inch above finished floor and provide sealant for watertight joint.
2. For blocked out floor openings: Provide 1-1/2 inch angle set in silicone adhesive around opening.
3. For drilled penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

F. Escutcheons: Provide for penetrations in finished spaces where pipes are exposed.

G. Plastic and copper piping penetrating framing members, and within one-inch of the framing, shall be protected with 10-gauge steel nailing plates. The steel plate shall extend along the framing member a minimum of 1.5” beyond the OD of the pipe or tubing.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated: Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment. Install flanges or Victaulic couplings, in piping NPS 2-1/2 and larger, adjacent to flanged or grooved-ended valves and at final connection to each piece of equipment. Provide dielectric fittings at connection between copper and ferrous metal.

B. Swing Connections for Expansion: Connect risers and branch connections to mains with at least five pipe fittings, including tee in main. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.7 GROUTING

A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors. Clean surfaces that will come into contact with grout. Provide forms as required for placement of grout. Avoid air entrapment during placement of grout. Place grout, completely filling equipment bases. Place grout on concrete bases and provide smooth bearing surface for equipment. Place grout around anchors. Cure placed grout.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

3.9 FIRESTOPPING

A. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Seal all penetrations through fire-or smoke-rated wall, partition, ceiling, or roof assemblies with firestopping system. Refer to Architectural plans for location of rated assemblies.

B. Install through-penetration firestop systems to comply with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

C. UL-Classified Systems shall be provided for all rated walls and floors.

D. Engage an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products per specified requirements.

E. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

F. Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

G. Provide components for each through-penetration firestop system that are needed to install fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

H. General: Use only through-penetration firestop system products that have been tested for specific fire-resistance-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

1. Latex Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture.

I. Keep areas of work accessible until inspection by authorities having jurisdiction.

J. Inspecting Agency: Owner may engage a qualified, independent inspecting agency to inspect through-penetration firestops. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

K. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.10 PAINTING

A. Painting of mechanical systems, equipment, and components is provided under this contract. Paint type and color shall be approved by engineer for type of material being painted.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.11 CONCRETE HOUSEKEEPING PADS

A. Concrete pads shall be provided by Division23, in accordance with the following:

1. Refer to Concrete Notes.

B. Coordinate size, thickness, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space, embedment and prevent edge breakout failures. Construct concrete bases not less than 4 inches larger in both directions than supported unit.

3.12 ROOFING

A. Coordinate installation of roof penetrations with roofing subcontractor.

3.13 PROJECT CLOSEOUT

A. Provide Demonstration and Training as required within.

B. Provide Operation and Maintenance information as required within.

END OF SECTION 230500

SECTION 230519 – THERMOMETERS AND PRESSURE GAUGES

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.

B. Related Sections include the following:

1. Division 23 Section “Common Work Results for Mechanical”
2. Mechanical equipment Sections that specify meters and gauges as part of factory-fabricated equipment.

1.2 SUMMARY

A. This Section includes thermometers and pressure gauges.

1.3 ACTION SUBMITTALS

A. Product Data: Include scale range, ratings, and calibrated performance curves for each gauge, fitting, specialty, and accessory specified.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ashcroft
2. Weksler
3. Ernst Gauge Co.
4. Trerice: H. O. Trerice Co.
5. Weiss Instruments, Inc.

2.2 THERMOMETERS

A. Liquid-In-Glass Industrial Thermometers: shall be a blue reading (Fill Type Spirit: Blue colored, organic) liquid-in-glass adjustable angle type, 9" scale, cast aluminum case with cured polyester powder coating, clear acrylic window and brass separable thermowell. Thermometers will be Trerice BX9 Series or approved equal.

B. Scale Range: Temperature ranges for services listed are as follows: The proper range will be selected so that the operating temperature of the material being measured will fall approximately in the middle of the scale.

1. Heating Hot Water: 30 to 180°F, with 2°F scale divisions.

C. Thermowells: Provide fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.

1. Material: Brass, for use in copper piping.
2. Material: Stainless steel, for use in steel piping.
3. Where insulation thickness exceeds 2", a longer stem thermometer will be used with an extension neck brass separable thermowell. The extension neck will be at least 2" long.
4. Thermometers for measuring fluid temperatures will have stems with insertion lengths of roughly half of the pipe diameter; minimum insertion length will be 2".
5. Cap: Threaded, with chain permanently fastened to socket. Heat-Transfer Fluid: Mixture of graphite and glycerin.

2.3 PRESSURE GAUGES

A. Pressure gauges shall be 3½" dial size with a flangeless cast aluminum case, stainless steel friction ring and glass window. Movement will be brass with a bronze bourdon tube and brass socket. Dial face will be white with black figures; pointer will be friction adjustable type. Accuracy shall be ±1% of scale range, ASME B40.1 Grade 1A. Pressure gauges will be Trerice No. 600CB approved equal.

1. Connector: Brass, NPT 1/4.
2. Units of Measure: PSI
3. Provide silicone-damped movement.
4. Range: The proper range shall be selected so that the average operating pressure falls approximately in the middle of the scale selected.
5. Install pressure-gauge needle valve and snubber (Trerice No. 872 pressure snubbers) in piping to pressure gauges; ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.
6. Needle Valves: Trerice 735 Series; NPS 1/4 brass or 316 stainless steel needle type.

B. Scale Range: Pressure ranges for services listed are as follows: The proper range will be selected so that the operating pressure of the material being measured will fall approximately in the middle of the scale.

1. Heating Hot Water: 0 to 60 psi.

2.4 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flow Design, Inc.
2. Peterson Equipment Co., Inc.
3. Trerice, H. O. Co.
4. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
5. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

PART 3 - EXECUTION

3.1 GAUGE INSTALLATION, GENERAL

A. Install according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

A. Install thermometers and adjust vertical and tilted positions.

B. Install thermowells with extension on insulated piping.

C. Install separable sockets in vertical position in piping tees.

3.3 PRESSURE-GAUGE INSTALLATION

A. Install pressure gauges in piping tees with pressure-gauge valve located on pipe at most readable position.

B. Install valve and snubber in piping for each pressure gage for fluids (except steam).

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping and specialties. Install adjacent to machines and equipment to allow service and maintenance. Connect per manufacturers recommendations.

3.5 ADJUSTING AND CLEANING

A. Calibrate according to manufacturer's written instructions, after installation.

B. Adjust faces to proper angle for best visibility.

C. Clean windows and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 230519

SECTION 220529 - HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

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.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for Mechanical"
2. Division 23 Section “Mechanical Insulation”
3. Division 23 Section “Ductwork”

1.2 SUMMARY

A. This Section includes hangers and supports for piping and equipment.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.

4. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.
3. Welded steel support designs

1.5 QUALITY ASSURANCE

A. Install in accordance with MSS SP69 - Manufacturers Standardization Society: Pipe Hangers and Supports- Selection and Application

B. Steel pipe hangers and supports shall have the manufacturer's name, part number, and applicable size stamped in the part itself for identification.

C. Pipe Hangers, Supports, and Components: The materials of all pipe hanging and supporting elements shall be in accordance with MSS SP-58.

D. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Pipe Hangers and Supports:

a. B-Line Systems, Inc.
b. Carpenter & Patterson, Inc.
c. Grinnell Corp.
d. Hubbard Enterprises/Holdrite®
e. National Pipe Hanger Corp.
f. Piping Technology & Products, Inc.
g. Unistrut
h. Anvil International, Inc.
i. Empire

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS (“UNISTRUT”)

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Cooper B-Line, Inc.
   b. Flex-Strut Inc.
   c. Thomas & Betts Corporation.
   d. Unistrut Corporation; Tyco International, Ltd.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with in-turned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Coating: Unistrut Perma-green or similar.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. ERICO International Corporation.
3. National Pipe Hanger Corporation.
4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
5. Piping Technology & Products, Inc.
6. Value Engineered Products, Inc.
7. Buckaroos, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. Shields: G90 galvanized steel.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.7 ACCESSORY PRODUCTS

A. Vertical Mid-Span Piping Supports: For use with vertically-installed pipe, NPS 4 and smaller, for a distance exceeding 48 inches . Subject to compliance with requirements, provide Holdrite; HOLDRITE Stout Bracket System, or equal.

B. Equipment Supports: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

C. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

D. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Provide per manufactures recommendations and calculations.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by plumbing code and ASME B31.9 for building services piping.

M. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

G. Hangers and strut located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123. All hanger hardware shall be hot dip galvanized or stainless steel. Zinc plated hardware is not acceptable for outdoor or corrosive use.

H. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

I. Use padded hangers for piping that is subject to scratching.

J. Use thermal-hanger shield inserts for insulated piping and tubing.

K. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 and larger.
2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 and larger if no insulation is required.
3. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 1.
4. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 and larger.
6. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
7. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 and larger if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

L. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 and larger.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 and larger if longer ends are required for riser clamps.

M. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel weld-less Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

N. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. C-Clamps (MSS Type 23): For structural shapes.
6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
11. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams. Provide hex lag screws for wood beams; size as per manufacturers recommendations.
13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

O. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.7 HANGER SPACING

A. Support piping and tubing not listed below according to MSS SP-69 and manufacturer's written instructions.

B. Water and Steam Boiler Piping Supports (State of Maine Fuel Board Rules)

1. NPS 1/2”: Maximum span, 6 feet; minimum rod size, 3/8 inch.
2. NPS ¾ to 1: Maximum span, 8 feet; minimum rod size, 3/8 inch.
3. NPS 1-1/4: Maximum span, 10 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
7. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.

C. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod sizes:

1. NPS ¾ to 1-1/4”: Maximum span, 7 feet; minimum rod size, 3/8 inch.
2. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
3. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
4. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
5. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.

D. Install hangers for drawn-temper copper piping with the following maximum horizontal spacing and minimum rod sizes:

1. NPS ½ and 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2 to 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 1/2 inch.

E. Provide means of preventing dissimilar metal contact such as plastic coated hangers, copper colored epoxy paint, or non adhesive isolation tape- B-Line Iso-pipe. Galvanized felt isolators sized for copper tubing may also be used, B-Line B3195CT.

F. Piping Hangers for Plastic Piping:

1. Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
2. In systems where large fluctuations in temperature occur, allowances must be made for expansion and contraction of the piping system. Since changes in direction in the system are usually sufficient to allow for expansion and contraction, hangers must be placed so as not to restrict this movement.
3. Hangers shall not compress, distort, cut or abrade the piping. All piping shall be supported at intervals sufficiently close to maintain correct pipe alignment and to prevent sagging or grade reversal. Pipe should also be supported at all branch ends and at all changes of direction.
4. Install hangers for piping with the following maximum horizontal spacing and minimum rod diameters (pipe temperature 100°F or lower).

    a. NPS 1 and smaller: 4 feet with 3/8-inch rod.
    b. NPS 1-1/4 and 1-1/2 and NPS 2: 5 feet with 3/8-inch rod.

5. Install supports for vertical piping every 10 feet.

G. Support vertical piping independently of connected horizontal piping. Support vertical pipes at base and at every floor. Wherever possible, locate riser clamps directly below pipe couplings or shear lugs.

H. Place a hanger within 12 inches of each horizontal elbow.

END OF SECTION 230529

SECTION 230548 - MECHANICAL SEISMIC CONTROLS

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.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for HVAC".
2. Division 23 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements.

1.2 SUMMARY

A. It is the intent of the seismic portion of this specification to keep building system components in place during a seismic event.

B. All such systems must be installed in strict accordance with seismic codes, component manufacturer's and building construction standards. Whenever a conflict occurs between the manufacturers or construction standards, the most stringent shall apply.

C. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements.

D. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

1.3 SCOPE

A. The work in this section includes, but is not limited to the following:

1. Seismic restraints for fuel gas piping.

1.4 PERFORMANCE REQUIREMENTS

A. Manufacturer of seismic control equipment shall have the following responsibilities:

1. Determine seismic restraint sizes and locations.
2. Provide seismic restraints as scheduled or specified.
3. Provide calculations and materials if required for restraint of un-isolated equipment.

4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

B. Seismic restraints shall be designed in accordance with seismic force levels as detailed herein.

C. Applicable Code: IBC

D. Seismic Design Category C

E. Design Spectral Response at Short Periods (SDS): See structural plans.

F. Short Period Spectral Response Acceleration (SS): See structural plans.

G. Building Use Group or Occupancy Category II

H. Equipment Schedule: The following list indicates individual equipment importance factors, Ip=1.5:

1. Natural gas piping

1.5 SUBMITTALS

A. The manufacturer of seismic restraints shall provide submittals for products as follows:

1. Catalog cuts or data sheets on specific restraints detailing compliance with the specification.
2. Detailed schedules of flexible and rigidly mounted equipment, showing seismic restraints by referencing numbered descriptive drawings.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:

1. Design Calculations: Calculate requirements for selecting seismic restraints.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Seismic-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
4. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y, and z planes.

C. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

A. Seismic-restraint devices shall have horizontal and vertical load testing and analysis performed according to OSHPD and shall bear anchorage preapproval "R" number, from OSHPD or another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If pre-approved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer. Testing and calculations must include both shear and tensile loads and 1 test or analysis at 45 degrees to the weakest mode.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Section 230500. The contractor shall ensure that all housekeeping pads used are adequately reinforced and are properly attached to the building structural flooring, so to withstand anticipated seismic forces. In addition, the size of the housekeeping pad is to be coordinated with the seismic restraint manufacturer so to ensure that adequate edge distances exist in order to obtain desired design anchor capabilities.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SEISMIC RESTRAINTS

A. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cables must be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Preapproval “R" Number from OSHPD in the State of California verifying the maximum certified load ratings. Cable assemblies shall be Type SCB at the ceiling and at the clevis bolt, Type SCBH between the hanger rod nut and the clevis or Type SCBV if clamped to a beam all as manufactured by Mason Industries, Inc.

B. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two

through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage preapproval "R" number from OSHPD in the state of California verifying the maximum certified load ratings. Solid seismic brace assemblies shall be Type SSB as manufactured by Mason Industries, Inc.

C. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.

D. Note: seismic cable restraints, seismic solid braces, and steel angles above apply to trapeze as well as clevis hanger locations. At trapeze anchor locations piping must be shackled to the trapeze.

E. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California. Clevis cross brace shall be Type CCB as manufactured by Mason Industries, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic-control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. All seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

B. All mechanical equipment shall be vibration isolated and seismically restrained as specified.

C. Installation of seismic restraints must not cause any change of position of equipment or piping resulting in stresses or misalignment.

D. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

E. Coordinate work with other trades to avoid rigid contact with the building.

F. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

G. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.

H. Correct, at no additional cost, all installations that are deemed defective in workmanship and materials at the contractor's expense.

I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:

1. Flanges of structural beams.
2. Upper truss cords in bar joist construction.
3. Cast in place inserts or wedge type drill-in concrete anchors.

J. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, piping or conduit. Cable assemblies shall be installed taut on non-isolated systems. Seismic solid braces may be used in place of cables on rigidly attached systems only.

1. The support rods must be braced when necessary to accept compressive loads with steel angles and rod clamp assemblies.
2. At all locations where restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with pipe clevis cross bolt braces.

3.3 SEISMIC RESTRAINT OF PIPING

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports."

B. Piping shall be provided with seismic restraints in accordance with Seismic Restraint Manual – Guidelines for Mechanical Systems dated 1998, as published by SMACNA.

1. Seismically restrain the following piping.

a. Natural gas piping that is 1" I.D. or larger.

2. Piping exclusions:

a. Gas piping less than 1" inside diameter.
b. All piping suspended by individual hangers 12" or less as measured from the top of the pipe to the bottom of the support where the hanger is attached. However, if the 12" limit is exceeded by any hanger in the run, seismic bracing is required for the run.

c. The 12" exemption applies for trapeze-supported systems if the top of each item supported by the trapeze qualifies.

3. Transverse piping restraints shall be at 20' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
5. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" of the elbow or tee or combined stresses are within allowable limits at longer distances.
6. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
7. Branch lines may not be used to restrain main lines.

3.4 ADJUSTING

A. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 230548

SECTION 230553 – IDENTIFICATION FOR MECHANICAL

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.

B. Division 23 Section "Common Work Results for Mechanical”

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation.

1.3 SUBMITTALS

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

B. Valve numbering scheme. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Markers: Engraved, color-coded laminated plastic; attach with screws or contact-type, permanent adhesive. Size: 2-1/2" x 1" or as applicable.

1. Terminology: Match schedules as closely as possible.
2. Data: Name and plan number, equipment service, design capacity, and other design parameters such as pressure drop, entering and leaving conditions, and speed.

B. Equipment located above the ceiling that requires servicing shall be labeled on the ceiling using a labeling machine.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Seton, Brady, or approved equal; preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.

2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length. Size of letters and length of color field per ASME A13.1.
3. Pipes with OD, Including Insulation; Full-band snap-around pipe markers extending 360 degrees around pipe at each location.
4. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
5. Minimum length of color field and size of letters shall be in accordance with Uniform Plumbing Code requirements.

B. Types:

1. Self-adhesive type: Seton Opti-Code.
2. Snap-around type: Seton Setmark.
3. Wrap-around type: Seton Ultra-mark; PVF over-laminated polyester construction seals in and protects graphics; suitable for outdoor or harsh environments.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved 1-1/2 round with 1/4-inch letters for piping system legend and 1/2-inch black-filled numbers, with numbering scheme; 3/16" hole for fastener; Material: 19-gauge brass; Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.4 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 22 or 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 PIPING IDENTIFICATION

A. Piping Identification Types:

1. Piping or Insulation 5-7/8 inch OD or smaller: Snap-around marker or self-adhesive marker.
2. Piping or Insulation 6 inch OD and Larger: Strap-around with nylon ties or self-adhesive marker.
3. Provide wrap-around pipe markers for unisulated pipes. Install wrap-around pipe markers completely around pipe.

B. Install manufactured pipe markers indicating service on EACH piping system.

1. Install pipe markers to manufacturer's instructions.
2. Identify piping, concealed or exposed. Include service and flow direction.
3. Install in clear view and align with axis of piping.
4. Locate identification at maximum 20 feet centers 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.
5. At access doors, manholes, and similar access points that permit view of concealed piping.
6. At least one per room.

3.3 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; and

HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.4 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room. Provide (2) copies of valve schedules burned to a DVD or memory stick; Word or Excel format.

3.5 CLEANING

A. Clean faces of mechanical identification devices.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

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.

B. Division 23 Section "Common Work Results for HVAC"

1.2 SUMMARY

A. This Section includes testing, adjusting, and balancing (TAB) of mechanical systems.

1.3 SUBMITTALS

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm. Warranties specified in this Section.

C. Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing." TAB firm's forms approved by Architect. TABB "Contractors Certification Manual."

1.4 QUALITY ASSURANCE

A. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

B. TAB Firm Qualifications: Perform all work in accordance with AABC, TABB, or NEBB procedures.

C. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems".

D. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's

"Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

E. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.5 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - GENERAL

2.1 EXAMINATION AND PREPARATION

A. Prior to commencing testing adjusting and balancing of environmental systems, verify the following HVAC Operational Readiness conditions, if deficiencies are evident, submit Deficiency Report to Architect. Do not begin testing, adjusting, and balancing of environmental system until deficiencies have been remedied.

B. Mechanical contractor shall prepare the systems as required by the Section 230500 Paragraph “Test Adjust and Balance Readiness”.

C. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

2.2 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing" and this Section.

B. Report on noise problems to the Contractor, A/E, and Owner which are discovered during balancing.

2.3 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

2.4 FINAL REPORT

A. The TAB activities described shall culminate in a report neatly typed and arranged. Include with the data the date tested, personnel present, and a list of all measurements taken. The intent of the final report is to provide a reference of actual operating conditions for the Owner’s operations personnel.

B. Include a list of instruments used for procedures, along with proof of calibration. Include instrument calibration report data: instrument type and make, serial number, application, dates of use, and dates of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:

1. Pump curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following: Indicated versus final performance, Notable characteristics of systems; Description of system operation sequence if it varies from the Contract Documents.

E. Provide report data for procedures described herein.

PART 3 - TAB PROCEDURES

3.1 PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. System Diagrams: Include schematic layouts of as-built hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Water flow rates.
2. Pipe and valve sizes and locations.
3. Terminal units.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set system controls so automatic valves are wide open.
6. Check air vents for a forceful liquid flow exiting from vents when manually operated.

D. Hydronic balancing shall include the following minimum data:

1. Prepare itemized equipment schedules, listing all hydronic elements and equipment in the systems to be balanced. List in order on equipment schedules, by pump or zone according to the design, all hydronic elements, all zone balancing valves, and circuit pumps, ending with the last items of equipment or transfer element in the respective zone or circuit. Include on schedule sheet column titles listing the location, type of element or apparatus, design conditions, and measured conditions. Prepare individual pump report sheets for each zone or circuit.
2. 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.
3. Effect system balance with automatic control valves fully open to heat or cooling transfer elements.
4. Adjust balancing valves at each coil and balancing valve for design flow. Adjust hydronic distribution systems by means of balancing valve; do not use service or shut-off valves for balancing unless indexed for balance point.
5. Water pressure shall be recorded at all gauge connections

E. Pumps:

1. Where available pump capacity is less than total flow requirements or individual system parts, proportional balancing must be performed.

2. Do not deadhead the pumps. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded. Running amps and brake horsepower of pump motor under full flow and no flow conditions.
3. Calculate impeller size by plotting the shutoff head on pump curves and include the following pump test report data:
4. Unit Data:

    a. Unit identification.
    b. Location.
    c. Service.
    d. Make and size.
    e. Model and serial numbers.
    f. Water flow rate in gpm.
    g. Water pressure differential in feet of head or psig.
    h. Pump rpm.
    i. Impeller diameter in inches.
    j. Motor Data: as specified herein before.

5. Test Data (Indicated and Actual Values):

    a. Static head in feet of head or psig.
    b. Pump shutoff pressure in feet of head or psig.
    c. Actual impeller size in inches.
    d. Full-open flow rate in gpm.
    e. Full-open pressure in feet of head or psig.
    f. Final discharge pressure in feet of head or psig.
    g. Final suction pressure in feet of head or psig.
    h. Final total pressure in feet of head or psig.
    i. Final water flow rate in gpm.
    j. Voltage at each connection.
    k. Pump VFD Hz.

END OF SECTION 230593

SECTION – 230700 - MECHANICAL INSULATION

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.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for Mechanical"
2. Division 23 Section "Hangers and Supports for Piping and Equipment" for pipe insulation shields and protection saddles.

1.2 SUMMARY

A. This Section includes insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.3 ACTION SUBMITTALS

A. Product Data: Identify thermal conductivity, Greenguard Certification, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

B. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.

C. Store tapes, adhesives, mastics, cements, and insulation materials in ambient conditions in accordance with the recommendations of the manufacturer.

D. Follow manufacturer's recommended handling practices.

E. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades.

F. Fiber Glass and Mold: Contractor shall take precaution to protect insulation. Any fiber glass insulation that becomes wet or torn should be replaced at no additional cost. Air handling insulation used in the air stream must be discarded if exposed to water.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields. Coordinate clearance requirements with other trades for insulation application.

B. Schedule insulation application after testing systems. Insulation application may begin on segments of systems that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Certainteed
2. Knauf
3. Owens-Corning
4. John Mansville
5. Armstrong
6. Aeroflex USA
7. Nomaco K-Flex
8. Pabco.

2.2 PIPING INSULATION MATERIALS

A. General

1. Surface Burning Characteristics: Insulation and related materials shall have surface burning characteristics determined by test performed on identical products per ASTM E 84 mounted and installed as per ASTM E 2231. All testing shall be performed by a testing and inspecting agency acceptable to authorities having jurisdiction. Insulation, jacket materials, adhesives, mastics, tapes and cement material containers shall be labeled with appropriate markings of applicable testing and inspecting agency. Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Supply fiber glass products that are manufactured using a certified 25 % minimum recycled content.

B. Provide thermal hanger shields as specified in Section 230529.

C. Glass Fiber:

1. Knauf 1000° Pipe Insulation with ECOSE Technology meeting ASTM C547 Type IV Grade A, ASTM C585, and ASTM C795; rigid, molded, noncombustible per ASTM E136; k value: ASTM C335, 0.23 at 75°F mean temperature. Maximum Service Temperature: 1000°F, or Johns Manville's Micro-Lok® *HP* meeting ASTM C547, Type I, maximum service temperature of 850°F meeting the other requirements. Vapor Retarder Jacket: ASJ/SSL conforming to ASTM C1136 Type I, secured with self-sealing longitudinal laps and butt strips.
2. PVC Fitting Covers: The Proto Fitting Cover System or Johns Manville Zeston® polyvinyl chloride (PVC) parts shall consist of one piece and two piece pre-molded high impact UV-resistant PVC fitting covers with fiberglass inserts and accessories, which include elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings. Fittings shall be made of Zeston® or LoSMOKE® grade PVC, 25/50 rated per ASTM E-84. Thermal Value of fiberglass insert: K value of 0.26 at 75°F; resistance to fungi and bacteria. (ASTM G 21, ASTM G 22): does not promote growth of fungi or bacteria.

D. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
3. Materials shall have a maximum thermal conductivity of 0.27 Btu-in/h-ft2- °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.
4. Materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96, Procedure-A, latest revision.
5. Materials shall have a flame spread index of less than 25 and a smoke developed index of less than 50 when tested in accordance with ASTM E 84, latest revision.
6. Provide Armaflex WB finish for outdoor exposed piping.

2.3 FIELD-APPLIED JACKETS FOR PIPING

A. General: ASTM C 921, Type 1, unless otherwise indicated.

B. PVC: Johns Manville's Zeston® PVC fittings, jacketing, and accessories or Proto Corporation 25/50 or Indoor/Outdoor, UV-resistant fittings, jacketing and accessories, white. Fitting cover system consists of pre-molded, high-impact PVC materials with fiber glass inserts. Fiber glass insert has a thermal conductivity (k value) of 0.26 at 75° F mean temperature. Closures: stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.

2.4 ACCESSORY MATERIALS

A. Accessory materials installed as part of insulation work under his section shall include (but not be limited to):

1. Closure Materials - Butt strips, bands, wires, staples, mastics, adhesives; pressure-sensitive tapes.
2. Adhesive: As recommended by insulation material manufacturer. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated
3. Support Materials - Hanger straps, hanger rods, saddles, support rings

B. All accessory materials shall be installed in accordance with manufacturer's instructions.

C. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION & PREPARATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application. Verify that systems to be insulated have been tested and are free of defects. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.

D. Ensure that all pipe and fitting surfaces over which insulation is to be installed are clean and dry. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation

shall not be acceptable for installation. Ensure that pressure testing of piping and fittings has been completed prior to installing insulation.

3.2 GENERAL APPLICATION REQUIREMENTS

A. Provide insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout, including the length of ducts and fittings, valves, and specialties.

B. Provide insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each system as specified in insulation system schedules.

C. Provide insulation with longitudinal seams at top and bottom of horizontal pipe runs and equipment.

D. Provide multiple layers of insulation with longitudinal and end seams staggered.

E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

F. Keep insulation materials dry during application and finishing.

G. Provide insulation over fittings, valves, and specialties, with continuous thermal and least number of joints practical.

H. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and specialties around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

I. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

J. Provide insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

K. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Penetrations:

1. Fire Dampers: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
2. Pipe or duct penetrations (no fire damper): Install insulation continuously through penetrations of fire-rated walls and partitions. Comply with requirements in Division 7 for firestopping and fire-resistive joint sealers.

3.4 INSTALLATION OF PIPING INSULATION

A. Metal shields shall be installed between hangers or supports and the piping insulation. Provide in accordance with Section 230529.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt

each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

C. Insulate instrument connections for specialties (examples: thermometers, sensors, etc.) on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Glass Fiber Piping Insulation

1. Locate seams in the least visible location.
2. Insulation installed on piping operating below ambient temperatures must have a continuous vapor retarder. All joints, seams and fittings must be sealed. On systems operating above ambient, the butt joints should not be sealed.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturers recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 PIPING INSULATION APPLICATION SCHEDULE

A. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements. For piping systems not indicated, insulate to with a similar thickness and type as those specified.

B. All cold surfaces that may “sweat” must be insulated. Vapor barrier must be maintained, insulation shall be applied with a continuous, unbroken moisture and vapor seal. All hangers, supports, anchors, or other projections that are secured to cold surfaces shall be insulated and vapor sealed to prevent condensation.

C. For above-ambient services, do not install insulation to the following: testing agency labels and stamps, nameplates, and cleanouts.

D. Insulation thicknesses and installations shall meet or exceed the requirements of ASHRAE Standard 90.1-2007, IECC 2009, or thicknesses indicated, whichever is of superior insulating performance.

E. If piping type is omitted from list below, provide insulation as per similar duty.

F. Provide PVC jackets in the following locations:

1. For all piping exposed in mechanical rooms within 6 feet above finished floor or high traffic areas.
2. Exposed vertical piping in finished spaces.

G. Domestic cold water

1. Pipe size 1-1/4” and less: Glass Fiber, 1” thickness.
2. Pipe size 1-1/2 and larger: Glass Fiber, 1.5” thickness.
3. Aquatherm: refer to Specification 221116, 2.4.F.

H. Heating supply and return, 105F to 200F:

1. Pipe size 1-1/4” and less: Glass Fiber; 1 1/2” thickness.
2. Pipe size 1-1/2” and larger: Glass Fiber; 2” thickness.
3. Insulation is not required for unions, flexible connectors, control valves, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 1-inch of un-insulated items.
4. Insulation is not required between the heating control valve and coil on run-outs when the control valve is located within 4 ft of the coil and the pipe size is 1 in or less.
5. Heating hot-water manual shutoff valves and balance valves 4”Ø and larger: same as water piping; no insulation required 3”Ø and smaller.

END OF SECTION 230700

SECTION 230900 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all labor, materials, equipment, and service necessary for an extension of the existing/addition to the existing building automation system.

B. The Controls Contractor's work shall consist of the provision of all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, project-specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, warranty, specified services and items required by the Contract that are required for the functional turn-key operation of the complete and fully functional Controls Systems. Documents are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans, which are required to meet the functional intent, shall be provided without additional cost to the Owner.

C. Related Sections include the following:

1. Drawings and general provisions of the Contract.
2. Division 23 Section "Common Work Results for Mechanical"
3. Division 23 Sections with controller interfaces.
4. Division 23 Section "Testing, Adjusting, and Balancing"
5. Division 26

1.2 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Written description of sequence of operation.
5. Schedule of dampers including size, leakage, and flow characteristics.
6. Schedule of valves including flow characteristics.
7. System Hardware:

a. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

1.3 QUALITY ASSURANCE

A. All products used in this project installation shall be new and currently under manufacture and shall have been applied in similar installations for a minimum of two years. This installation shall not be used as a test site for any new products unless explicitly approved by the owner's representative in writing. Spare parts shall be available for at least five years after completion of this contract.

B. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the temperature control system manufacturer. Use only employees who are qualified, skilled, experienced, manufacturer trained and familiar with the specific equipment, software and configurations to be provided for this Project.

C. Provide a complete, neat and workmanlike installation.

D. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

G. The contractor shall protect all work and material from damage by his/her work or employees. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

1.4 CONTRACTOR QUALIFICATIONS

A. Qualified Bidders: System shall be as manufactured, installed and serviced by:

1. Schneider Electric I/A, (Maine Controls)
2. Johnson Controls, Inc.
3. Honeywell
4. Siemens
5. Approved bidders. Bids from other vendors, franchised dealers, manufacturer's representatives, or from contractors who are authorized to represent the above named manufacturers must be pre-approved.

1.5 COORDINATION

A. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition.

B. Coordinate details of telephone line, internet service provider, and associated requirements.

C. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

D. Coordinate location of thermostats and other exposed control sensors with plans and room details before installation.

E. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the controls system specified in this section. These controls shall be integrated into the system and coordinated by the contractor.

F. Sheet Metal Subcontractor:

1. Installation of duct-mounted control devices.

G. HVAC Contractor:

1. Installation of immersion wells and pressure tappings, along with associated shut-off cocks.
2. Installation of flow switches.
3. Installation of automatic control valves.

H. Testing and Balancing Contractor:

1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.

I. Electrical Subcontractor: Complying with the principle of "unit responsibility" all electrical work for automatic controls, except as otherwise specified, or shown on the electrical drawings shall be included in Division 23. Electrical work shall, in general, comply with the following, unless otherwise directed by Division 26:

1. Power wiring.
2. All control wiring shown on electric plans such as unit heater line-voltage room thermostats.
3. All electrical work shall comply with the N.E.C. and local electrical codes.
4. All safety devices shall be wired through both hand and auto positions of motor starting device to insure 100% safety shut-off.

1.6 WARRANTY

A. At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the engineer, the engineer shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty of 1 year for all parts and labor.

PART 2 - PRODUCTS

2.1 BUILDING AUTOMATION SYSTEM

A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

2.2 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.

2.3 SENSING DEVICES

A. Where feasible, provide the same sensor type throughout the project. Avoid using transmitters unless absolutely necessary.

B. Resistance Temperature Detectors (RTDs): Provide RTD sensors with platinum elements compatible with the digital controllers. Encapsulate sensors in epoxy, series 300 stainless steel, anodized aluminum, or copper. Temperature sensor accuracy shall be 0.1 percent (1 ohm) of expected ohms (1000 ohms) at 32 degrees F. Temperature sensor stability error over five years shall not exceed 0.25 degree F cumulative. Direct connection of RTDs to digital controllers without transmitters is preferred. When RTDs are connected directly, lead resistance error shall be less than 0.25 degrees F. The total error for a RTD circuit shall not exceed 0.5 degree F.

C. Temperature Sensor Details

1. 7 day programmable thermostat: Equal to Honeywell Zonepro TB6980B1006/U or equal.

1) Timed override button
2) Setpoint adjustment lever or knob.

3) Digital temperature display.
4) Insulating Bases: For temperature sensors/thermostats located on exterior walls.

2.4 Control Valves: Control valves shall be two-type for two-position or modulating service as shown.

1. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:

a. Two-way: 150% of total system (pump) head.

2.5 Motorized control dampers, unless otherwise specified elsewhere, shall be as follows:

1. Submittals shall include leakage, maximum airflow and maximum pressure ratings based on AMCA Publication 500. Dampers shall meet the leakage requirements of the International Energy Conservation Code by leaking less than 3 cfm/sq. ft. at 1" of static pressure and shall be AMCA licensed as Class 1A. Dampers shall be Ruskin model CD60, or approved equal.

B. Electronic damper/valve actuation shall be provided.

1. Manufactured, brand labeled or distributed by BELIMO, or approved equal.
2. Size for torque required for damper seal at load conditions.
3. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
4. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
5. Overload protected electronically throughout rotation.
6. Fail-Safe Operation: Mechanical, spring-return mechanism.
7. Proportional Actuators shall be fully programmable through an EEPROM without the use of actuator mounted switches.
8. Proportional actuators shall have an external, built-in switch to allow the reversing of direction of rotation.
9. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10 VDC position feedback signal.
10. Temperature Rating: -22 to +122ºF -30 to +50ºC [-58 to +122ºF -50 to +50ºC]
11. Housing: Minimum requirement NEMA type 2 mounted in any orientation. .
12. Agency Listings: ISO 9001, cULus, CE or CSA
13. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.

2.6 ELECTRICAL POWER AND DISTRIBUTION

A. Transformers: Transformers shall conform to UL 506. For control power other than terminal level equipment, provide a fuse or circuit breaker on the secondary side of each transformer.

B. Surge and Transient Protection

1. Provide each digital controller with surge and transient power protection. Surge and transient protection shall consist of the following devices, installed externally to the controllers.
2. Power Line Surge Protection: Provide surge suppressors on the incoming power at each controller or grouped terminal controllers. Surge suppressors shall be rated in accordance with UL 1449, have a fault indicating light, and conform to the following:
3. Controller Input/Output Protection: Provide controller inputs and outputs with surge protection via optical isolation, metal oxide varistors (MOV), or silicon avalanche devices. Fuses are not permitted for surge protection.

C. Power Wiring: The following requirements are for field-installed wiring:

1. Wiring for 24 V circuits shall be insulated copper 18 AWG minimum and rated for 300 VAC service.
2. Wiring for 120 V circuits shall be insulated copper 14 AWG minimum and rated for 600 VAC service.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.

B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started. Verify that duct-, pipe-, and equipment-mounted devices and wiring are installed before proceeding with installation.

C. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor’s work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor’s work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by—and the expense of—this contractor.

3.2 INSTALLATION

A. Install all components in accordance with the manufacturer’s recommendations.

B. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

C. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. Contractor shall have work inspected by local and/or state authorities having jurisdiction over the work.

E. Room Temperature Sensors: Verify location of thermostats and other exposed control sensors with plans and room details before installation. Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Mount the center of the sensor 48 inches above the floor to meet ADA requirements.

F. Install automatic dampers according to SMACNA.

G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

H. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."

I. Install hydronic instrument wells, valves, and other accessories according to Section 232116 Hydronic Piping Specialties." Provide thermowells for sensors measuring piping, tank, or pressure vessel temperatures. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to sense flow across entire area of well. Wells shall not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide thermal conductivity material within the well to fully coat the inserted sensor.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."

B. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.

B. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

3. Temperature:

   a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
   b. Calibrate temperature switches to make or break contacts.

4. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

B. Adjust initial temperature and humidity set points.

3.6 DEMONSTRATION

A. Provide basic control system fundamentals training.

1. This project's list of control system components
2. This project's list of points and objects
3. This project's device and network communication architecture
4. This project's sequences of control, and:
5. Alarm capabilities
6. Trending capabilities

3.7 TEST AND BALANCE SUPPORT

A. The controls contractor shall coordinate with and provide on-site support to the test and balance (TAB) personnel This support shall include:

1. On-site operation and manipulation of control systems during the testing and balancing.
2. Control setpoint adjustments for balancing all relevant mechanical systems.
3. Tuning control loops with setpoints and adjustments determined by TAB personnel.

3.8 CONTROLS SYSTEM OPERATORS MANUALS

A. Provide three electronic and printed copies of a Controls System Operators Manual. The manual shall be specific to the project, written to actual project conditions, and provide a complete and concise depiction of the installed work. Provide information in detail to clearly explain all operation requirements for the control system.

3.9 CLEANING

A. The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be required to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

END OF SECTION 23900

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

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.

B. Related Sections include the following:

1. Division 23 Section “Common Work Results for Mechanical”
2. Section 230900 – INSTRUMENTATION AND CONTROL FOR HVAC for control equipment and devices and submittal requirements.
3. Division 23 - Boiler Section for control interface
4. Division 23 Section “Testing, Adjusting, and Balancing”
5. Division 26

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment. Provide control devices, control software and control wiring as required for automatic operation of each sequence specified.

1. Provide automatic control for system operation as described herein, although word “automatic” or “automatically”, is not used.
2. Manual operation is limited only where specifically described; however, provide manual override for each automatic operation.
3. Where manual start-up is called for, also provide scheduled automatic start-stop capabilities.

B. Normal positions for controlled devices:

1. Unless noted, the following valves and dampers shall <u>fail closed</u>:

   a. Outside air dampers

2. Unless noted, the following valves and dampers shall <u>fail open</u>:

   a. Heating coils, fin tube, CUHs.

PART 2 - HEATING PLANT

2.1 CONDENSING BOILER PLANT OPERATES VIA FACTORY CONTROLS (SEE 235216)

A. Domestic hot water generation pump: Via condensing boiler controls.

B. System Pumps: Via condensing boiler controls.

C. Boiler Room Combustion Air:

1. Combustion air is direct piped.

PART 3 - COOLING PLANT (Not Applicable)

PART 4 - AIR HANDLING SYSTEMS (Not Applicable)

PART 5 - HVAC DISTRIBUTION

5.1 TERMINAL UNITS

A. Unit Heaters

1. Unit Heater: On call for heat space 7 day programable thermostat starts fan and opens 2-way control valve on call for heat after pipe mounted aquastat setpoint (135°F) is satisfied. When space reaches setpoint the reverse happens.

a. Occupied Mode: The unit shall maintain a heating setpoint of 70°F (adj.).
b. Unoccupied Mode (night setback): The unit shall maintain a heating setpoint of 65°F (Adj)
c. Unit heaters in Mechanics' Bays and in the Garage Bays shall have set points set at 3 F below (Adj) infrared heaters set points.

B. Locker room Thermostat:

1. Controls:

a. Existing AHU-1 (on Admin building roof) start/stop and cooling set point.
b. Duct Heating Coil: Two way control valves with 0-10VDC modulating actuators shall modulate to maintain (existing) DA thermostat set point of 85 F (Adj).
c. Fin Tube: Two way on/off control of fin tube control valve to maintain space set point.

C. Perimeter Heating Units

1. Finned Radiators and convectors; Room Temperature:

a. Input Device: Electronic 7 day programmable temperature sensor.
b. Output Device: Electronic control-valve operator.
c. Action: 2-position valve controlled to maintain space temperature.

D. Heat Pump

1. Factory supplied thermostat shall operate heating and cooling to maintain space set point.

E. Gas fired Heating units.

1. Electronic 7 day programmable thermostat shall stage hi /lo heating or heating units to maintain space set point.
2. Garage Bays Setpoint: 55 F (Adj).
3. Mechanics' Bay Setpoint: 65 F (Adj).

5.2 EXHAUST FANS

1. Existing Welding Fan energized by local wall switch.

a. Interlock: Wire to control circuit to energize fan and open OA dampers when fan is energized. Dampers shall close 100% when fan is off.

PART 6 - PLUMBING SEQUENCES (Not Applicable)

PART 7 - MISCELLANEOUS SEQUENCES (Not Applicable)

PART 8 - WATER SOURCE HEAT PUMP SYSTEM (Not Applicable)

END OF SECTION 230993

SECTION 232113 – HYDRONIC HVAC 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.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for Mechanical"
2. Division 23 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements.
3. Division 23 Section "Thermometers and Pressure Gages"
4. Division 23 Section "Mechanical Identification" for labeling and identifying hydronic piping.
5. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
6. Division 23 Section – “Vibration and Seismic Controls For HVAC Piping and Equipment”
7. Division 23 controls section for temperature-control valves and sensors.

1.2 SUMMARY

A. This Section includes piping, special-duty valves, and specialties for hydronic HVAC piping.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer’s standard submittal cut sheets. For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.

B. Welding Certificates: Copies of certificates for welding procedures and personnel.

C. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

D. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Qualify soldering processes, procedures, and solderers for copper and copper alloy pipe and tube in accordance with ASTM B 828.

C. Qualify brazing processes for copper and copper alloy pipe and tube according to ANSI/AWS C3.4.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.5 COORDINATION

A. Drawings show the general layout of piping and accessories but do not show all required fittings and offsets that may be necessary to connect piping to equipment and to coordinate with other trades. Fabricate piping based on field measurements. Provide all necessary fittings and offsets.

B. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

C. Coordinate pipe sleeve installations for foundation wall penetrations.

D. Coordinate piping installation with roof penetrations.

E. Coordinate pipe fitting pressure classes with products specified in related Sections.

F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Refer to Division 23 Section “Common Work Results for Mechanical”.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Balancing Valves:

   a. Griswold Controls.
   b. ITT Bell & Gossett
   c. Taco, Inc.
   d. Tour & Anderson

e. Flow Design, Inc.
f. Griswold Controls
g. Watts Industries Inc.

2. Hydronic Pressure-Reducing Valves:

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Conbraco Industries, Inc.
d. ITT Bell & Gossett
e. Spence Engineering Company, Inc.
f. Watts Industries, Inc.

3. Safety Valves:

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Conbraco Industries, Inc.
d. ITT McDonnell & Miller.
e. Kunkle Valve Division.
f. Spence Engineering Company, Inc.
g. Watts Industries Inc.

4. Expansion Tanks, Air Separators, and Hydronic Specialties:

a. Amtrol, Inc.
b. Woods
c. ITT Bell & Gossett
d. Taco, Inc.
e. Aurora
f. Watts Industries Inc.

5. Air Vents and Vacuum Breakers:

a. Armstrong International, Inc.
b. Barnes & Jones, Inc.
c. ITT Hoffman
d. Johnson Corp. (The).
e. Spirax Sarco, Inc.

2.2 PIPING MATERIALS

A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. Wrought-Copper Fittings: ASME B16.22.

D. Wrought-Copper Unions: ASME B16.22.

E. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.

F. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.4 STEEL PIPE AND FITTINGS

A. Steel Pipe, NPS 2 and Smaller: ASTM A-53, Type S (seamless) or Type F (furnace-butt welded), Grade B, Schedule 40 and 80, black steel, plain ends.

B. Steel Pipe, NPS 2-1/2 and larger: ASTM A-53, Type E (electric-resistance welded), Grade B, Schedule 40 and 80, black steel, plain ends.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A-234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt-welding.
3. Facings: Raised face.

H. Mechanically formed copper or steel tee connections are not acceptable.

I. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and thredolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ANSI B16.11 may be used for drain, vent and gage connections.

J. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

K. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 PVC PIPE AND FITTINGS

A. Pipe and fittings shall be manufactured from PVC compound with a cell class of 12454 per ASTM D 1784 and conform with National Sanitation Foundation (NSF) standard 14. Pipe shall be iron pipe size (IPS) conforming to ASTM D 1785 and ASTM D 2665. Fittings shall conform to ASTM D 2665.

2.6 HYDRONIC VALVES

A. Gate Valves

1. Threaded Ends 2" and Smaller: Class 125, bronze body, union bonnet, rising-stem, solid wedge: Hammond IB617, Nibco T-124/134, Stockham B105, Milwaukee 1152 or equal.
2. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge: Hammond IR1140, Nibco F617-0, Stockham G623, Milwaukee F2885 or equal.
3. Solder Ends 2" and Smaller: Class 125, bronze body, union bonnet, rising-stem, solid wedge: Hammond IB648, Nibco S134, Stockham B115, Milwaukee 1169 or equal.
4. Comply with the following standards: Cast Iron Valves: MSS SP – 70; Bronze Valves: MSS SP – 80.

B. Ball Valves

1. Threaded Ends 4" and Smaller: 150 psi WP and 600psi non-shock CWP, forged brass full-port or cast bronze two piece body, hard chrome plated forged brass ball, true adjustable packing nut ("O"-ring only type stem seal not acceptable), blow-out proof stem: Watts FBV-3C series/B6080 series, Hammond 8501, Nibco T-585-70, Milwaukee BA100, Apollo 70-Series, or approved equal.
2. Soldered Ends 3" and Smaller: 150 psi WP and 600psi non-shock CWP, full-port cast bronze or forged brass two piece body, hard chrome plated forged brass ball, true adjustable packing nut ("O"-ring only type stem seal not acceptable), blow-out proof stem: Watts FBVS-3C series/B6081 series, Hammond 8511, Nibco S-585-70, Milwaukee BA150, Apollo 70-Series, approved or equal.
3. Aquatherm Climatherm: Valves shall be manufactured in accordance with the manufacturer’s specifications and shall comply with the performance requirements of ASTM F 2389 or CSA B137.11. The valves shall contain no rework or recycled thermoplastic materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.
4. Comply with MSS SP-110.

C. Swing check valves:

1. Construct pressure containing parts of Valves as follows: Bronze Valves: 125 or 150 psi: ANSI/ASTM B 62; Iron Body Valves: ANSI/ASTM A-126, Grade B
2. Comply with the following standards for design, workmanship, material and testing: Bronze Valves: MSS SP – 80; Cast Iron Valves: MSS SP – 71.
3. Construct valves of pressure casting free of any impregnating materials. Construct disc and hanger as one piece. Support hanger pins by removable side plug.
4. Threaded Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB904, Nibco T-413Y, Stockham B320T, Milwaukee 509 or approved equal.

5. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB912, Nibco S-413-Y, Stockham B310T, Milwaukee 511 or approved equal.

D. Calibrated Balancing Valves, Watts CSM-61/81 series, Taco Accu-Flo, or approved equal.

1. Accuracy 4-5 times greater than variable orifice balancing valves.
2. Flow measurement independent of stem and ball position.
3. Calibrated nameplate: Easy to read. Memory stop is tamper resistant and has a fast and accurate resetting if shut-off feature is used. Calibrated to aid in pre-balancing flow loop.
4. Tamper resistant memory- stop for accurate resetting; positive shut-off; ability to read low flows.
5. Schrader style pressure ports
6. Bronze Body rated to: 300 PSI, 250°F;
7. Cast Iron Body: Class 125
8. Modified venturi design; blowout-proof stem held secure by valve body; ball valve construction with Teflon seats; built-in drain port; all brass interior parts.
9. Provide a closed cell polyethylene foam insulation kit with each valve.

E. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.

F. ASME Safety Relief Valves: Bell & Gossett A-434D, or equal; diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV. The fluid shall not discharge into the spring chamber. The valve shall have a low blow-down differential. The valve seat and all moving parts exposed to the fluid shall be of non-ferrous material.

2.7 HYDRONIC SPECIALTIES

A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.

B. Automatic Air Vent: designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection. Seton, Brady, or approved equal.

C. Expansion Tanks: Taco Model CA, or approved equal. Construction: Welded steel, designed, tested and stamped in accordance with ASME (BPV code sec VIII, div 1); supplied with National Board Form U-1, rated for working pressure of (125/150 psi), with flexible heavy duty butyl rubber bladder. Bladder shall be able to accept the full volume of the expansion tank and shall be removable and replaceable. Bladder shall be NSF 61 rated for potable water service and shall be manufactured with FDA approved materials.

1. Expansion tank isolation valves: Provide valve lockouts: shall meet OSHA requirements to ensure ball valves are locked securely and effectively; for use on 1/4-turn valves to

prevent tampering; polypropylene material resists chemicals, solvents, cracking & rust; provide padlock locking mechanism. Seton, Brady, or approved equal.

2. Accessories: Pressure gage (field installed by others) and air-charging fitting.
3. Automatic Cold Water Fill Assembly (field installed by others): Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

D. Air and Dirt Separator

1. Furnish and install air and dirt removal device(s) of the size and type as shown on the plans. Air and dirt separation devices shall be Taco 4900 Series or approved equal by Spirovent or Bell & Gossett.
2. Air and dirt removal device shall be constructed of steel designed and fabricated per Section VIII Division 1 of the A.S.M.E. Boiler and Pressure Vessel Code with a maximum working pressure rating of (125 / 150) psi at 270°F. Units up to 3 inch in size shall be provided with (threaded / flanged) system connections. Units 4 inch and larger shall be provided with flanged system connections as standard.
3. Each air & dirt separator shall be equipped with a brass conical shaped air venting chamber designed to minimize system fluid from fouling the venting assembly. Air vent shall be furnished with a closeable port to prevent vent clogging during system fill. A brass flushing cock shall be located on the side of each separator to facilitate system fast-fill and the removal of floating impurities from the air / system fluid interface within the separator. A blowdown valve shall be provided by the unit manufacturer on the bottom of each air and dirt separator to allow cleaning as required.
4. The air & dirt separator shall employ the use of high surface area, stainless steel pall rings to achieve optimal separation of (air / air & dirt) from the system fluid. Screens made of 304-stainless steel are provided on the inlet and outlet of each separator to isolate the internals from the system. Units installed in open systems shall be provided with a removable top head for removal and cleaning of the internal coalescence media.
5. The supplier of the air & dirt separator shall furnish to the design engineer the results of independent air & dirt testing of a representative unit from the suppliers' standard product offering. Suppliers not providing these independent performance test results will not be accepted.

E. Y-Pattern Strainers: Strainers shall be Y-type with removable basket. Body shall have cast-in arrows to indicate direction of flow. Strainer screens shall have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material shall be AISI Type 304 corrosion-resistant steel. Provide fine-mesh start-up strainers.

1. Strainers in sizes 3-inch and smaller shall have screwed ends; Hammond 3010, or approved equal. Body material shall be cast bronze conforming to ASTM B584-C84400. Strainer bodies fitted with screwed screen retainers shall have straight threads and shall be gasketed with nonferrous metal. Strainer screens shall have perforations not to exceed 1/32".
2. In sizes 4 and larger, strainers shall have flanged ends; Hammond 3030, or approved equal. Body material shall be cast iron conforming to ASTM A126 Class B. Strainer bodies fitted with bolted-on screen retainers shall have offset blowdown holes. Strainer screens shall have perforations not to exceed 1/16" (4" size); 1/8" (5" size and larger).

PART 3 - EXECUTION

3.1 HYDRONIC PIPING APPLICATIONS – ABOVE GROUND

A. Hot Water, NPS 2 and Smaller: Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints; PEX-a piping, with F1960 cold-expansion fittings.

B. Hot Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded or welded and flanged joints.

C. Makeup water piping, downstream of backflow preventer: Aquatherm or Type L, drawn-temper copper tubing.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow.

3.3 VALVE APPLICATIONS

A. Hydronic Valve Applications: Unless otherwise indicated, use the following valve types:

1. Shutoff Duty: Ball and butterfly valves.
2. Throttling Duty: Globe, ball, and butterfly valves.

B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.

C. Install calibrated balancing valves in the return water line of terminal units [as indicated] [as required to facilitate system balancing].

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

3.4 HYDRONIC PIPING INSTALLATIONS

A. Refer to Division 23 Section "Common Work Results for Mechanical" for basic piping installation requirements.

B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

C. Refer to Division 23 Section "Common Work Results for Mechanical" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping; and solvent-welded joints for PVC and CPVC piping.

D. Hydronic piping systems shall be provided to permit the system to be drained. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and hose-end fitting with cap, at low points in piping system mains and elsewhere as required for system drainage.

E. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

F. Pipe size at connections to equipment shall be distribution main size, not connection size.

G. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

H. Provide dielectric fittings as specified in Section 230500.

I. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.

J. Install unions in piping**,** NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated. [Unions at PICV's specified in Section 230900.]

K. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, and elsewhere as indicated or recommended by component manufacturer to have strainer protection.

1. Provide valved drain and hose connection on strainer blow down connection.
2. Install with provisions for service clearance.
3. Remove and clean strainer after 24 hours of operation and after 30 days of operation.

3.5 SAFETY VALVE INSTALLATIONS

A. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

B. Check the settings and operation of each safety valve, including valves furnished by heater manufacturer. Record settings.

3.6 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports."

3.7 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

B. Air separator and expansion tank to be installed on the suction side of the system pumps. Expansion tank to be tied into system piping in close proximity to air separator and system fill line. Install piping to compression tank with a 2 percent upward slope toward tank.

C. Install expansion tanks on concrete pad. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements. Do not install drain valve.

3.8 CONTROL VALVE INSTALLATION

A. Perform the following as directed by the BAS contractor:

1. Install modulating control valves with minimum of 10 pipe diameters straight pipe at inlet and 5 pipe diameters straight pipe at outlet.
2. Installation of immersion wells and pressure tappings, along with associated shut-off cocks.
3. Installation of flow switches.
4. Setting of automatic control valves or other control devices.

B. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.

C. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal position.

D. Valves shall be installed in accordance with the manufacturer’s recommendations.

E. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be services and removed without interference from structure or other pipes and/or equipment.

F. Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at all connections to screw-type control valves.

3.9 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be same as for equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Arrange piping with offsets to allow for expansion, as well as terminal unit removal.

3.10 CLEANING AND FLUSHING

A. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 6 feet/second if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean.

B. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

C. Close and fill system as soon as possible after final flushing to minimize corrosion.

D. Chemical Treatment

1. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling.
2. Fill system and perform initial chemical treatment.
3. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
4. Water Treatment Chemicals: Furnish sufficient chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

3.11 FIELD QUALITY CONTROL

A. Prepare piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, un-insulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Check expansion tanks to determine that they are not air bound and that system is full of water.

3.12 ADJUSTING

A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

B. Perform these adjustments before operating the system:

1. Open valves to fully open position.
2. Check pump for proper direction of rotation.
3. Set automatic fill valves for required system pressure.
4. Check air vents at high points of system and determine if all are installed and operating and bleed air completely.
5. Set temperature controls so all coils are calling for full flow.
6. Check operation of automatic bypass valves.
7. Lubricate motors and bearings.

3.13 CLEANING

A. Flush piping systems with clean water.

B. Remove and clean or replace strainer screens.

C. After cleaning and flushing hydronic-piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers, and replace with the permanent stainless steel screens.

END OF SECTION 232113

SECTION 232123 - HYDRONIC PUMPS

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.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for HVAC"

1.2 SUMMARY

A. This Section includes

B. Hydronic pumps and accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

A. Coordinate electrical power with Division 26.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

B. Hydronic Pumps

1. Taco (Basis of Design)
2. Armstrong
3. Bell & Gossett ITT
4. PACO
5. Grundfos
6. Patterson
7. Wilo

2.2 GENERAL PUMP REQUIREMENTS

A. Pump Units: Factory assembled and tested.

B. Motors: Include built-in, thermal-overload protection and grease-lubricated ball bearings. Select each motor to be non-overloading over full range of pump performance curve.

C. Motors Indicated to be premium efficiency: Refer to Section 230500 for minimum efficiencies.

D. Motors shall be inverter duty.

2.3 PUMPS

A. In-Line Wet Rotor Pumps.

1. Pumps shall be Taco Model Viridian (VR) Series. The pumps shall be single stage, canned-rotor type, in-line design. The capacities and characteristics shall be as called for in the plans / schedules.
2. Pump casing shall be constructed of EN-GJL-250 or ASTM-A 48 Class 35 cast iron. The pump casing / volute shall be rated for 175psi working pressure for all jobs. The pump flanges shall be matched to suit the working pressure of the piping components on the job, with ANSI Class 125 flanges.
3. All casings shall be flanged connections.
4. The impeller and shaft shall be Class 304 stainless steel.
5. The pump and motor form an integral unit without a mechanical seal. The bearings are lubricated by the pumped liquid. No petroleum lubricated bearings will be accepted.
6. The pumps shall be able to operate as single or parallel variable speed pumps, where the speed is regulated by an on-board electronic device. The onboard electronics shall allow these pumps to run in parallel, standby or alternating modes.
7. The commissioning and set up of the pump shall be accessed through a web interface (data exchange) and use HTML 1.1 web language. The pump shall provide a port for a RJ-45 cable connection.
8. The electronics shall provide constant pressure control (Δp-c), variable differential pressure control (Δp-v) as the factory default, proportional pressure control, constant curve duty (uncontrolled pump), RPM regulation and power limitation control.
9. The pump electronics shall come standard with 2 external digital inputs and 1 external digital output to be available for additional mechanical room control.
10. The wiring / electronics enclosure shall be class 2, IP44.
11. Pumps should meet UL 778, 1004-1, 508C, CAN/CSA C22.2 #108, #100, #107.1, EMC (89/366 EEC): EN 61000, LVD (73/23/EC): EN 60335-1, EN 60335-2-51, and machine safety (98/37/EC): EN ISO 12100.
12. The pumps shall be electronically protected, be rated for continuous duty and have a built-in startup circuit. The pump electronics shall provide overcurrent, line surge and current limit protection, thermal monitoring, heat sink status and over temperature protection.
13. The pump shall be capable of being monitored 24/7 via integrated internet link.
14. The pump must be driven by an electrically commutated electrical motor (ECM) with permanent magnet rotor. The rotor magnets shall by time stable, non-toxic ceramic magnets (Sr-Fe). The electrically commuted electrical motor shall be driven by a frequency converter with an integrated PFC filter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations for compliance with requirements for installation. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Install pumps and equipment according to manufacturer's written instructions.

B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.

C. Pipe connections to pumps shall be made in such a manner so as not to exert any stress on pump housings. If necessary to meet this requirement, provide additional pipe supports and flex connectors.

D. Pumps shall **NOT** be run dry to check rotation.

3.3 INLINE PUMPS

A. Suspend in-line pumps using continuous-thread hanger rod and vibration-isolation hangers.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are the same size as piping connected to pumps.

D. Install electrical connections for power, controls, and devices. Electrical power and control wiring and connections are specified in Electrical Specification Sections. Ground equipment. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 COMMISSIONING

A. Verify that pumps are installed and connected according to the Contract Documents.

B. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.

C. Perform the following preventive maintenance operations and checks before starting:

1. Lubricate bearings.
2. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
3. Verify that pumps are free to rotate by hand. Do not operate pumps if they are bound or drag, until cause of trouble is determined and corrected.
4. Check suction piping connections for tightness to avoid drawing air into pumps.
5. Clean strainers.

6. Verify that pump controls are correct for required application.

D. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:

1. Prime pumps by opening suction valves and closing drains, and prepare pumps for operation.
2. Open sealing liquid-supply valves if pumps are so fitted.
3. Start motors with suction valves open and discharge valve closed. Open discharge valves slowly.
4. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
5. Check general mechanical operation of pumps and motors.
6. Follow manufacturers recommended procedures.

E. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
2. Review data in maintenance manuals.

END OF SECTION 232123

SECTION 235100 – CHIMNEYS AND VENTS

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.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for HVAC"
2. Division 23 Section “Infrared Heaters”
3. Division 23 Section "Fuel Fired Unit Heater"

1.2 SUMMARY

A. This Section includes the following: flue vents, and connectors.

B. Definitions

1. Chimney Connector: A pipe that connects a fuel burning appliance to a chimney.
2. Chimney: A primarily vertical structure for the purpose of carrying gaseous products of combustion and air from at fuel-burning appliance to the outside atmosphere.
3. Vent: A pipe or other conduit composed of factory-made components, containing a passageway for conveying combustion products and air to the atmosphere, listed and labeled for use with a specific type or class of appliance.

1.3 SUBMITTALS

A. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.

B. Factory Developed Drawings: Provide factory drawings which show specific chimney system layout complete with dimensions, penetrations, attachments and complete parts identification list.

C. Provide factory draft calculations of specific chimney system for engineer’s review.

D. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. All work shall be in accordance with Maine Rules.

B. All work shall be in accordance with NFPA 211, Chimneys, Fireplaces, Vents, and Solid Fuel Appliances, 2006 edition.

C. Source Limitations: Obtain listed system components through one source from a single manufacturer.

1.5 COORDINATION

A. Coordinate installation roof penetrations.

1.6 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.

B. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LISTED SPECIAL GAS VENT

A. Available Manufacturers or approved equal:

1. AMPCO (Basis of Design)
2. Heat-Fab Inc.
3. Metal-Fab, Inc.
4. Schebler Co. (The).
5. Selkirk Inc.; Selkirk Metalbestos and Air Mate.
6. Van-Packer Co.

B. AMPCO Safe-T- CI Vent factory-built Special Gas Vent system shall be factory prefabricated, and shall be tested and listed by the Underwriter’s Laboratory, Inc., for use with listed natural gas or propane burning equipment that produce continuous flue-gas temperatures not above 550º F.

1. The product shall consists of a flue-gas conduit fabricated from AL 29-4C® stainless steel.
2. The outer jacket shall be constructed of Type 430 stainless steel with a void of approximately 1" between the flue-gas conduit and the jacket.
3. There shall be 1" of air space between the inner and outer walls for insulation.
4. All joints shall be fastened with the patented Ring-and-Tab tapered closure system and are to be sealed with factory approved sealant when used with positive pressure or condensing applications.

C. The system is to be sized in accordance with appliance manufacturers' specifications, NFPA54 National Gas Code ANSIZ223.1 and ASHRAE recommendations.

D. The system shall comply with National Safety Standards and all building codes when installed in accordance with manufacturer's installation instructions.

E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

F. Termination: Listed and labeled cap in accordance with vent manufacturer's installation instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Provide in accordance with manufacturers' recommendations.

B. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

C. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer. The system shall be installed and sealed per manufacturers' instructions so all joints are gas tight, preventing leakage of products of combustion into a building.

D. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading. Support vents and chimneys from building structure with bolts, concrete inserts, steel expansion anchors, welded studs, C-clamps, or beam clamps according to manufacturer's written instructions.

E. Slope vents and connectors in accordance with NFPA 211.

F. Install, support, and restrain according to seismic requirements.

G. Termination height of chimneys shall be minimum of 3 feet above roof.

3.3 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Clean vents internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of vents and chimneys that are not completed or connected to equipment.

END OF SECTION 235100

SECTION 235216 - CONDENSING BOILERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes packaged, factory-fabricated and -assembled, gas-fired, condensing boilers, trim, and accessories for generating hot water.

1.3 EFFICIENCY MAINE

A. This project intends to pursue Efficiency Maine prescriptive and/or custom incentives. The contractor shall participate in the activities associated with Efficiency Maine incentive approval process including but not limited to; preparation and submission of required incentive applications and the tracking and submission of measure specific invoices to Efficiency Maine within 60 days of the completion of the work.

G9	Natural gas-fired condensing hot water boiler >500 MBtu/h and ≤1,000 MBtu/h	Thermal Efficiency ≥ 90%	$2,500.00

1.4 ACTION SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

C. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Special warranty specified in this Section.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. Heat Exchanger Damaged by Thermal Shock: 10 years from date of Substantial Completion.
b. Heat-Exchanger Corrosion: Non-prorated for ten years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 CONDENSING BOILERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following or approved equal:
1. Viessmann – Basis of Design

B. All individual components shall be accepted as part of the system under the governing body having jurisdiction. Field approval shall not be required for any component. Boiler shall be CSA approved and shall be built in compliance with ASME Section IV, carrying the "H" stamp.

C. The boiler shall have the following approvals and listings, or be in compliance with: CSA, CRN, ASME, I=B=R, AHRI (GAMA), Energy Star

1. ASME maximum allowable working pressure (MAWP): 60 psig.
2. Certified AFUE efficiency shall not be below 92.0%.
3. ASME maximum water temperature (Fixed High Limit): 210°F.
4. All individual components shall be accepted as part of the system under the governing body having jurisdiction. Field approval shall not be required for any component. Boiler shall be CSA approved and shall be built in compliance with ASME Section IV, carrying the "H" stamp.
5. All individual components shall be accepted as part of the system under the governing body having jurisdiction. Field approval shall not be required for any component.
6. All electrical wiring is to be done in accordance with the latest editions of ANSI/NFPA 70 National Electrical Code.
7. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
8. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
9. The Firing Control System shall meet CSD-1 and FM requirements.

D. The gas-fired hot water condensing heating boiler shall be fabricated of high-quality stainless steel **(SA240-316Ti)**, featuring the latest innovations of condensing boiler technology. **Any boiler with a Giannoni heat exchanger will not be accepted**. The boiler shall incorporate a modulating compact cylindrical stainless steel gas burner with a high-alloy stainless steel heat exchanger surface capable of operating with consistently high efficiency. The boiler control system shall maintain optimized combustion, even in case of fluctuating gas composition and air resistance. The boiler control shall have priority for both electrical and fuel savings with its intelligent combustion controller. Boiler shall be equipped with a variable speed combustion fan for quiet and economical operation.

E. The boiler shall include a single compact heat exchanger made of high-alloy stainless steel, designed based on the laminar heat transfer principle for high operational reliability and a long service life. A radial design shall be used to obtain maximum heat transfer performance in a single pass. Rectangular design of the coil is required to maximize the coil gap length and ensure maximum utilization of the heat exchanger surface. Defined gaps (0.8 mm) between coil passes and a heat exchanger length of 53 mm shall be sized to promote laminar flue gas flow for efficient heat transfer. The heat exchanger design shall allow for self-cleaning functionality.

F. The burner shall be constructed from high-grade stainless steel for universal use with natural gas or propane gas. Burner ignition shall be by a direct spark ignition system. The boiler shall be equipped with a digital boiler control unit interface.

G. Wire and cable entry to boiler shall be facilitated by strain reliefs to protect electrical wires. All controls, relays, transformers, ignition module, wiring, and redundant seat combination gas valve shall be installed behind the boiler enclosure.

H. The boiler shall be rated for zero (0") clearance to combustibles, including its vent system.

I. Standard equipment shall also include the following items:

1. Manual reset fixed high limit set at 180°F, wired in series with ignition system
2. Integrated Graphical User Interface (GUI) with digital temperature display
3. 45 psig relief valve
4. Temperature & Pressure gage and pipe fittings
5. Condensate Neutralization Kit complete with neutralization pellets
6. Low Water Cutoff w/Manual Reset & Test

2.2 CONTROLS

A. Digital boiler control supplied by Boiler Manufacture equal to Vitotronic 100 Digital Boiler Control.

B. The control unit shall provide through KMK communication protocol, in a system with a maine mixing valve circuit for OA reset of supply HW. The outdoor reset supply temperature of every heating circuit shall result from the outside temperature, the set room temperature, the operating mode and the heating curve.

C. Call for domestic hot water generation (existing DHW maker) shall ramp up the boiler to 180 F and start domestic hot water maker pump (existing pump). The 3-way main mixing valve shall modulate to maintain reset HW supply based on OA schedule. After DHW maker is satisfied DHW pump shall stop and boiler shall resume OA schedule HW supply temperature.

D. The controller shall have the following features:
   1. EPROM memory is maintained without main power.
   2. Control algorithms are PID-based.
   3. LON ready.
   4. Quick connect plug & play system for low voltage controls.
   5. Communication with other protocols such as Modbus, BACNet and Ethernet/IP shall be available through an external gateway.

E. The controller shall be factory tested and approved by CSA as part of a package with the compatible boilers.

F. The controller shall be able to support the following output devices:

   1. Domestic hot water pump.
   2. Heating loop circulation pumps (with accessory module).
   3. Heating loop mixing valve (with accessory module).

G. Control Interface: The control interface shall be a graphical user interface (°F or °C) and shall have the following features:

   1. Able to display all system temperatures and set points.
   2. Displays unique fault message during an alarm.
   3. Program selection.
   4. Domestic hot water temperature set point adjustment.
   5. Information indicator with confirmation button.
   6. Operating status check.
   7. Adjust the display contrast.

8. Temporary occupied mode.
9. Slope and shift adjustment for heating curve.

H. The controller shall have the following additional features:

1. On/Off switch.
2. Default factory settings reset button.
3. Operating status indication light.
4. Manual override switch.
5. Fault Indicator light.
6. Operating condition scans.
7. Maintenance requirement status.
8. Relay test function.
9. Participant check (LON nodes).
10. Quick heat up and quick set-back functions.
11. Start-up and shut-down optimization functions.
12. Warm weather shut-down.
13. Four different slab curing functions (30 day cycles).
14. Energy savings mode.

I. Boiler System Supply Water Temperature Control

1. Each controlled zone shall have a calculated heating curve which describes the required supply water temperature at different outside air temperatures. The slope and shift of each heating curve shall be adjusted to fit any type of building or system. The highest required temperature of all zones shall be used together with bias from an optional room temperature sensor to determine the common boiler supply temperature set-point. The boilers shall be sequenced to maintain this temperature, configured as having either two-stage or modulating burners.
2. Separate control strategies for condensing and non-condensing boilers shall be available.
3. Subject to the system design, there shall be a choice of three different start-up and shut-down programs, one gross calorific strategy and two net calorific strategies.
4. In the unoccupied mode, the supply water temperature set-point shall be reduced by a pre-determined amount. A call for domestic hot water or an external demand signal shall override this set-point to pre-determined values.
5. Control logic shall be equipped to protect the heating system from freeze-up if left powered during the off season.

J. Domestic Hot Water Control

1. The DHW temperature shall be controlled through starting and stopping the DHW circulation pump. An automatic or individual time program shall be selected for the control of the DHW and the DHW tank re-circulating pump. An individual time program shall enable up to four switching periods per day to be set to control the DHW heating and the DHW re-circulation pump.
2. The DHW control sequence shall use an adaptive algorithm that takes into account the rate at which the temperature changes and whether the boiler will be required to supply heat after the DHW tank has been heated or whether residual boiler heat should be transferred to the DHW tank. Available domestic hot water strategies shall include: priority control (supply water set-point increases, the mixing valve closes and the heating

circuit pumps are shut off on a call for DHW), modulating priority (the supply water set-point of the mixing valve circuits shall be reduced until the DHW supply temperature requirements have been met), or no priority at all.

3. A frost protection function shall energize the DHW production should the supply water temperature drop below a pre-determined value. An optional second temperature sensor placed in the cold water inlet can be incorporated to determine if DHW production should begin prematurely. If required, a solar heating control strategy using an extra temperature sensor in the solar system shall be selected.

K. Fault Management: If a fault occurs on a boiler, the fault code shall be indicated in the display window and by the flashing red fault lamp. A compiled failure alarm contact shall close in order to signal the alarm condition to a Building Automation System (BAS). The message shall also be broadcasted on the LON communication bus. The error history shall be saved to memory. An optional Output Module connected to the LON bus shall close a set of potential-free contacts for each of the following conditions: burner status, burner failure, high boiler temperature and low water cut-off alarm.

L. Scheduling: There shall be separate time schedules for central heating, DHW heating and the DHW re-circulation pump. Each device shall be able to be scheduled to switch between occupied and unoccupied modes up to four times per day.

M. Auxiliary Inputs: The following dry contact inputs shall be available to be wired to each boiler to control the following functions:

1. System disable.
2. External heat demand.
3. Change lead boiler into the lag boiler.

N. Building Management System Interface

1. The controller shall use the LON communication protocol and shall be able to be fully integrated into a building automation system running on the LON protocol without having to use a gateway.
2. The controller shall have the ability, through the use of an Input Module, to accept a 0-10V signal from a Building Management System for the purpose of allowing remote control of the boiler supply water temperature set point.
3. The controller shall be able to fully integrate with Building Management Systems running on the BACNet or N2 communication protocols via a gateway.

O. Remote Communication Interface

1. The controller shall have the ability to be connected to a phone dialer, enabling remote control of any of the functions listed in the Auxiliary inputs section.
2. The controller shall have the ability to be connected to an Internet server interface, which shall allow access to all programming and operating parameters over the World Wide Web.

2.3 BOILER VENTING

A. The boiler shall be equipped with a flue gas vent opening at the top of the boiler. Venting shall be a side wall horizontal (direct vent) chimney system. The boiler shall operate under Category IV positive vent pressure conditions for room air dependant operation. Venting material for room air dependant operation shall be stainless steel UL approved venting system for positive pressure or polypropylene ULC S636 listed material.

B. Provide an Al294C stainless steel or flame-resistant polypropylene vent and combustion air system (refer to drawing MP-401) for use with ANSI Category IV gas-burning condensing boilers, as manufactured by M&G / Duravent or Centrotherm InnoFlue. Vent system shall be listed for zero clearance to combustibles. System shall be UL-1738 and ULC-S636 listed for sustained flue gases up to 230°F

C. Provide support clamps, concentric termination, condensate drains, roof supports, appliance adapters, elbows, and other fittings as recommended by the vent manufacturer and boiler manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Install gas-fired boilers according to NFPA 54.

B. Provide wall blocking and support as per manufacturers recommendations.

C. Provide manufacturer required minimum service clearances.

D. Assemble and install boiler trim.

3.3 BOILER PLANT WIRING

A. Gas-fired boilers shall be wired in accordance with NFPA 54 requirements.

B. Install electrical devices furnished with boiler but not specified to be factory mounted.

C. Provide control wiring to field-mounted electrical devices.

D. Provide a Taco LF Series low water cutoff in the HW piping, located as recommended by the boiler manufacturer.

E. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Provide piping adjacent to boiler to allow service and maintenance.

C. Provide piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

E. Provide pressure regulator to provide proper gas pressure to boilers. Provide straight piping at inlet and outlet of pressure regulator.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Connect PVC drain piping to the boiler, route to the neutralizer kit. Pipe to the nearest floor drain.

3.5 INSTALLATION OF VENTS

A. Provide in accordance with manufacturers’ recommendations.

B. All joints must be sealed. Provide gasketing as per vent manufacturer’s and boiler manufacturer’s recommendations.

C. Performa concentric vent leak test as recommended by the boiler manufacturer.

D. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

E. Pitch venting toward boiler at ¼” per foot to allow for drainage of condensate.

F. Provide temporary closures at ends of vents and chimneys that are not completed or connected to equipment.

3.6 FIELD QUALITY CONTROL

A. Thoroughly flush the system (without boiler connected) to remove sediment.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

G. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

H. Performance Tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.

    a. Test for full capacity.
    b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.

4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.

6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Division 1 "Demonstration and Training."

END OF SECTION 235216

SECTION 235533 - FUEL-FIRED UNIT HEATERS

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.

B. Division 23 Section "Basic Mechanical Materials and Methods"

1.2 SUMMARY

A. This Section includes gas-fired unit heaters and gas-fire condensing unit heaters.

1.3 EFFICIENCY MAINE

A. This project intends to pursue Efficient Maine prescriptive and/or custom incentives. The contractor shall participate in the activities associated with Efficiency Maine incentive approval process including but not limited to; preparation and submission of required incentive applications and the tracking and submission of measure specific invoices to Efficiency Maine within 60 days of the completion of the work.

G16	Natural gas-fired, warm-air unit heater	Thermal Efficiency ≥ 90%	$600.00

1.4 SUBMITTALS

A. Product Data: For each type of fuel-fired unit heater indicated. Include rated capacities, operating characteristics, and accessories.

B. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Operation and Maintenance Data: For fuel-fired unit heaters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 MANUFACTUERSS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved eaqual:

1. Reznor/Thomas & Betts Corporation. (Basis of Design)
2. Trane
3. Sterling HVAC Products; Div. of Mestek Technology Inc.

2.2 ULTRA HIGH EFFICIENCY, PROP FAN, GAS FIRED UNIT HEATER

A. Provide (90 %+) high-efficiency, separated-combustion, power vented, condensing, gas-fired unit heaters; Reznor UEAS. The unit shall be designed for use in a building with negative pressures up to 0.15 “w.c. and for use in building where a non-explosive atmosphere exists that is dust laden and/or contains mildly corrosive fumes.

B. The unit heater shall be equipped for use with natural gas with propane conversion kit shipped with each unit. Gas connection shall be external to the cabinet.

C. The heater shall be equipped with a multi-cell, 4 pass serpentine style steel primary heat exchanger. Primary heat exchanger tubes shall be press fabricated of titanium stabilized, corrosion resistant aluminized steel. The heater shall also be equipped with an extruded aluminum secondary heat exchanger. Secondary heat exchanger shall have a PVC condensate drain connection. All heat exchangers shall be fabricated with no welding or brazing, only tool pressed mechanical joints. All heat exchanger cells shall be designed with an aerodynamic cross section to provide maximum airflow.

D. The units shall incorporate a single, one piece burner assembly with a single orifice. The burner shall have a continuous wound close pressed stainless steel ribbon separating the flame from the burner interior. All units shall have a single venturi tube and orifice supplying fuel to a one-piece burner housing. Each heat exchanger cell shall use balanced draft induction to maintain optimum flame control.

E. Controls shall include a single-stage gas valve; direct spark multi-try ignition with electronic flame supervision with 100% lockout integrally controlled via a printed circuit control board. The control board shall also incorporate diagnostic lights, DIP switches for fan overrun settings, and a relay for fan only operation. All units shall be equipped with a safety limit switch. All controls shall be enclosed in the sealed control compartment to protect them from accidental damage, dust, and atmospheric corrosion.

F. The unit shall have a factory-installed power venter device to draw combustion air from outside of the building. The outside air shall enter the unit through a factory-installed round inlet air terminal on the rear of the heater.

G. The control compartment shall be sealed and the access door shall be gasketed to prevent dirt, lint, dust, or other contaminants present in the heated space from entering the unit. The control

compartment door shall be equipped with a safety interlock switch to prevent operation when the door is open.

H. The combustion air supply pipe and flue exhaust pipe shall be run in parallel from the heater to a factory supplied concentric adapter assembly, which allows for a single wall or roof penetration, to the (horizontal) (vertical) air inlet and vent terminal. A 4" PVC clean out cap drilled and tapped for attaching a vent condensate drain is included with the vent/combustion air kit. The combustion air/venting system shall include a vibration isolated power venter motor and wheel assembly and a combustion air pressure switch.
   1. Horizontal kits: equal to Reznor #CC6
   2. Vertical kits: equal to Reznor # CC2
   3. Provide Breidert style vent cap for high wind environment.

I. Operation shall be controlled by an integrated circuit board that includes LED diagnostic indicator lights. Supply voltage connections shall be made in a sealed junction box. 24-volt control connections shall be made on an externally mounted terminal strip with connections (W1, W2, R, and G). All internal wiring, both line and control voltages, shall be terminated by insulated terminal connectors to minimize shock hazard during service.

J. Each unit shall be equipped for use with 115/1 volt power supply.

K. All units will be equipped with a built-in disconnect switch.

L. The cabinet shall be low profile with a pre-coat or powder-coat white paint finish. Finish shall be a minimum 80 gloss on G30 galvanized steel. The cabinet shall be constructed so that screws are not visible from the bottom, front, or sides, except for service panel and accessories. Unit construction shall incorporate a beveled front corner on control side for additional cabinet rigidity. All units shall be manufactured with a tooled drawn supply air orifice on the rear panel to reduce fan inlet noise.

M. The unit shall be designed for ceiling suspension featuring 3/8”-16 female threads (hanger kits for 1” pipe) at 4-point locations with no additional adapter kits.

N. The cabinet shall be equipped with burgundy painted, roll-formed horizontal louvers. Louvers shall be spring held and adjustable for directing airflow.

O. The cabinet shall be equipped with a full safety fan guard. The open drip proof motor and fan assembly shall be resiliently mounted to the cabinet to reduce vibration and noise.

P. The unit shall be designed with a full opening service access panel complete with screw closure attachment and lifting handle for removal. Service panel shall be fully gasketed and equipped with a safety interlock switch. All components in the gas train, all standard electrical controls, and the power venter shall be within the sealed service compartment.

Q. Minimum top clearance from combustibles shall be 4”. Minimum bottom clearance from combustibles shall be 1”. Minimum clearance from combustibles on non-service side shall be 2”.

2.3 SEPARATED COMBUSTION, LOW STATIC, AXIAL FAN, UNIT HEATER

A. Provide (82%, 83%) high-efficiency, separated-combustion, power vented, gas-fired unit heaters; Reznor UDAS. The unit shall be designed for use in a building with negative pressures up to 0.15 “w.c. and for use in building where a non-explosive atmosphere exist that is dust laden and/or contains mildly corrosive fumes.

B. The unit heater shall be equipped for use with natural gas. Gas connection shall be external to the cabinet.

C. The heater shall be equipped with a multi-cell, 4 pass serpentine style steel heat exchanger. Heat exchanger tubes shall be press fabricated of titanium stabilized, corrosion resistant aluminized steel. All heat exchangers shall be fabricated with no welding or brazing, only tool pressed mechanical joints. All heat exchanger cells shall be designed with an aerodynamic cross section to provide maximum airflow.

D. The units shall incorporate a single, one piece burner assembly with a single orifice. The burner shall have a continuous wound close pressed stainless steel ribbon separating the flame from the burner interior. All units shall have a single venturi tube and orifice supplying fuel to a one-piece burner housing. Each heat exchanger cell shall use balanced draft induction to maintain optimum flame control.

E. Controls shall include a single-stage gas valve; direct spark multi-try ignition with electronic flame supervision with 100% lockout integrally controlled via a printed circuit control board. The control board shall also incorporate diagnostic lights, DIP switches for fan overrun settings, and a relay for fan only operation. All units shall be equipped with a safety limit switch.

F. All controls shall be enclosed in the sealed control compartment to protect them from accidental damage, dust, and atmospheric corrosion.

G. The unit shall have a factory-installed power venter device to draw combustion air from outside of the building. The outside air shall enter the unit through a factory-installed round inlet air terminal on the rear of the heater. The control compartment shall be sealed and the access door shall be gasketed to prevent dirt, lint, dust, or other contaminants present in the heated space from entering the unit. The control compartment door shall be equipped with a safety interlock switch to prevent operation when the door is open.

H. The combustion air supply pipe and flue exhaust pipe shall be run in parallel from the heater to a factory supplied concentric adapter assembly, which allows for a single wall or roof penetration, to the (horizontal) (vertical) air inlet and vent terminal.

1. Horizontal Kit: equal to Reznor #CC6
2. Vertical Kit: equal to Reznor #CC2
3. Provide Breidert style vent cap for high wind environment.

I. The combustion air/venting system shall include a vibration isolated power venter motor and wheel assembly and a combustion air pressure switch. Unit Sizes 30-125 shall include a flame rollout switch.

J. Operation shall be controlled by an integrated circuit board that includes LED diagnostic indicator lights. Supply voltage connections shall be made in a sealed junction box. 24-volt control connections shall be made on an externally mounted terminal strip with connections (W1, W2, R, and G). All internal wiring, both line and control voltages, shall be terminated by insulated terminal connectors to minimize shock hazard during service.

K. All units will be equipped with a built-in disconnect switch.

L. The cabinet shall be low profile with a pre-coat or powder-coat white paint finish. Finish shall be a minimum 80 gloss on G30 galvanized steel. The cabinet shall be constructed so that screws are not visible from the bottom, front, or sides, except for service panel and accessories. Unit construction shall incorporate a beveled front corner on control side for additional cabinet rigidity. All units shall be manufactured with a tooled drawn supply air orifice on the rear panel to reduce fan inlet noise.

M. The unit shall be designed for ceiling suspension featuring 3/8”-16 female threads (hanger kits for 1” pipe) at both 2-point and 4-point locations with no additional adapter kits. (Hanger kit for ceiling mounting shall be available for Sizes 30-125.)

N. The cabinet shall be equipped with RAL 3005 burgundy painted, roll-formed horizontal louvers. Louvers shall be spring held and adjustable for directing airflow. (Vertical louvers) (downturn nozzles) (downturn nozzles with vertical louvers) shall be available.

O. The cabinet shall be equipped with a full safety fan guard with no more than ½ inch grill spacing on Sizes 30-125 or no more than 1 inch on Sizes 150-400. The (open dripproof) (enclosed) motor and fan assembly shall be resiliently mounted to the cabinet to reduce vibration and noise.

P. The unit shall be designed with a full opening service access panel complete with screw closure attachment and lifting handle for removal. Service panel shall be fully gasketed and equipped with a safety interlock switch. All components in the gas train, all standard electrical controls, and the power venter shall be within the sealed service compartment.

Q. Minimum top clearance from combustibles shall be 1” for Sizes 30-125 and 4” for Sizes 150-400. Minimum bottom clearance from combustibles shall be 1” for all sizes. Minimum clearance from combustibles on non-service side shall be 1” for Sizes 30-125 and 2” for Sizes 150-400.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect gas-fired unit heaters and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.

B. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

C. Restrain the unit to resist code-required horizontal acceleration.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to fuel-fired unit heater to allow service and maintenance.

C. Gas Piping: Comply with Division 23 Section "Fuel Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

D. Vent Connections: Comply with Division 23 Section "Breechings, Chimneys, and Stacks."

E. Electrical Connections: Comply with applicable requirements in Division 26 Sections. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify bearing lubrication.
3. Verify proper motor rotation.
4. Test Reports: Prepare a written report to record the following:

    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 ADJUSTING

A. Adjust initial temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fuel-fired unit heaters.

END OF SECTION 235533

SECTION 235533.16 - GAS-FIRED INFRARED HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes gas-fired unit heaters.

1.3 EFFICIENCY MAINE

A. This project intends to pursue Efficient Maine prescriptive and/or custom incentives. The contractor shall participate in the activities associated with Efficiency Maine incentive approval process including but not limited to; preparation and submission of required incentive applications and the tracking and submission of measure specific invoices to Efficiency Maine within 60 days of the completion of the work.

G15	Low-intensity, infrared, natural gas-fired unit heater	None	$500.00

1.4 ACTION SUBMITTALS

A. Product Data: For each type of gas-fired unit heater.

1. Include rated capacities, operating characteristics, and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which equipment will be attached.
2. Items penetrating roof and walls as well as the following:

   a. Vent and gas piping rough-ins and connections.

B. Seismic Qualification Certificates: For gas-fired unit heaters, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gas-fired unit heaters to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.8 QUALITY ASSURANCE

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace heat exchanger of gas-fired unit heater that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated in schedule on Drawings or comparable product by one of the following or approved equal:

1. Lennox International, Inc.
2. Modine Manufacturing Company.
3. Reznor/Thomas & Betts Corporation.
4. Sterling HVAC Products; Div. of Mestek Technology Inc.

2.2 PERFORMANCE REQUIREMENTS

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

B. Capacities and Characteristics:

1. Gas Input: See schedule on drawings.
2. Gas Output: See schedule on drawings.
3. Motor Enclosure: Totally enclosed, fan cooled.
4. Electrical Characteristics:

a. Volts: 120.
b. Phase: Single.
c. Hertz: 60.
d. Minimum Circuit Ampacity: 1.2.
e. Maximum Overcurrent Protection: 20.

2.3 MANUFACTURED UNITS

A. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.

B. Gas Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

C. Type of Venting: Indoor, separated combustion, power vented.

D. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.

1. External Casings and Cabinets: Baked enamel over corrosion-resistant-treated surface.

E. Accessories:

1. Terminal Vent Assembly: power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes, and flashing for wall or roof penetration.
   a. Provide Breidert style vent cap for high wind environment.

2. VPT combustion air intake kit complete with hose and assembly material.

F. Heat Exchanger: Aluminized steel.

G. Burner Material: Aluminized steel.

H. Centrifugal Unit Fan:

1. Steel, centrifugal fan dynamically balanced and resiliently mounted.

I. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

2. Efficiency: Premium efficient.

J. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

1. Gas Control Valve: Two stage.
2. Ignition: Electronically controlled electric spark with flame sensor.
3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
4. Vent Flow Verification: Flame rollout switch.
5. Control transformer.
6. High Limit: Thermal switch or fuse to stop burner.
7. Thermostat: Devices and wiring are specified in Section 230900 "Instrumentation and Control for HVAC."

K. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect gas-fired unit heaters and associated gas and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written instructions.

3.2 EQUIPMENT MOUNTING

A. Suspended Units: Suspend from substrate using threaded rods, cahins, and building attachments recommended by manufacturer. Adjust all supports so unit is level and plumb.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to gas-fired unit heater, allow space for service and maintenance.

C. Gas Piping: Comply with Section 231123 "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

D. Vent Connections: Comply with Section 235100 "Breechings, Chimneys, and Stacks."

E. Combustion Air Kit: Install per manufacturer's written instructions.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify bearing lubrication.
3. Verify proper motor rotation.
4. Test Reports: Prepare a written report to record the following:

    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas-fired unit heaters.

END OF SECTION 235533.16

SECTION 238126 - SINGLE SPLIT-SYSTEM HEAT PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes multi split-system air-conditioning het pumps consisting of separate fan coils (indoor units) and condensing unit (outdoor unit) for change over cooling and heating.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Field quality-control reports.

E. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

F. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

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

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

1.5 COORDINATION

A. Coordinate location of wall bracket system and refrigerant piping penetrations.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: 7 year(s) from date of Substantial Completion.
b. For Parts: 5 year(s) from date of Substantial Completion.
c. For Labor: One year(s) from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Gaskets: One set(s) for each outdoor unit access door.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product scheduled on Drawings or comparable product by one of the following or approved equal:

1. Daikin AC (Americas), Inc. (Basis of Design: Briggs Equipment Sales, Inc. Gray, ME)
2. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
3. Fujitsu General.

2.2 OUTDOOR UNITS

A. Condensing Unit Module: General: RZQ18PVJU9

B. Unit Cabinet:

1. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels powder coated with a baked enamel finish.

C. Fan:

1. The fan shall be a direct drive, propeller type fan.
2. The motor shall be inverter drive, permanently lubricated type bearings, inherent.
3. The fan shall be capable of operating in “silent operation” which lowers the outdoor fan speed in either cool, heat or auto modes.
4. A fan guard is provided on the outdoor unit to prevent contact with fan operation.
5. Airflow shall be horizontal discharge.

D. Coil:

1. The outdoor coil shall be nonferrous construction with corrugated fin tube.
2. Refrigerant flow from the condenser will be controlled via a metering device.

E. Compressor:

1. The compressor shall be a Daikin swing inverter-driven compressor.
2. The outdoor unit shall have an accumulator, four-way reversing valve.
3. The compressor shall have an internal thermal overload.
4. The outdoor unit can operate with a maximum vertical height difference of 49 feet and overall maximum length of 230 feet (or 82 feet for one room) without any oil traps or additional components.
5. Provide factory low ambient operating kit.

F. Electrical:

1. The electrical power requirement is 208-230 volt, 1-phase, and 60 Hz power.
2. The voltage range limitations shall be a minimum of 187 volts and a maximum of 253 volts.
3. The outdoor shall be controlled by a microprocessor located in the outdoor and indoor units via commands from the infrared remote controller.

4. Dedicated EEV's shall be provided for capacity control during part load of each connected indoor unit.

2.3 INDOOR UNITS - FAQ

A. The indoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.

B. Unit Cabinet:

1. The indoor unit shall be wall mounted.
2. The drain and refrigerant piping shall be accessible for flexible installation from the right side.
3. The cabinet includes a receiver to accept signals from an infra-red remote controller.

C. Fan:

1. The evaporator fan shall be an assembly consisting of a direct-driven sirocco fan by a single motor.
2. The fan shall be statically and dynamically balanced and operate on a motor with permanent lubricated bearings.
3. The indoor fan shall offer a choice of high and low speeds.

D. Filter:

1. The unit shall have a washable long life filter with mildew proof resin.

E. Coil:

1. The evaporator coil shall be a nonferrous, aluminum fin on copper tube heat exchanger.
2. All tube joints shall be brazed with silver alloy or phoscopper.
3. All coils will be factory pressure tested.
4. A condensate pan shall be provided under the coil with a drain connection.

F. Electrical:

1. The indoor unit shall have a separate power 208-230 volts, 1 phase, 60 hertz..
2. The allowable voltage range shall be 187 volts to 253 volts.

G. Control:

1. The unit shall have a remote wired senor/controller. It shall have Cooling Operation, Heating Operation, Automatic Operation, Dry Operation and Fan Only Operation.

2. The wired senor/controller shall consist of an On/Off Power switch, Mode Selector, Silent Button (for outdoor unit), Fan Setting, On/Off Timer Setting, Temperature Adjustment, and Powerful Operation.

   a. On/Off switch powers the system on or off.
   b. Mode selector shall operate the system in auto, cool, heat, fan or dry operation
   c. Temperature adjustment allows for the increase or decrease of the desired temperature.

3. Temperature range on the remote control shall be 64°F to 90°F in cooling mode and 50°F to 86°F in heating mode.

4. Accessories:

   a. Remote “in-room” sensor kit (KRCS01-1B).

      1) The Daikin wall mounted, hard wired remote sensor kit is recommended for applications where there could be a difference between set temperature and actual temperature. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).

2.4 CAPACITIES AND CHARACTERISTICS

A. Cooling Capacity: Refer to Equipment Schedules on Drawings.

B. Heating Capacity: Refer to Equipment Schedules on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install indoor unit components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install outdoor unit bolted to field fabricated building brackets.

D. Install seismic restraints as required.

3.2 CONNECTIONS

A. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 238230 - ELECTRIC CEILING HEATERS

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 SUMMARY

A. This Section includes ceiling heaters.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Plans, elevations, sections, and details.

C. Wiring Diagrams: Power, signal, and control wiring.

D. Operation and Maintenance Data: For wall and ceiling heaters to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 ELECTRIC CEILING HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Berko Electric Heating
2. Chromalox, Inc
3. Indeeco.
4. REZNOR (Basis of Design)

B. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

C. Cabinet:

1. Front Panel: Extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.
2. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

D. Surface-Mounting Cabinet Enclosure: Steel epoxy powder coated cabinet.

E. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection.

F. Fan: Aluminum propeller directly connected to motor.

G. Motor: Permanently lubricated.

H. Controls: Remote mounted thermostat (See Section 230900).

I. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive wall and ceiling heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for electrical connections to verify actual locations before wall and ceiling heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly.

B. Install ceiling heaters to comply with NFPA 90A.

3.3 CONNECTIONS

A. Ground equipment according to Electrical Specification Section "Grounding and Bonding."

B. Connect wiring according to Electrical Specification Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.

END OF SECTION 238230

SECTION 238239 - UNIT HEATERS

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.

B. Related Sections include the following:

1. Division 23 Section “Common Work Results for Mechanical”

1.2 SUMMARY

A. This Section includes hydronic unit heaters.

1.3 SUBMITTALS

A. Product Data: Include specialties and accessories for each unit type and configuration.

1. Plans, elevations, sections, and details.
2. Power, signal, and control wiring diagrams. Differentiate between manufacturer-installed and field-installed wiring.
3. Equipment schedules to include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
4. Cabinet Unit Heater color samples for initial selection: Manufacturer's color charts showing the full range of colors available for units with factory-applied color finishes.

B. Maintenance Data: For unit heaters to include in maintenance manuals specified in Division 1. Include maintenance schedules and repair parts lists for motors, coils, integral controls, and filters.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 COORDINATION

A. Coordinate layout and installation of unit heaters and suspension system components

B. Coordinate wall construction and conditions with recessed or semi-recessed cabinet unit heater installation requirements.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit Heater Filters: Furnish one set of spare filter for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Carrier Corp.
2. Trane (Basis of Design)
3. McQuay
4. Sterling
5. Vulcan
6. Modine

2.2 CABINET UNIT HEATERS

A. Description: An assembly including filter, chassis, coil, fan, and motor in blow-through configuration with heating coil.

B. Cabinet: For one or more of the following configurations:
1. Semi-recessed, wall-mounting front grilles for air inlet and outlet.

C. Chassis: Galvanized steel, with flanged edges and unit-leveling bolts.

D. Coil Section Insulation: 1-inch duct liner complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916. Fire-Hazard Classification: Duct liner and adhesive shall have a maximum flame-spread rating of 25 and smoke-developed rating of 50 when tested according to ASTM E 84.

E. Cabinet: Galvanized steel, with removable panels.

F. Cabinet Finish: Cabinet parts and exposed recessed panels shall be cleaned, bonderized, phosphatized, and painted with a baked powder finish available in six colors. Finish shall meet ASTM B117 specifications (salt spray test). Owner shall select color from submittal color chart.

G. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and with manual air vent. Coils shall be rated for a minimum working pressure of 300 psig and a maximum entering water temperature of 275 deg F, with manual air vent.

H. Filters: 1-inch- thick, pleated glass-fiber media in fiberboard frame, Farr 30/30 Pleated Panel Air Filter or equivalent.

I. Fan: Centrifugal, with forward-curved, double-width wheels and fan scrolls made of galvanized steel or thermoplastic material; directly connected to motor.

J. Motors shall be brushless DC (BLDC)/electronically commutated motors (ECM) factory-programmed and run-tested in assembled units. The motor controller shall be mounted in a touch-safe control box with a built-in integrated user interface and LED tachometer. If adjustments are needed, motor parameters can be adjusted through momentary contact switches accessible without factory service personnel on the motor control board. Motors shall soft-ramp between speeds to lessen the acoustics due to sudden speed changes. Motors shall be operated at three speeds. The motor will choose the highest speed if there are simultaneous/conflicting speed requests. Motors shall have integral thermal overload protection with a maximum ambient operating temperature of 104°F and shall be permanently lubricated. Motors shall be capable of starting at 50 percent of rated voltage and operating at 90 percent of rated voltage on all speed settings. Motors shall operate up to 10 percent over voltage.

K. Accessories

1. Steel recessing flanges for recessing cabinet unit heaters into ceiling or wall.
2. Tamperproof locks.
3. Leveling feet for vertical floor mounted cabinet unit heaters.
4. Control Devices: Unit-mounted fan-speed switch and line voltage wall-mounting thermostat.
5. Provide a unit-mounted disconnect switch.

2.3 SOURCE QUALITY CONTROL

A. Test unit heater coils according to ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before cabinet unit heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install unit heaters level and plumb.

B. Install unit heaters to comply with NFPA 90A.

C. Relocated Hung unit heaters shall be suspended from structure with rubber-in-shear vibration isolators (rubber hangers).

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Unless otherwise indicated, install shutoff valve and union or flange at each connection.

C. Install piping adjacent to machine to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing and report results in writing:

1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.

B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.5 CLEANING

A. After installing units, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. After installing units, clean unit heaters internally according to manufacturers written instructions.

C. Install new filters in each cabinet unit heater within two weeks after Substantial Completion.

END OF SECTION 238239

SECTION 261000 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Alternates: Refer to Division 01 to determine extent of, if any, work of this section that will be affected by any alternates if accepted.

B. Furnish all materials, equipment, labor, and supplies and perform all operations necessary to complete the electrical work in accordance with the intent of the drawings and these specifications.

1.3 QUALITY ASSURANCE

A. All wiring shall be in accordance with the latest issue of the National Electrical Code.

B. The Contractor shall show evidence, upon request, of having successfully completed at least five similar projects. Installation of each system shall be under the supervision of a factory-authorized organization.

C. The Contractor shall show evidence, upon request, that he maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The Contractor must have a service contract program for the maintenance of the system after the guarantee period.

D. All electrical equipment shall be approved by Underwriters Laboratories, Inc. Each system shall be products of a single manufacturer of established reputation and experience. The Contractor shall have supplied similar apparatus to comparable installations rendering satisfactory service for at least three years.

1.4 PROJECT CONDITIONS

A. Regulatory Requirements:

1. Conform to the requirements of all laws and regulations applicable to the work.
2. Cooperate with all authorities having jurisdiction.
3. Compliance with laws and regulations governing the work on this project does not relieve the Contractor from compliance with more restrictive requirements contained in these specifications.

4. If the Contract Documents are found to be at variance with any law or regulation, the Contractor shall notify the Architect/Engineer promptly in writing. The Contractor shall assume full responsibility for any work contrary to law or regulation, and shall bear all costs for the corrections thereof.
5. Minimum Requirements: The National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL), the National Fire Codes, and National Fire Protection Association (NFPA) are a minimum requirement for work under this section. Design drawings and other specification sections shall govern in those instances where requirements are greater than those required by code.

B. Permits, Fees, and Inspections:

1. Secure and pay for all permits, fees, licenses, inspections, etc., required for the work under Division 26.
2. Schedule and pay for all legally required inspections and cooperate with inspecting officers.
3. Provide Certificates of Inspection and Approval from all regulatory authorities having jurisdiction over the work in Division 26.

C. Drawings:

1. Do not scale the drawings. The general location of the apparatus and the details of the work are shown on the drawings, which form a part of this specification. Exact locations are to be determined at the building as the work progresses, and shall be subject to the Architect/Engineer's approval. Actual field conditions shall govern all dimensions.
2. Anything shown on the drawings and not mentioned in the specifications or vice versa shall be provided as if it were both shown and specified.
3. It is not intended that the drawings shall show every wire, device, fitting, conduit or appliance, but it shall be a requirement to furnish without additional expense, all material and labor necessary to complete the systems in accordance with applicable codes and the best practice of the trade.

1.5 WARRANTY

A. The Contractor shall guarantee all equipment and wiring free from inherent mechanical or electrical defects for one year from date of acceptance.

1.6 RELATED WORK

A. Division 23 - Mechanical

PART 2 - PRODUCTS

2.1 MATERIALS

A. Switches

1. Toggle Switches: 20A, 277V, 1-pole, ivory specification grade, mount 4'-0" above finished floor at door entrance.

B. Disconnect Switches shall be heavy-duty type, horsepower rated.

C. Motor Starters:

1. Manual motor starters shall be toggle-switch type with melting alloy thermal overload relay. Thermal units shall be one-piece construction and interchangeable. Starter shall be inoperative with thermal unit removed. Contacts shall be double break, silver alloy. Starters in finished areas shall be flush mounted over the light switch at 60" above finished floor. Starters shall be mounted behind stainless steel device plate and shall have adjacent pilot lights. Square D Class 2510 Type FS-1P-FL1 or approved equal. Starters in unfinished areas shall be surface mounted 60" above finished floor. Square D Class 2510 Type FG-5P or approved equal.
2. Magnetic motor starters shall be combination circuit breaker or fused disconnect switch type, mounted in a common enclosure. Starters shall be three-pole with three melting alloy overload relays. Overload heaters shall be coordinated with Division 23. Thermal units shall be of one-piece construction and interchangeable. Starter shall be inoperative with any thermal unit removed. The disconnect operating handle shall be position indicating.

    a. Provide a control device and pilot light on the cover of each combination starter. Control devices for motors with remote manual or automatic control shall be "hand-off-auto" switches. Control devices for locally controlled motors shall be "start-stop" pushbuttons.
    b. 120-volt magnetic motor starters may consist of a circuit breaker or fused disconnect switch and a magnetic starter in separate enclosures mounted next to each other.
    c. Control circuits shall operate at a maximum of 120 volts. Provide control transformers as required.

3. Starters shall be mounted within NEMA-1 enclosures unless specified otherwise.
4. All starters shall be lockable in the "off" position.
5. Overload heaters shall be sized for the motor nameplate full-load amperes per the manufacturer's recommendations.

D. Wiring Materials:

1. Wiring shall be enclosed in electrical rigid galvanized steel, intermediate metal conduit, or electrical metallic tubing sized in accordance with code requirements for the conductors. Type MC cable may be used where concealed in walls or ceilings and allowed by code.

    a. Conduit fittings shall be steel compression type.
    b. Terminations for all conduit shall have insulated bushings or insulated throat connectors in accordance with code requirements.
    c. All conduits shall be substantially supported with approved clips or hangers spaced not to exceed ten feet on center. Minimum conduit size shall be 1/2".

2. Flexible Metal Conduit shall be used for all connections to motors and vibrating equipment and shall comply with Fed. Spec. WW-C-566.
3. Liquid-Tight Flexible Metal Conduit shall consist of flexible steel conduit with a liquid-tight PVC jacket over the conduit.

    a. Fittings shall incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening.
    b. Liquid-tight flexible metal conduit shall be used in damp or wet locations when flexible metal conduit would otherwise be used.
    c. Liquid-tight flexible metal conduit shall not penetrate the roof or exterior walls, and shall not be installed in lengths exceeding 72” except where necessary for flexibility.

4. All Wiring shall be type THW, XHHW, or THWN, UL labeled, copper conductors with 600-volt insulation, except as otherwise noted. Minimum size wire shall be No. 12 AWG.
5. Type MC Cable shall have minimum No. 12 AWG type THWN or XHHW insulated copper conductors with an internal bare or insulated copper ground wire.

E. Fire-Stop Material:

1. Fire-stopping material shall maintain its dimension and integrity while preventing the passage of flame, smoke, and gases under conditions of installation and use when exposed to the ASTM E 119 time-temperature curve for a time period equivalent to the rating of the assembly penetrated. Cotton waste shall not ignite when placed in contact with the non-fire side during the test. Fire-stopping material shall be noncombustible as defined by ASTM E 136; and in addition for insulation materials, melt point shall be a minimum of 1700°F for one-hour protection and 1850°F for two-hour protection.
2. Seals for floor, exterior wall, and roof shall also be watertight.

F. Circuit Breakers: Circuit breakers to be added to existing panelboards shall match existing circuit breakers.

G. Grounding Conductors:

1. Grounding conductors shall be soft-drawn bare copper.
2. Insulated grounding wires shall be UL and NEC approved types, copper, with THWN or XHHW insulation color identified green, except where otherwise shown on the drawings or specified.
3. Wire shall not be less than shown on the drawings and not less than required by the NEC.

H. Equipment Grounding Connections: Connections shall be of the compression type solderless connectors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. All work shall be in accordance with the National Electrical Code's requirements as amended to date, with the local electric utility company's rules, the Fire Underwriter's requirements, and all local, state and federal laws and regulations.
2. In general, all wiring in finished areas shall be concealed in walls or above ceilings. Where wiring cannot be concealed due to existing construction, exposed wiring shall be installed in conduit or surface metal raceway as indicated on the drawings. Exposed wiring shall not be installed in finished areas without prior written authorization from the Engineer.
3. Conduits shall be of sizes required by the National Electrical Code. Exposed conduits shall be installed with runs parallel or perpendicular to walls and ceiling, with right-angle turns consisting of bends, fittings, or outlet boxes. No wire shall be installed until work that might cause damage to wires or conduits has been completed. Conduits shall be thoroughly cleaned of water or other foreign matter before wire is installed.
4. Where conduits, wireways and other electrical raceways pass through fire partitions, fire walls, or floor, install a fire-stop that provides an effective barrier against the spread of fire, smoke and gases. Fire-stop material shall be packed tight and completely fill clearances between raceways and openings. Floor, exterior wall, and roof seals shall also be made watertight.
5. Where raceways puncture roof, coordinate with Division 07.
6. All splices shall be mechanically and electrically perfect, using crimp type wire connectors.
7. Provide all disconnect switches required by the N.E.C.
8. Locate motor starters as shown on drawings.
9. Mount disconnect switches and starters at a height of 60" above finished floor unless otherwise noted.
10. Provide all necessary hardware for mounting motor starters.
11. A typewritten schedule of circuits, approved by the Owner's Representative shall be on the panel directory cards. Type the room numbers and items served on the cards. Three-complete separate copies of all directories, neatly bound, shall be delivered to the Owner's Representative.
12. Revise existing panelboard directories. Furnish new cards as needed. Directories shall be typewritten or printed using a computer.
13. Circuit numbers indicated on the drawings are the actual numbers assigned to the circuit in the panelboard and shall not be varied without the consent of the Architect/Engineer.
14. Feeder circuit wiring shall be in conduit or EMT.
15. In general, conductors shall be the same size from the last protective device to the load and shall have an ampacity the same as or greater than the ampacity of the protective device where the wire size is not shown on the drawings. Use the 60°C ampacity rating for wire sizes No. 14 through No. 1. For 120V circuits, home runs longer than 100 feet shall be minimum No. 10 AWG, longer than 200 feet shall be minimum No. 8 AWG.

B. Grounding:

1. The entire electrical system shall be permanently and effectively grounded in accordance with Code requirements.
2. Connections to junction boxes, equipment frames, etc., shall be bolted.
3. Conduit Systems:

   a. Ground all metallic conduit systems.
   b. Conduit systems shall contain a grounding conductor sized per NEC Table 250-122 or as shown on the drawings. Increase conduit size where necessary to accommodate the grounding conductor.

4. Feeders and Branch Circuits: Install green grounding conductors with all feeders and branch circuits.

C. Alterations:

1. The Contractor shall study all drawings and specifications, visit the site, and acquaint himself with the existing conditions and the requirements of the plans and specifications. No claim will be recognized for extra compensation due to the failure of the Contractor to familiarize himself with the conditions and extent of the proposed work.
2. The Contractor shall execute all alterations, additions, removals, relocations or new work, etc., as indicated or required to provide a complete installation in accordance with the intent of the drawing and specifications.
3. Reconnect existing circuits to remain. Remove existing equipment to be discontinued.
4. Any existing work disturbed or damaged by the alterations or new work shall be repaired or replaced to the Engineer's satisfaction.
5. Equipment relocated or removed and reinstalled shall be cleaned and repaired to a first-class condition before reinstallation.

D. Continuity of Services: Arrange to execute work at such times and in such locations to provide uninterrupted service to the building or any of its sections. If necessary, temporary power shall be installed to provide for this condition. Authorization for interrupting service shall be obtained in writing from the Owner. Any interruption of normal supply shall be performed during an overtime period to be scheduled with the Owner. Cost for overtime work shall be included in the bid.

E. Identification: Provide tags on each end of all pulled wires giving location of other end. Provide phenolic nameplates for motor starters and disconnect switches (except switches located at motors).

F. Record Drawings: The Contractor shall keep on the job a set of prints showing any changes to the installation. These shall be given to the Engineer at the completion of the work.

G. Testing and Adjusting:

1. The entire installation shall be free from short-circuits and improper grounds. Tests shall be made in the presence of the Engineer or his representatives.
2. Each system shall be completely tested and shall be adjusted for proper operation as required by the Engineer.

END OF SECTION 261000