

## SECTION 15010

## MECHANICAL GENERAL PROVISIONS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and other sections of Division 15.

## 1.2 SUMMARY:

- A. This Section includes general administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements of Division 1:
1. Submittals.
  2. Coordination Drawings.
  3. Record Documents.
  4. Maintenance manuals.
  5. Rough-ins.
  6. Mechanical installations.
  7. Cutting and patching.
- B. Related Sections: The following sections contain requirements that relate to this section:
1. Division 15 Section "MOTORS," for factory-installed motors, controllers, accessories, and connections.
  2. Division 15 Section "BASIC MECHANICAL MATERIALS AND METHODS," for materials and methods common to the remainder of Division 15, plus general related specifications including:
    - a. Access to mechanical installations.

- b. Excavation for mechanical installations within the building boundaries, and from building to utilities connections.

## 1.2 SUBMITTALS:

- A. General: Follow the procedures specified in Division 1 Section "SUBMITTALS."
- B. Additional copies may be required by individual sections of these Specifications.

## 1.3 COORDINATION DRAWINGS:

- A. Prepare coordination drawings in accordance with Division 1 Section "PROJECT COORDINATION," TO A SCALE OF 1/4"-1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to the following: Indicate the proposed locations of piping, ductwork, equipment, and materials. Include the following:
  - 1. Clearances for installing and maintaining insulation.
  - 2. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
  - 3. Equipment connections and support details.
  - 4. Exterior wall and foundation penetrations.
  - 5. Fire rated wall and floor penetrations.
  - 6. Sizes and location of required concrete pads and bases.
  - 7. Valve stem movement.
- B. Indicate scheduling, sequencing, movement, and positioning of large equipment into building during construction.
- C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
- D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets

and inlets, light fixtures, communication systems components, sprinkler, and other ceiling mounted items.

#### 1.4 RECORD DOCUMENTS:

- A. Prepare record documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT."
- B. In addition to the requirements specified in Division 1, indicate the following installed conditions:
  - 1. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters boxes, and terminal units requiring periodic maintenance or repair.
  - 2. Mains and branches of piping systems, with valves and control devices located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 15 Section " Mechanical Identification." Indicate actual inverts and horizontal locations of underground piping.
  - 3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
  - 4. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
  - 5. Contract Modifications, actual equipment and materials installed.

#### 1.5 MAINTENANCE MANUALS:

- A. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT."
- B. In addition to the requirements specified in Division 1, include the following information for equipment items:
  - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
  - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping,

shutdown, and emergency instructions; and summer and winter operating instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and re-assembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

#### 1.6 DELIVERY STORAGE AND HANDLING:

Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

### PARTS 2 - PRODUCTS

NOT APPLICABLE

### PARTS 3 - EXECUTION

#### 3.1 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 16 for rough-in requirements.

#### 3.2 MECHANICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment.
- B. Coordinate mechanical systems, equipment, and materials installation with other building components.
- C. Verify all dimensions by field measurements.
- D. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.

- E. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- F. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
- G. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
- H. Coordinate connection of mechanical systems with the exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide the required connection for each service.
- I. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by Contract Documents, recognizing that portions of the Work are shown in diagrammatic form. Where coordination requirements conflict with the individual system requirements, refer conflict to Contracting Officer.
- J. Install systems, materials, and equipment level plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- K. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
- L. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "ACCESS DOORS" and Division 15 Section "BASIC MATERIALS AND METHODS."
- M. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

### 3.3 CUTTING AND PATCHING:

- A. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply: Protection of Installed Work: During the cutting and patching operations, protect adjacent installations.
- B. Perform cutting, fitting, and patching of mechanical equipment and materials

required to:

1. Uncover Work to provide for installation of ill-timed Work.
  2. Remove and replace defective Work.
  3. Remove and replace Work not conforming to requirements of the Contract Documents.
  4. Remove samples of installed Work as specified for testing.
  5. Install equipment and materials in existing structures.
  6. Upon written instructions from the Contracting Officer, uncover and restore Work to provide for observation of concealed Work.
- C. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.
- D. Protect the structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.
- E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust to adjacent areas.
- G. Where new building components must be cut and patched for mechanical installations; patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installer's qualifications refer to the materials and methods required for the surface and building components being patched. Refer to Division 1 Section "DEFINITIONS AND STANDARDS" for definition of "experienced Installer."

END OF SECTION

## SECTION 15050

## BASIC MECHANICAL MATERIALS AND METHODS

## PART 1 - GENERAL

## 1.1. RELATED DOCUMENTS:

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

## 1.2. SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 15 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Concrete equipment base construction requirements.
3. Equipment nameplate data requirements.
4. Labeling and identifying mechanical systems and equipment is specified in Division 15 Section "Mechanical Identification."
5. Non-shrink grout for equipment installations.
6. Field fabricated metal and wood equipment supports.
7. Installation requirements common to equipment specification Sections.
8. Mechanical demolition.
9. Cutting and patching.
10. Touch-up painting and finishing.

B. Pipe and pipe fitting materials are specified in piping system Sections.

## 1.3. DEFINITIONS:

- A. Pipe, pipefittings, and piping include tube, tube fittings, and tubing.
- B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- C. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- D. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- E. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- F. 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.

#### 1.4 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for following piping specialties.
  - 1. Mechanical sleeve seals.
  - 2. Identification materials and devices.
- C. Samples of color, lettering style, and other graphic representation required for each identification material and device.
- D. Shop drawings detailing fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
- E. Coordination drawings for access panel and door locations.
- F. Prepare coordination drawings according to Division 1 Section "Submittals" to a 1/4 inch equals 1 foot (1:48) scale or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for

installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. Include the following:

1. Proposed locations of piping, ductwork, equipment, and materials. Include the following:
    - a. Planned piping layout, including valve and specialty locations and valve stem movement.
    - b. Planned duct systems layout, including elbows radii and duct accessories.
    - c. Clearances for installing and maintaining insulation.
    - d. Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
    - e. Equipment service connections and support details.
    - f. Exterior wall and foundation penetrations.
    - g. Fire rated wall and floor penetrations.
    - h. Sizes and location of required concrete pads and bases.
  2. Scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
  3. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
  4. Reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.
- G. Welder certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.

#### 1.5 QUALITY ASSURANCE:

- A. Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code-Steel."
- B. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
  1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."
  2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

- C. ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
- D. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

#### 1.6 DELIVERY, STORAGE AND HANDLING:

- A. Deliver pipes and tubes 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.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Protect stored plastic pipes from direct sunlight. Support to prevent sagging and bending.

#### 1.7 SEQUENCING AND SCHEDULING:

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
- C. Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.
- E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

- F. Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."
- G. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.
- H. Coordinate connection of electrical services.

## PART 2 - PRODUCTS:

### 2.1. PIPE AND PIPE FITTINGS:

- A. Refer to individual piping system specification Sections for pipe and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### 2.2 JOINING MATERIALS:

- A. Refer to individual piping system specification Sections in Division 15 for special joining materials not listed below.
- B. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3mm) maximum thickness, except where thickness or specific material is indicated.
    - a. Full-Face Type: For flat face, Class 125 cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised face, Class 250 cast-iron and steel flanges.
  - 2. ASME B16.20 for grooved, ring-joint, steel flanges.
  - 3. AWWA C110, rubber, flat face, 1/8 inch (3mm) thick, except where other thickness is indicated; and full-face or ring type, except where type is indicated.

- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, except where other material is indicated.
- D. Plastic Pipe Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, except where other material is indicated.
- E. Solder Filler Metal: ASTM B 32.
  - 1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent), having 0.10-percent lead content.
  - 2. Alloy HA: Tin-antimony-silver-copper-zinc, having 0.10-percent maximum lead content.
  - 3. Alloy HB: Tin-antimony-silver-copper-nickel, having 0.10-percent maximum lead content.
  - 4. Alloy Sb5: Tin (95 percent) and antimony (5 percent), having 0.20-percent maximum lead content.
- F. Brazing Filler Metals: AWS A5.8.
  - 1. BCuP Series: Copper-phosphorus alloys.
  - 2. BAg1: Silver alloy.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements: Manufacturer's standard solvents complying with the following:
  - 1. Chlorinated Poly(Vinyl Chloride) (CPVC): ASTM F 493.
  - 2. Poly(Vinyl Chloride) (PVC): ASTM D 2564.
- I. Plastic Pipe Seals: ASTM F 477, elastomeric gasket.
- J. Flanged, Ductile Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon steel bolts and nuts.
- K. Couplings: Iron body sleeve assembly, fabricated to match outside diameters of plain-end, pressure pipes.
  - 1. Sleeve: ASTM A 126, Class B, gray iron.

2. Followers: ASTM A 47 (ASTM A 47M), Grade 32510 or ASTM A 536 ductile iron.
3. Gaskets: Rubber.
4. Bolts and Nuts: AWWA C111.
5. Finish: Enamel paint.

### 2.3 PIPING SPECIALTIES:

- A. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type, where required to conceal protruding fittings and sleeves.
1. Inside Diameter: Closely fit around pipe, tube, and insulation.
  2. Outside Diameter: Completely cover opening.
  3. Cast Brass: One piece, with set screw.
    - a. Finish: Rough Brass
    - b. Finish : Polished chrome plate.
  4. Cast Brass: Split casting, with concealed hinge and set screw.
    - a. Finish Rough brass.
    - b. Polished chrome plate.
  5. Stamped Steel: One-piece, with set-screw and chrome plated finish.
  6. Stamped Steel: One-piece, with spring clips and chrome plated finish.
  7. Stamped Steel: Split plate, with concealed hinge, set-screw, and chrome plated finish.
  8. Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome plated finish.
  9. Stamped Steel: Split plate, with exposed rivet hinge, set-screw, and chrome plated finish.
  10. Stamped Steel: Split plate, with exposed-rivet hinge, spring clips, and chrome-plated finished.
  11. Cast Iron Floor Plate: One-piece casting.

- B. Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.
1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
  2. Insulating Material: Suitable for system fluid, pressure, and temperature.
  3. Dielectric Unions: Factory-fabricated, union assembly, for 250 psig (1725kPa) minimum working pressure at 180 deg F (82 deg C) temperature.
  4. Dielectric Flanges: Factory-fabricated, companion-flange assembly for 150- or 300 psig (1035kPa or 2070kPa) minimum pressure to suit system pressures.
  5. Dielectric-Flange Insulation Kits: Field assembled, companion-flange assembly, full face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers. Provide separate companion flanges and steel bolts and nuts for 150- or 300- psig (1035kPa or 2070kPa) minimum working pressure to suit system pressures.
  6. Dielectric Couplings: Galvanized-steel coupling, having inert and non-corrosive, thermoplastic lining, with threaded ends and 300 psig (2070kPa) minimum working pressure at 225 deg F (107 deg C) temperature.
  7. Dielectric Nipples: Electroplated steel nipple, having inert and non-corrosive, thermoplastic lining, with combination of plain, threaded, or grooved end types and 300 psig (2070kPa) working pressure at 225 deg F (107 deg C) temperature.
- C. Mechanical Sleeve Seals: Modular, watertight, mechanical type. Components include interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve. Connecting bolts and pressure plates cause rubber sealing elements to expand when tightened.
- D. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:
1. Steel Sheet Metal: 24 gage (0.70mm) or heavier, galvanized sheet metal, round tube closed with welded longitudinal joint.
  2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.

3. Cast-Iron: Cast or fabricated "wall pipe" equivalent to ductile iron pressure pipe, having plain ends and integral water stop, except where other features are specified.
4. Wall Penetration Systems: Wall sleeve assembly, consisting of housing, gaskets, and pipe sleeve, with 1 mechanical-joint end conforming to AWWA C110 and 1 plain pipe sleeve end.
  - a. Penetrating Pipe Deflection: 5 percent without leakage.
  - b. Housing: Ductile-iron casting having waterstop and anchor ring, with ductile-iron gland, steel studs and nuts, and rubber gasket conforming to AWWA C111, of housing and gasket size as required to fit penetrating pipe.
  - c. Pipe Sleeve: AWWA C 151, ductile iron pipe.
  - d. Housing to Sleeve Gasket: Rubber or neoprene, push-on type, of manufacturer's design.
5. Cast-Iron Sleeve Fittings: Commercially made, sleeve having integral clamping flange, with clamping ring, bolts, and nuts for membrane flashing. Underdeck Clamp: Clamping ring with set-screws.
6. PVC Plastic: Manufactured, permanent, with nailing flange for attaching to wooden forms.
7. PVC Plastic Pipe: ASTM D 1785, Schedule 40.
8. PE Plastic: Manufactured, reusable, tapered, cup-shaped, smooth outer surface, with nailing flange for attaching to wooden forms.

#### 2.4 IDENTIFYING DEVICES AND LABELS:

- A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 15 Sections. Where more than one type is specified for listed application, selection is Installer's option, but provide single selection for each product category.
- B. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment.
  1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.
  2. Location: An accessible and visible location.

- C. Stencils: Standard stencils, prepared for required applications with letter sizes conforming to recommendations of ASME A13.1 for piping and similar applications, but not less than 1-1/4 inch (30mm) high letters for ductwork and not less than 3/4-inch (19mm)-high letters for access door signs and similar operational instructions.
- a. Material: Fiberboard.
  - b. Material: Brass.
  - c. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
  - d. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems, comply with ASME A13.1 for colors.
- D. Snap On Plastic Pipe Markers: Manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, conforming to ASME A13.1
- E. Pressure Sensitive Pipe Markers: Manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure sensitive vinyl pipe markers, conforming to ASME A13.1.
- F. Plastic Duct Markers: Manufacturer's standard laminated plastic, color coded duct markers. Conform to the following color code.
1. Green: Cold air.
  2. Yellow: Hot air.
  3. Yellow/Green: Supply air.
  4. Blue: Exhaust, outside, return, and mixed air.
  5. For hazardous exhausts, use colors and designs recommended by ASME A13.1.
  6. Nomenclature: Include the following:
    - a. Direction of air flow.
    - b. Duct service (supply, return, exhaust, etc.).
    - c. Duct origin (from).
    - d. Duct destination (to).
    - e. Design cfm.
- G. Engraved Plastic Laminate Signs: ASTM D 709, Type I, cellulose, paper-base,

phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white (letter color) melamine subcore, except when other colors are indicated.

1. Fabricate in sizes required for message.
  2. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.
  3. Punch for mechanical fastening.
  4. Thickness: 1/16 inch (1.5mm) for units up to 20 square inches (13,000 sq. mm) or 8-inches (200 mm) long; 1/8 inch (3 mm) for larger units.
  5. Fasteners: Self-tapping stainless steel screws or contact-type permanent adhesive.
- H. Plastic Equipment Markers: Laminated-plastic, color-coded equipment markers. Conform to following color code:
1. Green: Cooling equipment and components.
  2. Yellow: Heating equipment and components.
  3. Yellow/Green: Combination cooling and heating equipment and components.
  4. Brown: Energy reclamation equipment and components.
  5. Blue: Equipment and components that do not meet any of the above criteria.
  6. For hazardous equipment, use colors and designs recommended by ASME A13.1.
  7. Nomenclature: Include the following, matching terminology on schedules as closely as possible.
    - a. Name and plan number.
    - b. Equipment service.
    - c. Design capacity.
    - d. Other design parameters such as pressure drop, entering and leaving conditions, and rpm.
    - e. Size: Approximately 2-1/2 by 4 inches (65 by 100 mm) for control devices, dampers, and valves, and 4-1/2 by 6 inches (115 by 150 mm) for equipment.

- I. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment. Multiple Systems: Where multiple systems of the same generic name are indicated, provide identification that indicates individual system number as well as service such as "Boiler No. 3," "Air Supply No. 1H," or "Standpipe F12."

## 2.5 GROUT:

Nonshrink, Nonmetallic Grout:: ASTM C 1107, Grade B. Characteristics: Post-hardening, volume adjusting, dry, hydraulic-cement grout, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications. Design Mix: 5000 psi (34.50MPa), 28-day compressive strength. Packaging: Premixed and factory-packaged.

## PART 3 - EXECUTION

### 3.1 PIPING SYSTEMS - COMMON REQUIREMENTS:

- A. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 15 specify piping installation requirements unique to the piping system.
- B. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.
- C. Install piping at indicated slope.
- D. Install components having pressure rating equal to or greater than system operating pressure.
- E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
- F. Install piping free of sags and bends.
- G. Install exposed interior and exterior piping at right angles or parallel to building

walls. Diagonal runs are prohibited, except where indicated.

- H. Install piping tight to slabs, beams, joists, columns walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- I. Install piping to allow application of insulation plus 1-inch (25 mm) clearance around insulation.
- J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- K. Install fittings for changes in direction and branch connections.
- L. Install couplings according to manufacturer's printed instructions.
- M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wallboard partitions, and suspended ceilings according to the following:
  - 1. Chrome-Plated Piping: Cast-brass, one piece, with set-screw, and polished chrome-plated finish. Use split-casting escutcheons where required, for existing piping.
  - 2. Uninsulated Piping Wall Escutcheons: Cast-brass or stamped steel, with set-screw.
  - 3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
  - 4. Insulated Piping: Cast-brass or stamped steel, with concealed hinge, spring clips, and chrome-plated finish.
  - 5. Piping in Utility Areas: Cast-brass or stamped steel, with set-screw or spring clips.
- N. Sleeves are not required for core drilled holes.
- O. Permanent sleeves are nor required for holes formed by PE plastic (removable) sleeves.
- P. Install sleeves for pipes passing through concrete and masonry walls, concrete floor and roof slabs, and where indicated.
- Q. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, concrete floor and roof slabs, and where indicated.
  - 1. Cut sleeves to length for mounting flush with both surfaces. Exception: Extend sleeves installed in floors of mechanical equipment areas or other

wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring where specified.

2. Build sleeves into new walls and slabs as work progresses.
  3. Install large enough sleeves to provide 1/4-inch (6mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - a. PVC Pipe Sleeves: For pipes smaller than 6 inches (150 mm).
    - b. Steel Sheet Metal Sleeves: For pipes 6 inches (150 mm) and larger that penetrate gypsum-board partitions.
    - c. Cast-Iron Sleeve Fittings: For floors having membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2-inches (50 mm) above finished floor level. Flashing is specified in Division 7 Section "Flashing and Sheet Metal." Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.
- R. Except for below-grade wall penetrations, seal annular space between sleeves and mechanical sleeve seals. Size sleeve for 1-inch (25 mm) annular clear space between pipe and sleeve for installation of mechanical seals. Install steel pipe for sleeves smaller than 6 inches (150mm).
- S. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping sealant material. Firestopping materials are specified in Division 7.
- T. Verify final equipment for roughing-in.
- U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- V. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping system specification Sections.
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
  2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
  3. Soldered Joints: Construct joints according to AWS "Soldering Manual," Chapter 22 "The Soldering of Pipe and Tube."

4. Brazed Joints: Construct joints according to AWS "Brazing Manual," Chapter 28 "Pipe and Tube."
5. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:
  - a. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
  - b. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
  - c. Align threads at point of assembly.
  - d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
  - e. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
6. Welded Joints: Construct joints according to AWS D10.12 "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe" using qualified processes and welding operators according to "Quality Assurance" Article.
7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
8. Plastic Pipe and Fitting Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following standards:
  - a. Comply with ASTM F 402 for safe handling practice of solvent-cement and primers.
  - b. Chlorinated Poly(Vinyl Chloride) (CPVC): ASTM D 28946 and ASTM F 493.

- c. Poly(Vinyl Chloride) (PVC) Pressure Application: ASTM D 2672.
  - e. Poly(Vinyl Chloride) (PVC) Non-Pressure Application: ASTM D 2855.
9. Plastic Pipe and Fitting Heat-Fusion Joints: Prepare pipe and fittings and join with heat-fusion equipment, according to manufacturer's printed instructions.
- a. Plain-End Pipe and Fittings: Butt joining.
  - b. Plain-End Pipe and Socket-Type Fittings: Socket-joining.
- W. Piping Connections: Except as otherwise indicated make piping connections as specified below.
- 1. Install unions, in piping 2 inches and smaller, adjacent to each valve and at final connection to each piece of equipment having 2-inches or smaller threaded pipe connection.
  - 2. Install flanges, in piping 2-1/2 inches and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
  - 3. Dry Piping Systems (Gas, Compressed Air, and Vacuum): Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  - 4. Wet Piping Systems (Water and Steam): Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### 3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS:

- A. Install equipment to provide the maximum possible headroom, where mounting heights are not indicated.
- B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Contracting Officer.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.

- D. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
- E. Install equipment giving right-of-way to piping systems installed at a required slope.

### 3.3 LABELING AND IDENTIFYING:

- A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
  - 1. Stenciled Markers: Complying with ASME A13.1.
  - 2. Plastic markers with application systems. Install on pipe insulation segment where required for hot non-insulated pipes.
  - 3. Locate pipe markers as follows wherever piping is exposed in finished spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
    - a. Near each valve and control device.
    - b. Near each branch, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, where flow pattern is not obvious.
    - c. Near locations where pipes pass through walls, floors, ceilings, or enter non-accessible enclosures.
    - d. At access doors, manholes, and similar access points that permit view of concealed piping.
    - e. Near major equipment items and other points of origination and termination.
    - f. Spaced at a maximum of 50 feet intervals along each run. Reduce intervals to 25 feet in congested areas of piping and equipment.
    - g. On piping above removable acoustical ceilings, except omit intermediately spaced markers.
- B. Equipment: Install engraved plastic laminate sign or equipment marker on or near each major item of mechanical equipment.

1. Lettering Size: Minimum 1/4-inch-high lettering for name of unit where viewing distance is less than 2 feet, 1/2-inch-high for distances up to 6 feet, and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
  2. Text of Signs: Provide text to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to name of identified unit.
- C. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers, or provide stenciled signs and arrows, showing duct system service and direction of flow. Location: In each space where ducts are exposed or concealed by removable ceiling system, locate signs near points where ducts enter into space and at maximum intervals of 50 feet.
- D. Adjusting: Relocate identifying devices which become visually blocked by work of this Division or other Divisions.

#### 3.4 PAINTING AND FINISHING:

- A. Refer to Division 9 Section "Painting" for field painting requirements.
- B. Damage and Touch-Up: Repair marred and damaged factory painted finishes with materials and procedures to match original factory finish.

#### 3.5 CONCRETE BASES:

Construct concrete equipment bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000 psi, 28-day compressive strength concrete and reinforcement as specified in Division 3 Section "Cast-In-Place Concrete."

#### 3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGE:

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

### 3.7 ERECTION OF WOOD SUPPORTS AND ANCHORAGE:

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

### 3.8 DEMOLITION:

- A. Disconnect, demolish and remove Work specified under Division 15 and as indicated.
- B. Where pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- C. Accessible Work: Remove indicated exposed pipe and ductwork in it's entirety.
- D. Abandoned Work: Cut and remove buried pipe abandoned in place, 2 inches beyond the face of adjacent construction. Cap and patch surface to match existing finish.
- E. Removal: Remove indicated equipment from the project site.
- F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

### 3.9 CUTTING AND PATCHING:

- A. Cut, channel chase, and drill floors, walls, partitions, ceilings and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
- B. Repair cut surfaces to match adjacent surfaces.

### 3.10 GROUTING:

- A. Install nonmetallic, nonshrink grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout

according to manufacturer's printed instructions.

- B. Clean surfaces that will come into contact with grout.
- C. Provide forms for placement of grout, as required.
- D. Avoid air entrapment when placing grout.
- E. Place grout, completely filling equipment bases
- F. Place grout, on concrete bases to provide a smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout according to manufacturer's printed instructions.

END OF SECTION

## SECTION 15100

## VALVES

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 15 Sections apply to this section:
  - 1. "Basic Mechanical Requirements."
  - 2. "Basic Mechanical Materials and Methods."

## 1.2 SUMMARY:

This Section includes general duty valves common to most mechanical piping systems. Special purpose valves are specified in individual piping system specifications.

## 1.3 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.

## 1.3 QUALITY ASSURANCE:

- A. Single Source Responsibility: Comply with the requirements specified in Division 1 Section "MATERIALS AND EQUIPMENT," under "Source Limitations."
- B. American Society of Mechanical Engineers (ASME Compliance: Comply with ASME B 31.9 for building services piping and ASME B31.1 for power piping.

- C. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the various MSS Standard Practices referenced.

#### 1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Preparation for Transport: Prepare valves for shipping as follows:
  - 1. Ensure valves are dry and internally protected against rust and corrosion.
  - 2. Protect valve ends against damage to threads, flange faces, and weld-end preps.
  - 3. Set valves in best position for handling. Set globe and gate valves closed to prevent rattling; set ball and plug valves open to minimize exposure of functional surfaces; set butterfly valves closed or slightly open; and block swing check valves in either closed or open position.
- B. Storage: Use the following precautions during storage.
  - 1. Do not remove valve end protectors unless necessary for inspection; then reinstall for storage.
  - 2. Protect valves from weather. Store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement in watertight enclosures.
- C. Handling: Use a sling to handle valves whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels and stems as lifting or rigging points.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturer's offering products which may be incorporated in the work include, but are not limited to, those listed in valve schedule, located at end of this section..

#### 2.02 VALVE FEATURES, GENERAL:

- A. Valve Design: Rising stem or rising outside screw and yoke stems. Non-rising stem valves may be used where headroom prevents full extension of rising stems.
- B. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.
- C. Sizes: Same size as upstream pipe, unless otherwise indicated.
- D. Operators: Provide the following special operator features:
  - 1. Handwheels, fastened to valve stem for valves other than quarter turn.
  - 2. Lever handles, on quarter-turn valves 6-inch and smaller, except for plug valves. Provide plug valves with square heads; provide one wrench for each ten plug valves.
  - 3. Chain-wheel operators, for valves 2-1/2 inch and larger, installed 72 inches or higher above finished floor elevation. Extend chains to an elevation of 5'-0" above finished floor elevation.
- E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- F. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.
- G. End Connections: As indicated in the valve specifications.
  - 1. Threads: Comply with ANSI B 1.20.1.
  - 2. Flanges: Comply with ANSI B 16.1 for cast iron, ANSI B 16.5 for steel, and ANSI B 16.24 for bronze valves.
  - 3. Solder-Joint: Comply with ANSI B 16.18. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for gate, globe, and check valves; below 421 deg F for ball valves.

### 2.3 GATE VALVES:

- A. Gate and Valves, 2-inch and Smaller: MSS SP-80; Class 125, body and bonnet of ASTM B 62 cast bronze; with threaded or solder ends, solid disc, copper-silicon alloy stem, brass packing gland, "Teflon" impregnated packing, and malleable iron handwheel. Provide Class 150 valves meeting the above where system

pressure requires.

- B. Gate and Valves, 2-inch and Smaller: MSS SP-80; Class 150, body and union bonnet of ASTM B 62 cast bronze; with threaded or solder ends, solid disc, copper-silicon alloy stem, brass packing gland, "Teflon" impregnated packing, and malleable iron handwheel. Do not use solder end valves for hot water or steam piping applications.
- C. Gate Valves, 2-1/2-inch and Larger: MSS SP-70; Class 125, iron body bronze mounted, with body and bonnet conforming to ASTM A 126 Class B; with flange ends, "Teflon" impregnated packing, and two-piece backing gland assembly.

#### 2.4 BALL VALVES:

- A. Ball Valves, 1 Inch and Smaller: Rated for 150 psi saturated steam pressure, 400 psi WOG pressure; two-piece construction; with bronze body conforming to ASTM B 62, standard (or regular) port, seals, blowout-proof stem, and vinyl-covered steel handle. Provide solder ends for condenser water, chilled water, and domestic hot and cold water service; threaded ends for heating hot water water and low pressure steam.
- B. Ball Valves, 1-1/4-Inch to 2-Inch: Rated for 150 psi saturated steam pressure, 400 psi WOG pressure; 3-piece construction; with bronze body conforming to ASTM B 62, conventional port, chrome plated brass ball, replaceable "Teflon" or TFE seats and seals, blowout-proof stem, and vinyl-covered steel handle. Provide solder ends for condenser water, chilled water, and domestic hot and cold water service; threaded ends for heating hot water water and low pressure steam.

#### 2.5 PLUG VALVES:

- A. Plug Valves, 2-Inch and Smaller: Rated at 150 psi WOG; bronze body, with straightaway pattern, square head, and threaded ends.
- B. Plug Valves, 2-1/2-Inch and Larger: MSS SP-78; rated at 175 psi WOG; lubricated plug type, with semisteel body, single gland, wrench operated, and flanged ends.

#### 2.6 GLOBE VALVES:

- A. Globe Valves, 2-Inch and Smaller: MSS SP-80; Class 125; body and screwed bonnet of ASTM B 62 cast bronze; with threaded or solder ends, brass or replaceable composition disc, copper-silicon alloy stem, brass packing gland,

"Teflon" impregnated packing, and malleable iron handwheel. Provide Class 150 valves meeting the above system where pressure requires.

B. Globe Valves, 2-1/2" and Larger: MSS SP-85; Class 125; iron body and bolted bonnet conforming to ASTM A 126, Class B; with outside screw and yoke, bronze mounted, flanged ends, and "Teflon" impregnated packing, and two-piece backing gland assembly.

## 2.7 BUTTERFLY VALVES:

Butterfly Valves, 2-1/2" and Larger: MSS SP-67; rated at 200 psi; cast-iron body conforming to ASTM A 126, Class B. Provide valves with field replaceable EPDM sleeve, nickel-plated ductile iron disc (except aluminum bronze disc for valves installed in condenser water piping), stainless steel stem, and EPDM O-ring stem seals. Provide lever operators with locks for sizes 2 through 6 inches and gear operators with position indicator for sizes 8 through 24 inches. Provide lug or wafer type as indicated. Drill and tap valves on dead-end service or requiring additional body strength.

## 2.8 CHECK VALVES:

A. Swing Check Valves 2-Inch and Smaller: MSS SP-80; Class 125, cast-bronze body and cap conforming to ASTM B 62; with horizontal swing, Y-pattern, and bronze disc; and having threaded or solder ends. Provide valves capable of being reground while the valve remains in the line. Provide Class 150 valves meeting the above specifications, with threaded end connections, where system pressure requires or where Class 125 valves are not available.

B. Swing Check Valves, 2-1/2 Inch and Larger: MSS SP-71; Class 125 (Class 175 FM approved for fire protection piping systems), cast iron body and bolted cap conforming to ASTM A 126, Class B; horizontal swing, and bronze disc or cast-iron disc with bronze disc ring; and flanged ends. provide valves capable of being refitted while the valve remains in the line.

C. Wafer Check Valves: Class 250, cast-iron body; with replaceable bronze seat, and non-slam design lapped and balanced twin bronze flappers and stainless steel trim and torsion spring. Provide valves designed to open and close at approximately one foot differential pressure.

D. Lift-Check Valves, 2-Inch and smaller: Class 125; cast-bronze body and cap conforming to ASTM B 62; horizontal or angle pattern, lift-type valve, with stainless steel spring, bronze disc holder with renewable "Teflon" disc, and threaded ends. Provide valves capable of being refitted and ground while the valve remains in the line.

## PART 3 - EXECUTION

### 3.1 EXAMINATION:

- A. Examine valve interior through the end ports for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks used to prevent disc movement during shipping and handling.
- B. Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such actuation. Following examination, return the valve closure member to the shipping position.
- C. Examine threads on both the valve and the mating pipe for form (i.e., out-of-round or local indentation) and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check gasket material for proper size, material and composition suitable for service, and freedom from defects and damage.
- E. Prior to valve installation, examine the piping for cleanliness, freedom from foreign materials, and proper alignment.
- F. Replace defective valves with new valves.

### 3.2 VALVE ENDS SELECTION:

Select valves with the following ends or types of pipe/tube connections:

- A. Copper Tube Size, 2-Inch and Smaller: Solder ends, except provide threaded ends for heating hot water and low-pressure steam service.
- B. Steel Pipe Sizes, 2-Inch and Smaller: threaded or grooved end.
- C. Steel Pipe Sizes 2-1/2 Inch and Larger: grooved end or flanged.

### 3.3 VALVE INSTALLATIONS:

- A. General Applications: Use gate, ball and butterfly valves for shutoff duty; globe, ball, and butterfly valves for throttling duty. Refer to piping system specification sections for specific valve applications and arrangements.

- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.
- D. Install three-valve bypass around each pressure reducing valve using throttling-type valves.
- E. Install valves in horizontal piping with stem at or above the center of the pipe.
- F. Install valves in a position to allow full stem movement.
- G. Installation of Check Valves: Install for proper direction of flow as follows:
  - 1. Swing Check Valves: Horizontal position with hinge pin level.
  - 2. Wafer Check Valves: Horizontal or vertical position, between flanges.
  - 3. Lift Check Valve: With stem upright and plumb.

#### 3.4 SOLDER CONNECTIONS:

- A. Cut tube square and to exact lengths.
- B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket in same manner.
- C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.
- D. Open gate and globe valves to full open position.
- E. Remove the cap and disc holder of swing check valves having composition discs.
- F. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.
- G. Apply heat evenly to outside of valve around joint until solder will melt upon contact. Feed solder until it completely fills the joint around the tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

3.5 THREADED CONNECTIONS:

- A. Note the internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
- B. Align threads at point of assembly.
- C. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
- D. Assemble joint, wrench tight, wrench on valve shall be on the valve end into which the pipe is being threaded.

3.6 FLANGED CONNECTIONS:

- A. Align flange surfaces parallel.
- B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.
- C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.7 FIELD QUALITY CONTROL:

Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.8 ADJUSTING AND CLEANING:

Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

3.9 VALVE PRESSURE/TEMPERATURE CLASSIFICATION SCHEDULES:

- A. VALVES, 2-INCH AND SMALLER

SERVICE \_\_\_\_\_ GATE \_\_\_\_\_ GLOBE \_\_\_\_\_ BALL \_\_\_\_\_ CHECK \_\_\_\_\_

Chilled Water	125	125	150	125
Domestic Hot and Cold Water	125	125	150	125
Heating Hot Water	150	150	150	150

B. VALVES, 2-1/2-INCH AND LARGER

SERVICE	GATE	GLOBE	BALL	CHECK
Chilled Water	125	125	200	125
Domestic Hot and Cold Water	125	125	200	125
Heating Hot Water	125	125	200	125

3.10 VALVE SCHEDULE

A. GATE VALVES (CLASS 125) - 2 INCH AND SMALLER:

MANUFACTURER	THREADED		SOLDER	
	NRS	RS	NRS	RS
Crane	438	428	1701S	1700S
Grinnell 3010SJ	3000	3010	3000SJ	
Hammond	IB645	IB640	IB647	IB635
Jenkins	370	47	1240	1242
Lunkenheimer 2132	2129	2127	2133	
Milwaukee 1149	105	148	115	
Nibco	T113	T111	S113	S111
Powell	507	500	1822	1821
Stockham B-108	B-103	B-100	B-104	

B. GATE VALVES (CLASS 150) - 2 INCH AND SMALLER (“x” means not available):

MANUFACTURER	THREADED		SOLDER	
	NRS	RS	NRS	RS

Crane	x	431UB	x	x
Grinnell	3050	3060	x	x
Hammond	IB637	IB629	x	IB648
Jenkins	x	47U	x	x
Lunkenheimer	3153	3151	3154	3155
Milwaukee	x	1151	x	1169
Nibco	T-136	T-135	S-136	x
Powell	2712	2714	x	1842
Stockham	B-130	B-120	x	B-124

## C. GATE VALVES - 2-1/2 INCH AND LARGER:

<u>MANUFACTURER</u>	<u>OS&amp;Y RS</u>	<u>NRS</u>
Crane	465-1/2	461
Grinnell	6020A	6060A
Hammond	IR1140	IR1138
Jenkins	651A	326
Lunkenheimer	1430	1428
Milwaukee	F-2885	F-2882
Nibco	617-O	F-619
Powell	1793	1787
Stockham	G-623	G-612

## D. BALL VALVES - 1 INCH AND SMALLER ("x" means not available):

<u>MANUFACTURER</u>	<u>THREADED ENDS</u>	<u>SOLDER ENDS</u>
Conbraco (Apollo)	70-100	70-200
Crane	9302	9322
Grinnell	3500	3500SJ
Jamesbury	351	x
Jenkins	900T	902T
Lunkenheimer	708HST	x
Metraflex	IT	IS
Nibco	T-580	S-580
Powell	4210T	x
Stockham	S-216 BR-R-T	S-216 BR-R-S
Watts	B-6000	B-6001

E. BALL VALVES - 1-1/4 INCH TO 2 INCH (For grooved end connections, use Victualic Style 721.):

MANUFACTURER	THREADED	SOLDER
	ENDS	ENDS
Conbraco (Apollo)	82-100	82-200
Grinnell	3810	3810SJ
Nibco	T-590-Y	S-590-Y
Powell	4201R	x
Stockham	S-216 BR-R-T	S-216 BR-R-S
Watts	B-6800	B-6801

F. PLUG VALVES - 2 Inch and Smaller

Lunkenheimer: 454

G. PLUG VALVES - 2-1/2 Inch and Larger:

Powell: 2201.

H. GLOBE VALVES - 2 INCH AND SMALLER:

MANUFACTURER	CLASS 125	CLASS 150	THREADED
	THREADED	SOLDER	
Crane	1	1310	17TF
Grinnell	3210	3210SJ	3240
Hammond	IB440	IB423	IB413T
Jenkins	746	1200	106-A-2
Lunkenheimer	2140	2146	407
Milwaukee	502	1502	590
Nibco	T-211-B	S-211-B	T-235-Y
	T-211-Y	S-211-Y	
Powell	650	1823	150
Stockham	B-16	B-14T	B-22

I. GLOBE VALVES - 2-1/2 INCH AND LARGER (“x” means not available):

STRAIGHT      ANGLE

<u>MANUFACTURER</u>	<u>BODY</u>	<u>BODY</u>
Crane	351	353
Grinnell	6200A	x
Hammond	IR116	IR118
Jenkins	613	x
Lunkenheimer	1123	1124
Milwaukee	F2981	F2986
Nibco	F-718-B	F-818-B
Powell	241	243
Stockham	G-512	G-515

J. BUTTERFLY VALVES - 2-1/2 INCH AND LARGER Grooved Ends (Victaulic Series 300 and 704.):

<u>MANUFACTURER</u>	<u>LEVER</u>	<u>GEAR</u>
Center Line	Series A	Series A
Crane	12	12
Conbraco (Apollo)	6X13X-01	6X13X-02
Grinnell	WC-8209-7	WC-8202-7
Keystone	239	239
Nibco	WD-20103	WD-20105
Powell	1011-DA1	1011-DA1
Stockham	LG-512-DS3E	LG-522-DS3E
Watts	BF-04-111-11	BF-04-111-11

The following are model numbers for lug-type, with nickel-plated ductile iron disc:

<u>MANUFACTURER</u>	<u>LEVER</u>	<u>GEAR</u>
Center Line	Series LT	Series LT
Crane	14	14
Conbraco (Apollo)	6L13X-01	6L13X-02
Grinnell	LC-8209-7	LC-8202-7
Keystone	129	129
Nibco	LD-20103	LD-20105
Powell	5011-DA1	5011-DA1
Stockham	LG-712-DS3E	LG-722-DS3E
Watts	BF-03-111-11	BF-03-111-12

Grooved Ends: Victaulic Series 300 and 704.

The following are model numbers for wafer-type, with aluminum-bronze disc:

<u>MANUFACTURER</u>	<u>LEVER</u>	<u>GEAR</u>
Center Line	Series A	Series A
Crane	42	42
Conbraco (Apollo)	6W14X-01	6W14X-02
Grinnell	WC-8289-7	WC-8282-7
Keystone	239	239
Nibco	WD-20003	WD-20005
Powell	1011-EA1	1011-EA1
Stockham	LG-512-BS3E	LG-522-BS3E
Watts	BF-04-121-11	BF-04-121-12

Grooved Ends: Victaulic Series 300A, 700A, and 703A.

The following are model numbers for lug-type, with aluminum-bronze disc:

<u>MANUFACTURER</u>	<u>LEVER</u>	<u>GEAR</u>
Center Line	Series LT	Series LT
Crane	44	44
Conbraco (Apollo)	6L14X-01	6L14X-02
Grinnell	LC-8289-7	LC-8282-7
Keystone	129	129
Nibco	LD-20003	LD-20005
Powell	5011-BA1	5011-BA1
Stockham	LG-712-BS3E	LG-722-BS3E
Watts	BF-03-121-11	BF-03-121-12

Grooved Ends: Victaulic Series 300A, 700A, and 703A.

K. SWING CHECK VALVES - 2 INCH AND SMALLER:  
CLASS 125 CLASS 150

<u>MANUFACTURER</u>	<u>THREADED</u>	<u>SOLDER</u>	<u>THREADED</u>
Crane	37	1342	137
Grinnell	3300	3300SJ	3320
Hammond	IB940	IB941	IB946
Jenkins	92-A	1222	92-A
Lunkenheimer	2144	2145	230-70
Milwaukee	509	1509	510
Nibco	T-413	S-413	T-433

Powell	578	1825	596
Stockham	B-319	B-309	B-321

For grooved connections, use Victaulic Series 712.

L. SWING CHECK VALVES - 2-1/2 INCH AND LARGER (“X” means not available):

<u>MANUFACTURER</u>	<u>CLASS 125</u>	<u>CLASS175</u>
Crane	373	X
Grinnell	6300A	X
Hammond	IR1124	X
Jenkins	X	729
Kennedy	X	Fig. 126
Lunkenheimer	1790IBBM	X
Milwaukee	F2974	X
Nibco	F-918	X
Powell	559	X
Stockham	G-931	G-940

For grooved connections, use Victaulic Series 712.

M. WAFER CHECK VALVES:

MANUFACTURER

Bell & Gossett:	NS.
Center Line:	CLC.
Metraflex:	Chexx.
Mission:	12HMP.
Stockham:	WG970.
Victaulic:	Series 710/711.

N. LIFT CHECK VALVES - 2 INCH AND SMALLER (“X” means not available):

<u>MANUFACTURER</u>	<u>HORIZONTAL</u>	<u>ANGLE</u>
Hammond	x	IB954
Jenkins	655-A	x
Lunkenheimer	233	x

END OF SECTION

SECTION 15135  
METERS AND GAGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 15 Sections apply to this section:
  - 1. "Basic Mechanical Requirements."
  - 2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY:

- A. This Section includes the following types of meters and gages.
  - 1. Temperature gages and fittings.
  - 2. Pressure gages and fittings.
  - 3. Flow meters.
- B. Meters and gages furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 15 sections.

1.3 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.
- C. Product certificates signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and products' compliance with

specified requirements.

- D. Maintenance data for each type of meter and gage for inclusion in Operating and Maintenance Manuals specified in Division 15 Section "Basic Mechanical Requirements."

#### 1.4 QUALITY ASSURANCE:

- A. UL Compliance: Comply with applicable UL standards pertaining to meters and gages.
- B. ASME and ISA Compliance: Comply with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include but are limited to the following:

- A. Mercury in Glass Thermometers:
  - 1. Marshalltown Instruments, Inc.
  - 2. Trerice (H.O.) Co.
  - 3. Weiss Instruments, Inc.
  - 4. Weksler Instruments.
- B. Direct Mount Filled-System Dial Thermometers
  - 1. Ashcroft Dresser Industries\Instrument Div.
  - 2. Marsh Instrument Co., Unit of General Signal.
  - 3. Trerice (H.O.) Co.
  - 4. Weiss Instruments, Inc.

5. Weksler Instruments.
- C. Remote-Reading Filled-System Dial Thermometers
1. Ametek, U.S. Gauge Div.
  2. Ashcroft Dresser Industries\Instrument Div.
  3. Marsh Instrument Co., Unit of General Signal.
  4. Tel-Tru Manufacturing Co., Inc.
  5. Trerice (H.O.) Co.
  6. Weiss Instruments, Inc.
  7. Weksler Instruments.
- D. Bimetal Dial Thermometers:
1. Ashcroft Dresser Industries\Instrument Div.
  2. Marshalltown Instruments, Inc.
  3. Tel-Tru Manufacturing Co., Inc.
  4. Trerice (H.O.) Co.
  5. Weiss Instruments, Inc.
  6. Weksler Instruments.
- F. Thermometer Wells: Same as for thermometers.
- G. Insertion Dial Thermometers:
1. Ashcroft Dresser Industries\Instrument Div.
  2. Marshalltown Instruments, Inc.
  3. Tel-Tru Manufacturing Co., Inc.
  4. Trerice (H.O.) Co.
  5. Weiss Instruments, Inc.

6. Weksler Instruments.
- H. Pressure Gages:
1. Ametek, U.S. Gauge Div.
  2. Ashcroft Dresser Industries\Instrument Div.
  3. Marsh Instrument Co., Unit of General Signal.
  4. Marshalltown Instruments, Inc.
  5. Trerice (H.O.) Co.
  6. Weiss Instruments, Inc.
  7. Weksler Instruments.
  8. WIKA Instruments Corp.
- I. Pressure Gage Accessories: Same as for pressure gages.
- J. Water Orifice Type Measurement System:
1. Armstrong Pumps
  2. Bell and Gossett, ITT, Fluid Handling Division.
- K. Venturi-Type Flow Measurement System:
1. Armstrong Pumps
  2. Barco Div., Marison Industries.
  3. Gerand Engineering Co.
- L. Pitot Tube-Type Flow Measurement System:
1. Dieterich Standard, A Dover Industries Co.
  2. Taco, Inc.
- M. Window Type Flow Meters:
1. Armstrong Pumps, Inc.

2. Metraflex Co.

N. Test Plugs:

1. MG Piping Products Co.
2. Peterson Equipment Co., Inc.
3. Sisco, A Spedco, Inc. Co.
4. Trerice (H.O.) Co.
5. Watts Regulator Co.

## 2.2 THERMOMETERS, GENERAL:

- A. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.
- B. Scale Range: Temperature ranges for services listed below:
  1. Domestic Hot Water: 30 to 240 deg F with 2 degree scale divisions.
  2. Domestic Cold Water: 0 to 100 deg F with 2 degree scale divisions.
  3. Heating Water: 30 to 300 degree F with 2 degree scale divisions.
  4. Chilled Water: 0 to 100 deg F with 2-degree scale divisions.

## 2.3 MERCURY-IN-GLASS THERMOMETERS:

- A. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9 inches long.
- B. Adjustable Joint: Finished to match case, 180-degree adjustment in horizontal plane, with locking device.
- C. Tube: Red reading, mercury filled, magnifying lens.
- D. Scale: Satin-faced, nonreflective aluminum or brass, for separable socket, length to suit installation.
- E. Stem: Copper plated steel, aluminum or brass, for separable socket, length to suit installation.

#### 2.4 DIRECT-MOUNT FILLED-SYSTEM DIAL THERMOMETERS:

- A. Type: Vapor actuated, universal angle.
- B. Case: Drawn steel or cast aluminum, glass lens, 4-1/2 inch diameter.
- C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
- D. Thermal Bulb: Copper with phosphor bronze bourdon pressure tube.
- E. Movement: Brass, precision geared.
- F. Scale: Progressive, satin-faced, nonreflective aluminum, permanently etched markings.
- G. Stem: Copper plated steel, aluminum, or brass, for separable socket, length to suit installation.

#### 2.5 BIMETAL DIAL THERMOMETERS:

- A. Type: Direct mounted, bimetal, universal angle.
- B. Case: Stainless steel, glass lens, 5 inch diameter.
- C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
- D. Element: Bimetal coil.
- E. Scale: Satin-faced, nonreflective aluminum, permanently etched marking.
- F. Stem: Stainless steel for separable socket, length to suit installation.

#### 2.6 REMOTE READING FILLED SYSTEM DIAL THERMOMETERS:

- A. Type: Vapor actuated.
- B. Case: Drawn steel or cast aluminum, glass lens, 4-1/2 inch diameter.
- C. Movement: Brass, precision geared.
- D. Scale: Progressive, satin-faced, nonreflective aluminum, permanently etched

marking.

- E. Tubing: Bronze double-braided armor over copper capillary, length to suit installation.
- F. Bulb: Copper with separable socket for liquids, averaging element for air.

## 2.7 BIMETAL DIAL THERMOMETERS:

- A. Type: Direct mounted, bimetal, universal angle.
- B. Case: Stainless steel, glass lens, 5 inch diameter.
- C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
- D. Element: Bimetal coil.
- E. Scale: Satin-faced, nonreflective aluminum, permanently etched marking.
- F. Stem: Stainless steel for separable socket, length to suit installation.

## 2.8 DIAL TYPE INSERTION THERMOMETERS:

Type: Bimetal, stainless steel case and stem, 1-inch-diameter dial, dust- and leakproof, 1/8-inch-diameter tapered-end stem with nominal length of 5 inches..

## 2.9 THERMOMETER WELLS:

Thermometer wells: Brass or stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

## 2.10 PRESSURE GAGES:

- A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection.
- B. Case: Drawn steel or brass, glass lens, 4-1/2-inches diameter.
- C. Connector: Brass, 1/4" NPS.
- D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1 percent of range span.

F. Range: Conform to the following:

1. Vacuum 30 inches Hg to 15 psi.
2. All fluids: 2 times operating pressure.

#### 2.11 PRESSURE GAGE ACCESSORIES:

- A. Syphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.
- B. Snubber: 1/4 inch NPS brass bushing with corrosion resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

#### 2.12 FLOW METERS, GENERAL:

Flow rate of elements and meters shall be same as connected equipment or system.

#### 2.13 WAFER ORIFICE-TYPE FLOW ELEMENTS:

- A. Type: Differential-pressure wafer type orifice insert flow elements designed for installation between pipe flanges.
- B. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate. Elements shall be pressure rated for 300 psig and 250 deg.F (120 deg C).

#### 2.14 VENTURI-TYPE FLOW ELEMENTS:

- A. Type: Differential-pressure venturi type, designed for installation in piping.
- B. Construction: Bronze or cadmium plated steel with brass fittings and attached tag with flow conversion data. Ends shall be threaded for 2 inches and smaller elements and flanged or welded for 2-1/2 inches and larger elements.

#### 2.15 PITOT TUBE-TYPE FLOW ELEMENTS:

- A. Type: Differential-pressure pitot tube-type, design with probe for insertion into piping.

- B. Construction: Stainless steel probe of length to span inside of pipe, with brass fittings and attached tag with flow conversion data. Elements shall be pressure rated for 150 psig and 250 deg F (120 deg C).

#### 2.16 METERS:

- A. Permanently Mounted Meters: Suitable for mounting on wall or bracket, 6-inch dial or equivalent with fittings and copper tubing for connecting to flow element.
  - 1. Scale shall be in gpm unless otherwise indicated.
  - 2. Accuracy: Plus or minus 1 percent between 20 to 80 percent of range.
- B. Portable Meters: Differential-pressure gage and two 12-foot hoses in carrying case with handle.
  - 1. Scale: In inches of water unless otherwise indicated.
  - 2. Accuracy: Plus or minus 2 percent between 20 to 80 percent of range.
- C. Each meter shall be complete with operating instructions.

#### 2.17 WINDOW TYPE FLOW METERS:

- A. Type: Window type flow meters designed for installation on hydronic piping and measure flow directly in gpm.
- B. Construction: Bronze body and impact tube, integral self-closing valve, glass calibrated tube with indicator ball, and protection shield. Meters shall be pressure rated for 150 psig and temperature rated for 240 deg F.
- C. Accuracy: Plus or minus 5 percent.

#### 2.18 TEST PLUGS:

- A. Test Plugs shall be nickel plated brass body, with 1/2-inch NPS fitting and 2 self sealing valve type core inserts, suitable for inserting a 1/8-inch O.D. probe assembly from a dial-type thermometer or pressure gage. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating to be 500 psig.
- B. Core Material: Conform to the following for fluid and temperature range:

1. Air, Water, Oil, and Gas, 20 deg to 200 deg. F (minus 7 to 93 deg C): Neoprene.
  2. Air and Water, minus 30 deg to 275 deg. F (minus 35 to 136 deg C): EPDM.
- C. Test Kit: Provide test kit consisting of 1 pressure gage, gage adapter with probe, 2 bimetal dial thermometers, and carrying case.
- D. Ranges of pressure gage and thermometers shall be approximately 2 times systems operating conditions.

### PART 3 - EXECUTION

#### 3.1 THERMOMETERS INSTALLATION:

- A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.
- B. Install in the following locations and elsewhere as indicated:
1. At inlet and outlet of each hydronic boiler and chiller.
  2. At inlet and outlet of each hydronic coil in air handling units and built-up central systems.
  3. At inlet and outlet of each thermal storage tank.
- C. Remote-Reading Dial Thermometers: Install in control panels, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.
- D. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

#### 3.2 INSTALLATION OF PRESSURE GAGES:

- A. Install pressure gages in piping tee with pressure gage valve, located on pipe at most readable position.
- B. Install in the following locations, and elsewhere as indicated:

1. At suction and discharge of each pump.
  2. At discharge of each pressure reducing valve.
  3. At building water service entrance.
  4. At chilled water inlets and outlets of chillers.
- C. Pressure Gage Needle Valves: Install in piping tee with snubber.

### 3.3 INSTALLATION OF TEST PLUGS:

Test Plugs: Install in piping tee where indicated, located in accessible locations at most readable position. Secure cap.

### 3.4 INSTALLATION OF FLOW MEASURING ELEMENTS AND METERS:

- A. General: Install flow meters for piping systems located in accessible locations at most readable position.
- B. Locations: Install flow meters in the following locations and elsewhere as indicated:
1. At discharge of each pump.
  2. At inlet of each hydronic coil in built-up central systems.
- C. Differential-Pressure-Type Flow Elements: Install minimum straight lengths of pipe upstream and downstream from element as prescribed by the manufacturer's installation instructions.
- D. Install wafer orifice -type element between 2 Class 125 pipe flanges, ANSI B16.1 (cast iron) or ANSI B16.24 (bronze).
- E. Install connections for attachment to portable flow meters in a readily accessible location.
- F. Meters for Use With Flow Elements: Install meters on wall or bracket in accessible location.
- G. Install connections, tubing, and accessories between flow elements and meters as prescribed by the manufacturer's installation instructions.
- H. Window Flow Meters: Install in vertical upward position with impact tube

mounted in bushing centered on pipe with 10 pipe diameters upstream and 5 pipe diameters downstream of straight unrestricted piping for 1-1/4 inches and smaller, 20 pipe diameters upstream and 10 pipe diameters downstream for 1-1/2 inches and larger. Calibrate meter after installation in accordance with manufacturer's installation instructions.

### 3.5 ADJUSTING AND CLEANING:

- A. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.
- B. Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.

### 3.6 CONNECTIONS:

Piping installation requirements are specified in other sections of Division 15. The drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements: Install meters and gages piping adjacent to machine to allow servicing and maintaining of machine.

END OF SECTION

## SECTION 15145

## HANGERS AND SUPPORTS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

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

## 1.2 SUMMARY:

- A. This section includes hangers and supports for mechanical systems piping and equipment.
- B. Related sections: The following sections contain requirements that relate to this Section: Division 5 Section "Metal Fabrications" for materials for anchoring piping systems to building structure.

## 1.3 DEFINITIONS:

Terminology used in this section is defined in MSS SP-90.

## 1.4 SUBMITTALS:

- A. General: Submit the following in accordance with conditions of contract and Division 1 Specification Sections.
- B. Product data for each type of hanger and support.
- C. Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support.
- D. Welder certificates signed by the Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.
- E. Shop drawings for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly.

## 1.5 QUALITY ASSURANCE:

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel." Certify that each welder has satisfactorily passed AWS qualification test for welding processes involved and, if pertinent, has undergone recertification.
- B. Qualify welding processes and welding operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- C. NFPA Compliance: Comply with NFPA Standard No. 13 for hangers and supports used as a component of fire protection systems.
- D. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70, Article 100.
  - 1. UL and FM Compliance: Hangers, supports, and components shall be listed and labeled by UL and FM where used for fire protection piping systems.
  - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- E. Licensed operators: Use operators that are licensed by powder-operated tool manufacturers to operate their tools and fasteners.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURED UNITS:

- A. Hangers, Supports and Components: Factory fabricated according to MSS SP-58.
  - 1. Components include galvanized coatings where installed for piping and equipment that will not have a field applied finish.
  - 2. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Thermal Hanger Shield Inserts: 100-psi (690kPa) average compressive strength, waterproofed calcium silicate, encased with a sheet metal shield. Insert and shield shall cover entire circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

- C. Powder-Actuated drive-Pin Fasteners: Powder actuated type, drive pin attachments with pull out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.
- D. Mechanical-Anchor Fasteners: Insert type attachment with pull out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

## 2.2 MISCELLANEOUS MATERIALS:

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex-head, track bolts and nuts.
- C. Washers: ASTM F 844, steel, plain, flat washers.
- D. Grout: ASTM C1100, Grade B, nonshrink, nonmetallic.
  - 1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is nonstaining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
  - 2. Design Mix: 5000-psi (34.5MPa), 28-day compressive strength.
  - 3. Water: Potable.
  - 4. Packaging: Premixed and factory-packaged.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT APPLICATIONS:

- A. Specific hanger requirements are specified in the Section specifying the equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping specification Sections.

### 3.2 HANGER AND SUPPORT INSTALLATION:

- A. General: Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.
- C. Install supports with maximum spacings complying with MSS SP-69.
- D. Where pipes of various sizes are supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
- F. Install building attachments within concrete or to structural steel. Space attachments within maximum pipe span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Install reinforcing bars through openings at top of inserts.
- G. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer's operating manual. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches (100 mm) thick.
- H. Install mechanical-anchor fasteners in concrete after concrete after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches (100 mm) thick.
- I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- J. Heavy Duty Steel Trapezes: Field fabricate from ASTM A 36 steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- K. Support fire protection systems piping independently from other piping systems.
- L. Install hangers and supports to allow controlled 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.
- M. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected

equipment.

- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.
- O. Insulated Piping: Comply with the following installation requirements:

- 1. Clamps: Attach galvanized clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
- 2. Saddles: Install galvanized protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
- 3. Shields: Install galvanized protective shields MSS Type 40 on cold and chilled water piping that has vapor barrier. Shields shall span an arc of 180 degrees and shall have dimensions in inches not less than the following:

NPS (Inches) (Inches)	LENGTH (Inches)	THICKNESS
1/4 to 3-1/2	12	0.048
4	12	0.060
5 and 6	18	0.060
8 and 14	24	0.075
16 to 24	24	0.105

- 4. Pipes 8 Inches (200 mm) and Larger: Include wood inserts.
- 5. Insert Material: Length at least as long as the protective shield.
- 6. Thermal-Hanger Shields: Install where indicated, with insulation of same thickness as piping.

3.3 EQUIPMENT SUPPORTS:

- A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
- B. Grouting: Place grout under supports for piping and equipment.

3.4 METAL FABRICATION:

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.
- 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 for procedures of manual shielded metal arc welding, appearance and quality of welds made, methods used in correcting welding work, and 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 that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

### 3.5 ADJUSTING:

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

### 3.6 PAINTING:

- A. Touching Up: Clean field welds and abraded areas of shop paint and paint exposed areas immediately after erection of hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of the shop paint on miscellaneous metal is specified in Division 9 section "Painting".
- C. Galvanized surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

END OF SECTION

## SECTION 15170

## MOTORS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

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

## 1.2 SUMMARY:

This section specifies the basic requirements for motors. It includes motors that are factory installed as part of equipment and appliances as well as field installed motors.

## 1.3 QUALITY ASSURANCE:

- A. Comply with NFPA 70, "National Electrical Code".
- B. NRTL Listing: Provide NRTL listed motors.
  - 1. Term "Listed": As defined in "National Electrical Code," Article 100
  - 2. Listing Agency Qualifications: "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7..
- C. Comply with NEMA MG 1: "Motors and Generators."
- D. Comply with UL 1004: "Motors, Electric."

## PART 2 - PRODUCTS

## 2.1 MOTORS, GENERAL:

- A. General: Requirements below apply to motors covered by this Section except as otherwise indicated.
- B. Motors 3/4 HP and Larger: Polyphase.

- C. Motors Smaller than 3/4 HP: Single phase.
- D. Frequency Rating: 60 Hz.
- E. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (Utilization voltages):
  - 1. 120 V Circuit: 115 V - motor rating.
  - 2. 208 V Circuit: 200 V - motor rating.
- F. Capacity: Sufficient to start and operate connected loads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings. Provide motors rated for continuous duty at 100 percent of rated capacity.
- G. Temperature Rise: Based on 40 deg. C ambient except as otherwise noted.
- H. Enclosure: Totally Enclosed, Fan Cooled (TEFC)

## 2.2 POLYPHASE MOTORS:

- A. General: Squirrel-cage induction-type conforming to the following requirements except as otherwise indicated.
- B. NEMA Design Letter Designation: "B."
- C. Multi-Speed Motors: Separate winding for each speed.
- D. Energy Efficient Motors: Nominal efficiency equal to or greater than that stated in NEMA MG 1, table 12-6B for that type and rating of motor.
- E. Energy Efficient Motors: Nominal efficiency equal to or greater than that stated in NEMA MG 1, table 12-6C for that type and rating of motor.
- F. Internal Thermal Overload Protection For Motors: For motors so indicated, protection automatically opens control circuit arranged for external connection. Protection operates when winding temperature exceeds safe value calibrated to the temperature rating of the motor insulation.
- G. Bearings: Double shielded, pre-lubricated ball bearings suitable for radial and thrust loading of the application.
- H. Rugged Duty Motors: Totally enclosed with 1.25 minimum service factor.

Provide motors with re-greasable bearings and equipped with capped relief vents. Insulate windings with non-hygroscopic material. External finish shall be chemical resistant primer. Provide integral condensate drains.

- I. Motors for Reduced Inrush Starting: Coordinate with indicated reduced inrush controller type and with characteristics of driven equipment load. Provide required wiring leads in motor terminal box to suit control method.

## 2.3 SINGLE PHASE MOTORS:

- A. General: Conform to the following requirements except as otherwise indicated.
- B. Energy Efficient Motors: One of the following types as selected to suit the starting torque and other requirements of the specific motor application.
  - 1. Permanent Split Capacitor.
  - 2. Split-Phase Start, Capacitor Run.
  - 3. Capacitor-Start, Capacitor-Run.
- C. Shaded-Pole Motors: Use only for motors smaller than 1/20 hp.
- D. Internal Thermal Overload Protection For Motors: For motors so indicated, protection automatically opens the power supply circuit to the motor, or a control circuit arranged for external connection. Protection operates when winding temperature exceeds a safe value calibrated to the temperature rating of the motor insulation. Provide device that automatically resets when motor temperature returns to normal range except as otherwise indicated.
- E. Bearings, belt connected motors and other motors with high radial forces on motor shaft shall be ball bearing type. Sealed, pre-lubricated sleeve bearings may be used for other single-phase motors.

## PART 3 - EXECUTION

### 3.1 INSTALLATION:

- A. General: The following requirements apply to field-installed motors.
- B. Install motors in accordance with manufacturer's published instructions and the following:

1. Direct Connected Motors: Mount securely in accurate alignment.
2. Belt Drive Motors: Use adjustable motor mounting bases. Align pulleys and install belts. Use belts identified by the manufacturer and tension belts in accordance with manufacturer's recommendations.

### 3.2 COMMISSIONING:

- A. Check operating motors, both factory and field installed, for unusual conditions during normal operation. Coordinate with the commissioning of the equipment for which motor is a part.
- B. Report unusual conditions.
- C. Correct deficiencies of field installed units.

END OF SECTION

## SECTION 15250

## MECHANICAL INSULATION

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

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

## 1.2 SUMMARY:

- A. This Section includes pipe, duct, and equipment insulation:
- B. Related Sections: The following sections contain requirements that relate to this section:
  - 1. Division 15 Section "Supports and Anchors" for pipe insulation shields and protection saddles.
  - 2. Division 15 section "Metal Ductwork" for duct lining.

## 1.3 DEFINITIONS:

- A. Hot Surfaces: Normal operating temperatures of 100 deg F or higher.
- B. Dual Temperature Surfaces: Normal operating temperatures that vary from hot to cold.
- C. Cold Surfaces: Normal operating temperatures less than 75 deg F.
- D. Thermal Resistivity: "r-values" represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogeneous material exactly 1 inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between two exposed faces required to cause one BTU to flow through one square foot of material, in one hour, at a given mean temperature.
- E. Density: Is expressed in lb/sq.ft.

#### 1.4 SUBMITTALS:

General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

- A. Product data for each type of mechanical insulation identifying, k-value, thickness, and accessories.
- B. Samples of each type of insulation and jacket. Identify each sample describing product and intended use. Submit the following sizes of sample materials.
  - 1. Block and Board Insulation: 12-inch square section.
  - 2. Pre-Formed Pipe Insulation: 12 inches long, 2-inch NPS.
- C. Material certificates, signed by the manufacturer, certifying that materials comply with specified requirements where laboratory test reports cannot be obtained.
- D. Material test reports prepared by a qualified independent testing laboratory. Certify insulation meets specified requirements.

#### 1.5 QUALITY ASSURANCE:

- A. Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.
  - 1. Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.
  - 2. Exterior Insulation: Flame spread rating of 75 or less and a smoke developed rating of 150 or less.
- B. Accessories such as adhesives, mastics, tapes, and cements shall have the same component ratings as listed herein above.

#### 1.6 SEQUENCING AND SCHEDULING:

- A. Schedule insulation application after testing of piping and duct systems.
- B. Schedule insulation application after installation and testing of heat trace tape.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS:

Available Manufacturers: Subject to compliance with the requirements, manufacturer's offering products that may be incorporated in the Work include, but are limited to the following:

- A. Glass Fiber:
  - 1. CertainTeed Corp.
  - 2. Knauf Fiber Glass GmbH.
  - 3. Manville.
  - 4. Owens-Corning Fiberglas Corp.
- B. Cellular Glass: Pittsburgh Corning Corp.
- C. Flexible Elastomeric Cellular:
  - 1. Armstrong World industries, Inc.
  - 2. Halstead Industrial Products.
  - 3. IMCOA.
  - 4. Rubatex Corporation.
- D. Calcium Silicate:
  - 1. Manville.
  - 2. Owens-Corning Fiberglas Corp.

### 2.2 GLASS FIBER:

- A. Material: Inorganic glass fibers, bonded with a thermosetting resin.
- B. Jacket: All purpose, factory-applied, laminated glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil having self sealing lap.

- C. Board: ASTM C 612, Class 2, semi-rigid jacketed board.
  - 1. Thermal Conductivity: 0.26 average maximum, at 75 deg F mean temperature.
  - 2. Density: 12 pcf average maximum.
- D. Blanket: ASTM C 553, Type II, Class F-1, jacketed flexible blankets. Thermal Conductivity: 0.32 average maximum, at 75 deg F mean temperature.
- E. Preformed Pipe Insulation: ASTM C 547, Class 1, rigid pipe insulation, jacketed.
  - 1. Thermal Conductivity: 0.26 average maximum, at 75 deg F mean temperature.
  - 2. Density: 10 pcf average maximum.
- F. Adhesive: Produced under the UL Classification and Follow-up service.
  - 1. Type: Non-flammable, solvent-based.
  - 2. Service Temperature Range: Minus 20 to 180 deg F.
- G. Vapor Barrier Coating: Waterproof coating recommended by insulation manufacturer for outside service.

### 2.3 CELLULAR GLASS:

- A. Material: Inorganic foamed or cellulated glass, annealed, rigid, hermetically sealed cells, incombustible.
- B. Facing: ASTM C 921, Type 1, factory-applied, laminated foil, flame retardant, vinyl facing.
- C. Form: The following as indicated:
  - 1. Blocks: ASTM C 552, Type I.
  - 2. Boards: ASTM C 552, Type IV.
  - 3. Preformed Pipe: ASTM C 552, Type II, Class 2 (jacketed).
  - 4. Special Shapes: ASTM C 552, Type III, in shapes and thicknesses as indicated.

- D. Thermal Conductivity: 0.38 average maximum, at 75 deg F mean temperature.
- E. Minimum Density: 7 pcf.
- F. Maximum Density: 9.5 pcf.

#### 2.4 FLEXIBLE ELASTOMERIC CELLULAR:

- A. Material: Flexible expanded closed-cell structure with smooth skin on both sides.
  - 1. Tubular Materials: ASTM C 534, Type I.
  - 2. Sheet Materials: ASTM C 534, Type II.
- B. Thermal Conductivity: 0.30 average maximum, at 75 deg F.
- C. Coating: Water based latex enamel coating recommended by insulation manufacturer.

#### 2.5 CALCIUM SILICATE:

- A. Material: ASTM C533, Type I; inorganic, hydrous calcium silicate, non-asbestos fibrous reinforcement.
- B. Form: Molded flat block, curved block, grooved block, and preformed pipe sections as appropriate for surface.
- C. Thermal Conductivity: 0.60 at 500 deg F.
- D. Dry Density: 15.0 pcf maximum.
- E. Compressive Strength: 60 psi minimum at 5 percent deformation.
- F. Fire Performance Characteristics: Provide materials identical to those whose fire performance characteristics have been determined, per test method indicated below, by UL or other testing and inspecting organization acceptable to authorities having jurisdiction.
  - 1. Test Method: ASTM E 84.
  - 2. Flame Spread: 0.
  - 3. Smoke Developed: 0

## 2.6 INSULATING CEMENTS:

- A. Mineral Fiber: ASTM C 195.
  - 1. Thermal Conductivity: 1.00 average maximum at 500 deg F mean temperature.
  - 2. Compressive Strength: 10 psi minimum at 5 percent deformation.
- B. Expanded or Exfoliated Vermiculite: ASTM C 196.
  - 1. Thermal Conductivity: 1.10 average maximum at 500 deg F mean temperature.
  - 2. Compressive Strength: 5 psi minimum at 5 percent deformation.
- C. Mineral Fiber, Hydraulic-Setting Insulating and Finishing Cement: ASTM C 449.
  - 1. Thermal Conductivity: 1.20 average maximum at 400 deg F mean temperature.
  - 2. Compressive Strength: 100 psi minimum at 5 percent deformation.

## 2.7 ADHESIVES:

- A. Flexible Elastomeric Cellular Insulation Adhesive: Solvent-based, contact adhesive recommended by insulation manufacturer.
- B. Lagging Adhesive: MIL-A-3316C, non-flammable adhesive in the following Classes and Grades:
  - 1. Class 1, Grade A for bonding glass cloth and tape to unfaced glass fiber insulation, sealing ridges of glass fiber insulation, and bonding lagging cloth to unfaced glass fiber insulation.
  - 2. Class 2, Grade A for bonding glass fiber insulation to metal surfaces.

## 2.8 JACKETS:

- A. General: ASTM C 921, Type 1, except as otherwise indicated.
- B. Foil and Paper Jacket: Laminated glass-fiber-reinforced, flame retardant kraft paper and aluminum foil.

1. Water Vapor Permeance: 0.02 perm maximum, when tested according to ASTM E 96.
  2. Puncture Resistance: 50 beach units minimum, when tested according to ASTM D 781.
- C. PVC Jacketing: High impact, ultra-violet-resistant PVC, 20 mils thick, roll stock ready for shop or field cutting and forming to indicated sizes. Adhesive: As recommended by insulation manufacturer.
- D. PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20 mil thick, high impact, ultra-violet-resistant PVC. Adhesive: As recommended by insulation manufacturer.
- E. Aluminum Jacket: ASTM B 209, 3003 Alloy, H-14 temper, factory cut and rolled to indicated sizes.
1. Finish and Thickness: Smooth finish, 0.010 inch thick.
  2. Moisture Barrier: 1-mil, heat-bonded polyethylene and kraft paper
  3. Elbows: Preformed 45-degree and 90-degree, short-and long-radius elbows, same material, finish, and thickness as jacket.

## 2.9 ACCESSORIES AND ATTACHMENTS:

- A. Glass Cloth and Tape: Woven glass fiber fabrics, plain weave, presized a minimum of 8 ounces per yard.
1. Tape Width: 4 inches.
  2. Cloth Standard: MIL-C-20079H, Type I.
  3. Tape Standard: MIL-C-20079H, Type II
- B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
1. Stainless Steel: Type 304, 0.020 inch thick.
  2. Galvanized Steel: 0.005 inch thick.
  3. Aluminum: 0.007 inch thick.
  4. Brass: 0.01 inch thick.

5. Nickel-Copper Alloy: 0.005 inch thick.
- C. Wire: 14-gage nickel copper alloy, 16-gage, soft-annealed stainless steel, or 16-gage, soft annealed galvanized steel.
- D. Corner Angles: 28-gage, 1-inch aluminum, adhered to 2-inch by 2-inch kraft paper.
- E. Anchor Pins: Capable of supporting 20 pounds each. Provide anchor pins and speed washers of sizes and diameters as recommended by the manufacturer for insulation type and thickness.

#### 2.10 SEALING COMPOUNDS:

- A. Vapor Barrier Compound: Water-based, fire resistive composition.
  1. Water Vapor Permeance: 0.08 perm maximum.
  2. Temperature Range: Minus 20 to 180 deg. F.
- B. Weatherproof Sealant: Flexible-elastomeric-based, vapor-barrier sealant designed to seal metal joints.
  1. Water Vapor Permeance: 0.02 perm maximum.
  2. Temperature Range: Minus 50 to 250 deg. F.
  3. Color: Aluminum.

### PART 3 - EXECUTION

#### 3.1 PREPARATION:

- A. Surface preparation: Clean, dry, and remove foreign materials such as rust, scale, and dirt.
- B. Mix insulating cements with clean potable water. Mix insulating cements contacting stainless-steel surfaces with de-mineralized water. Follow cement manufacturer's printed instructions for mixing and portions.

#### 3.2 INSTALLATION, GENERAL:

- A. Refer to schedules at end of this Section for materials, forms, jackets, and thicknesses required for each mechanical system.
- B. Select accessories compatible with materials suitable for the service. Select accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either the wet or dry state.
- C. Install vapor barriers on insulated pipes, ducts, and equipment having surface operating temperatures below 60 deg. F.
- D. Apply insulation material, accessories, and finishes according to the manufacturer's printed instructions.
- E. Install insulation with smooth, straight, and even surfaces.
- F. Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.
- G. Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.
- H. Seal Ends: Except for flexible elastomeric insulation, taper ends at 45 degree angle and seal with lagging adhesive. Cut ends of flexible elastomeric cellular insulation square and seal with adhesive.
- I. Apply adhesives and coatings at manufacturer's recommended coverage-per-gallon rate.
- J. Keep insulation materials dry during application and finishing.
- K. Items Not Insulated: Unless otherwise indicated do not apply insulation to the following systems, materials, and equipment:
  - 1. Fibrous glass ducts.
  - 2. Metal ducts with duct liner.
  - 3. Factory-insulated flexible ducts.
  - 4. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
  - 5. Flexible connectors for ducts and pipes.
  - 6. Vibration control devices.

7. Testing laboratory labels and stamps.
8. Nameplates and data plates.
9. Access panels and doors in air distribution systems.
10. Fire protection-piping systems.
11. Sanitary drainage and vent piping.
12. Drainage piping located in crawl spaces, unless indicated otherwise.
13. Below grade piping.
14. Chrome-plated pipes and fittings, except for plumbing fixtures for the disabled.
15. Piping specialties including air chambers, unions, strainers, check valves, plug valves, and flow regulators.

### 3.3 PIPE INSULATION INSTALLATION, GENERAL:

- A. Tightly butt longitudinal seams and end joints. Bond with adhesive.
- B. Stagger joints on double layers of insulation.
- C. Apply insulation continuously over fittings, valves, and specialties, except as otherwise indicated.
- D. Apply insulation with a minimum number of joints.
- E. Apply insulation with integral jackets as follows:
  1. Pull jacket tight and smooth.
  2. Cover circumferential joints with butt strips, at least 3-inches wide, and of same material as insulation jacket. Secure with adhesive and outward clinching staples along both edges of butt strip and space 4 inches on center.
  3. Longitudinal Seams: Overlap seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staple along edge at 4 inches on center. Exception: Do not staple

longitudinal laps on insulation applied to piping systems with surface temperature at or below 35 deg F.

4. Vapor Barrier Coatings: Where vapor barriers are indicated, apply on seams and joints, over staples, and at ends butt to flanges, unions, valves, and fittings.
  5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor barrier coating.
  6. Repair damaged insulation jackets, except metal jackets, by applying jacket material around damaged jacket. Adhere, staple, and seal. Extend patch at least 2 inches in both directions beyond damaged insulation jacket and around the entire circumference of the pipe.
- F. Roof Penetrations: Apply insulation for interior applications to a point even with the top of the roof flashing. Seal with vapor barrier coating. Apply insulation for exterior applications butted tightly to interior insulation ends. Extend metal jacket for exterior insulation outside roof flashing at least 2 inches below top of roof flashing. Seal metal jacket to roof flashing with vapor barrier coating.
- G. Exterior Wall Penetrations: For penetrations of below grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor barrier coating.
- H. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except for fire-rated walls and partitions. Apply an aluminum jacket with factory-applied moisture barrier over insulation. Extend 2 inches from both surfaces of wall or partition. Secure aluminum jacket with metal bands at both ends. Seal ends of jacket with vapor barrier coating. Seal around penetration with joint sealer. Refer to Division 7 "Joint Sealants."
- I. Fire-Rated Wall and Partition Penetrations: Terminate insulation at penetrations through fire-rated walls and partitions. Seal insulation ends with vapor barrier coating. Seal around penetration with firestopping or fire-resistant joint sealer. Refer to Division 7 for firestopping and fire-resistant joint sealers.
- J. Floor Penetrations: Terminate insulation underside of floor assembly and at floor support at top of floor.
- K. Flanges, Fittings, and Valves - Interior, Exposed and Concealed: Coat pipe insulation ends with vapor barrier coating. Apply premolded, precut, or field-fabricated segments of insulation around flanges, unions, valves, and fittings. Make joints tight. Bond with adhesive.
1. Use same material and thickness as adjacent pipe.

2. Overlap nesting insulation by 2 inches or 1-pipe diameter, whichever is greater.
  3. Apply materials with adhesive, fill voids with mineral fiber insulating cement. Secure with wire or tape.
  4. Insulate elbows and tees smaller than 3-inch pipe size with premolded insulation.
  5. Insulate elbows and tees 3 inches and larger with premolded insulation or insulation material segments. Use at least 3 segments for each elbow.
  6. Cover insulation, except for metal jacketed insulation, with 2 layers of lagging adhesive to a minimum thickness of 1/16 inch. Install glass cloth between layers. Overlap adjacent insulation by 2 inches in both directions from joint with glass cloth and lagging adhesive.
- L. Hangers and Anchors: Apply insulation continuously through hangers and around anchor attachments. Install saddles, shields, and inserts as specified in Division 15 Section "Supports and Anchors." For cold surface piping, extend insulation on anchor legs a minimum of 12 inches and taper and seal insulation ends. Inserts and Shields: Cover hanger inserts and shields with jacket material adjacent to pipe insulation.

#### 3.4 BELOW GRADE PIPE INSULATION INSTALLATION:

- A. General: The following are additional requirements for insulation applied to piping installed below ground.
- B. Coat bore surfaces of insulation materials with insulating cement of type recommended by insulation manufacturer. Apply enough cement to fill surface cells. Do not use adhesive for this coating.
- C. Secure insulation with a minimum of 2 stainless-steel bands for each section of insulation.
- D. Terminate insulation at anchor blocks.
- E. Apply insulation continuously through sleeves and manholes, except as specified above for exterior wall penetrations.
- F. Finishing: Apply 3 coats of asphaltic mastic to a finish thickness of 3/16 inch over insulation materials. Apply 10 x 10 mesh glass cloth between coats. Overlap edges of glass cloth by 2 inches.

### 3.5 GLASS FIBER PIPE INSULATION INSTALLATION:

- A. Bond insulation to pipe with lagging adhesive.
- B. Seal exposed edges with lagging adhesive.
- C. Seal seams and joints with vapor barrier compound

### 3.6 CELLULAR GLASS PIPE INSULATION INSTALLATION:

Cellular Glass Insulation: Join sections of cellular glass insulation with vapor barrier compound. Secure insulation with manufacturer's recommended adhesive. Seal joints with manufacturer's recommended joint sealer.

- A. Multiple Layer Installations: Stagger joints of multilayer installations. Secure inner layer with glass fiber reinforced tape. Secure inner layer with glass fiber reinforced tape. Secure outer layers with 2 metal bands for each insulation section.
- B. Finishing: Apply manufacturer's recommended weather barrier mastic.
- C. Finishing: Apply metal jacket over manufacturer's recommended vapor barrier mastic.

### 3.7 FLEXIBLE ELASTOMERIC CELLULAR PIPE INSULATION INSTALLATION:

- A. Slip insulation on the pipe before making connections wherever possible. Seal joints with adhesive. Where the slip-on technique is not possible, cut one side longitudinally and apply to the pipe. Seal seams and joints with adhesive.
- B. Valves, Fittings, and Flanges: Cut insulation segments from pipe or sheet insulation. Bond to valve, fitting, and flange and seal joints with adhesive.
  - 1. Miter cut materials to cover soldered elbows and tees.
  - 2. Fabricate sleeve fitting covers from flexible elastomeric cellular insulation for screwed valves, fittings, and specialties. Miter cut materials. Overlap adjoining pipe insulation.

### 3.8 CALCIUM SILICATE PIPE INSULATION INSTALLATION:

- A. Secure insulation with stainless steel bands spaced at 12-inch intervals.

- B. Apply 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 16-gage soft-annealed stainless-steel wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
- C. Finishing: Apply a skim coat of mineral fiber, hydraulic-setting cement to surface of installed insulation. When dry, apply flood coat of lagging adhesive and press on 1 layer of glass cloth or glass tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth finish.
- D. Metal Jacket: Where indicated, apply metal jacket over finished insulation as specified in this Section for installation of metal jackets.

### 3.9 EQUIPMENT INSULATION INSTALLATION, GENERAL:

- A. Install board and block materials with a minimum dimension of 12 inches and a maximum dimension of 48 inches.
- B. Groove and score insulation materials as required to fit as closely as possible to the equipment and to fit contours of equipment. Stagger end joints.
- C. Insulation Thicknesses Greater than 2 Inches: Install insulation in multiple layers with staggered joints.
- D. Bevel insulation edges for cylindrical surfaces for tight joint.
- E. Secure sections of insulation in place with wire or bands spaced at 9-inch centers, except for flexible elastomeric cellular insulation.
- F. Protect exposed corners with corner angles under wires and bands.
- G. Manholes, Handholes, and Information Plates: Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
- H. Removable Insulation: Install insulation on components that require periodic inspecting, cleaning, and repairing for easy removal and replacement without damage to adjacent insulation.
- I. Finishing: Except for flexible elastomeric cellular insulation, apply 2 coats of vapor barrier compound to a minimum thickness of 1/16 inch. Install a layer of glass cloth embedded between layers.

### 3.10 GLASS FIBER EQUIPMENT INSULATION INSTALLATION:

- A. Secure insulation with anchor pins and speed washers.
- B. Space anchors at maximum intervals of 18 inches in both directions and not more than 3 inches from edge.
- C. Apply a smoothing coat of insulating and finishing cement to finished insulation.

### 3.11 CELLULAR GLASS EQUIPMENT INSULATION INSTALLATION:

- A. Join sections of insulation with vapor barrier compound.
- B. Secure insulation with manufacturer's recommended adhesive. Seal joints with manufacturer's recommended joint sealer.
- C. Secure inner layer of multiple layer installations with glass fiber reinforced tape. Secure outer layers with 2 metal bands for each insulation section.

### 3.12 FLEXIBLE ELASTOMERIC CELLULAR EQUIPMENT INSULATION INSTALLATION:

- A. Install sheets of the largest manageable size.
- B. Apply full coverage of adhesive to the surface of adhesive to the surfaces of the equipment and to the insulation.
- C. Butt insulation joints firmly together and apply adhesive to insulation edges at joints.

### 3.13 DUCTWORK INSULATION:

- A. Install block and board insulation as follows:
  - 1. Adhesive and Band Attachment: Secure block and board insulation tight and smooth with at least 50 percent coverage of adhesive. Install bands spaced 12 inches apart. Protect insulation under bands and at exterior corners with metal corner angles. Fill joints, seams, and chipped edges with vapor barrier compound.
  - 2. Speed Washers Attachment: Secure insulation tight and smooth with speed washers and welded pins. Space anchor pins 18 inches apart each way and 3 inches from insulation joints. Apply vapor barrier coating compound to insulation in contact, open joints, breaks, punctures, and voids in insulation.

- B. Blanket Insulation: Install tight and smooth. Secure to ducts having long sides or diameters as follows:
1. Smaller Than 24 Inches: Bonding adhesive applied in 6-inch-wide transverse strips on 12-inch centers.
  2. 24 Inches and Larger: Anchor pins spaced 12 inches apart each way. Apply bonding adhesive to prevent sagging of the insulation.
  3. Overlap joints 3 inches.
  4. Seal joints, breaks, and punctures with vapor barrier compound.

### 3.14 JACKETS:

- A. Foil and Paper Jackets (FP): Install jackets drawn tight. Install lap or butt strips at joints with material same as jacket. Secure with adhesive. Install jackets with 2-1/2-inch laps at longitudinal joints and 3-inch-wide butt strips at end joints. Seal openings, punctures, and breaks in vapor barrier jackets and exposed insulation with vapor barrier compound.
- B. Interior Exposed Insulation: Install continuous glass cloth jackets.
- C. Exterior Exposed Insulation: Install continuous aluminum jackets and seal all joints and seams with waterproof sealant. OR
- D. Exterior Exposed Insulation: Install continuous PVC jackets and seal all joints and seams with waterproof sealant.
- E. Install metal jacket with 2-inch overlap at longitudinal and butt joints. Overlap longitudinal joints to shed water. Seal butt joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel draw bands 12 inches on center and at butt joints.
- F. Install the PVC jacket with 1-inch overlap at longitudinal and butt joints and seal with adhesive.
- G. Install glass cloth jacket directly over insulation. On insulation with a factory-applied jacket, install the glass cloth jacket over the factory-applied jacket. Install jacket drawn smooth and tight with a 2-inch overlap at joints. Embed glass cloth between (2) 1/16-inch-thick coats of lagging adhesive. Completely encapsulate the insulation with the jacket, leaving no exposed raw insulation.

## 3.15 FINISHES:

- A. Paint finished insulation as specified in Division 9 Section "Painting."
- B. Flexible Elastomeric Cellular Insulation: After adhesive has fully cured, apply 2 coats of protective coating to exposed insulation.

## 3.16 INSULATION APPLICATIONS:

- A. General: Materials and thicknesses are specified in schedules at the end of this Section.
- B. Interior, Exposed Piping Systems: Unless otherwise indicated, insulate the following piping systems:
  - 1. Domestic cold water.
  - 2. Storm water. Insulate only roof drain bodies and horizontal rainwater leaders of storm water piping.
  - 3. Domestic hot water.
  - 4. Recirculated hot water.
  - 5. Sanitary drains for fixtures accessible to the disabled.
  - 6. Hydronic piping (35 to 99 deg F)
  - 7. Hydronic piping (100 to 250 deg F)
- C. Interior, Concealed Piping Systems: Unless otherwise indicated, insulate the following piping systems:
  - 1. Domestic cold water.
  - 2. Storm water. Insulate only roof drain bodies and horizontal rainwater leaders of storm water piping.
  - 3. Domestic hot water.
  - 4. Recirculated hot water.
  - 5. Chilled water (35 to 55 deg F)
  - 6. Hydronic piping (35 to 99 deg F)

7. Hydronic piping (100 to 250 deg F)
- D. Exterior, Exposed Piping Systems: Unless otherwise indicated, insulate the following piping systems:
1. Domestic cold water.
  2. Storm water.
  3. Hydronic piping (35 to 99 deg F)
- E. Exterior, Concealed Piping Systems: Unless otherwise indicated, insulate the following piping systems:
1. Domestic cold water.
  2. Storm water.
  3. Hydronic piping (35 to 99 deg F)
- F. Equipment: Unless otherwise indicated, insulate the following indoor equipment:
1. Domestic cold water equipment, tanks, and pumps.
  2. Domestic hot water equipment, tanks, and water heaters.
  3. Chilled water equipment, tanks pumps and heat exchangers.
  4. Heating water equipment, tanks, pumps, and heat exchangers, 100 deg F to 250 deg F.
  5. Boiler flues and breechings.
- G. Duct Systems: Unless otherwise indicated, insulate the following duct systems:
1. Interior concealed supply, return and outside air ductwork.
  2. Interior exposed supply, return and outside air ductwork.
  3. Exterior exposed supply and return ductwork.
  4. Interior exposed and concealed supply fans, air handling unit casings and outside air plenums.

## 3.17 PIPE INSULATION SCHEDULES:

- A. General: Abbreviations used in the following schedules include:
1. Field-Applied Jackets: P - PVC, K - Foil and Paper, A - Aluminum, SS - Stainless Steel.
  2. Pipe Sizes: NPS - Nominal Pipe Size.
- B. Domestic Cold Water and Storm Water All Sizes (Interior): 1/2-inch-thick glass fiber, cellular glass or flexible elastomeric insulation. Field-applied jacket is not required.

**INTERIOR DOMESTIC HOT WATER AND RECIRCULATED HOT WATER**

PIPE SIZES (NPS)	MATERIAL	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD-APPLIED JACKET
1/2 TO 1-1/4	GLASS FIBER	1/2	NO	NONE
	CELLULAR GLASS	1	NO	NONE
	FLEXIBLE ELASTOMERIC	1/2	NO	NONE
1-1/2 TO 4	GLASS FIBER	1/2	NO	NONE
	CELLULAR GLASS	1	NONE	NONE
	FLEXIBLE ELASTOMERIC	3/4	NO	NONE

**SANITARY DRAINS AND TRAPS EXPOSED AT FIXTURES FOR DISABLED**

PIPE SIZES (NPS)	MATERIAL	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD-APPLIED JACKET
1/2 TO 1-1/4	GLASS FIBER	2	NO	NONE
	FLEXIBLE ELASTOMERIC	2	NO	NONE



**EXTERIOR REFRIGERANT SUCTION AND DUAL TEMP HYDRONIC  
(35 TO 100 DEG F) EXPOSED AND CONCEALED**

PIPE SIZES (NPS)	MATERIAL	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD-APPLIED JACKET
1/2 TO 1-1/4	GLASS FIBER	2	YES	NONE
	CELLULAR GLASS	2	YES	NONE
	FLEXIBLE ELASTOMERIC	3/4	YES	NONE
1-1/2 TO 4	GLASS FIBER	2	YES	NONE
	CELLULAR GLASS	2-1/2	YES	NONE
	FLEXIBLE ELASTOMERIC	3/4	YES	NONE
5 TO 10	GLASS FIBER	2-1/2	YES	NONE
	CELLULAR GLASS	2-1/2	YES	NONE

**INTERIOR HYDRONIC (100 TO 250 DEG F)  
EXPOSED AND CONCEALED**

PIPE SIZES (NPS)	MATERIAL	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD-APPLIED JACKET
1/2 TO 4	GLASS FIBER	1	NO	NONE
	CELLULAR GLASS	1-1/2	NO	NONE
	CALCIUM SILICATE	1-1/2	NO	(P)(K)(A)(SS)
5 TO 10	GLASS FIBER	2	NO	NONE
	CELLULAR GLASS	2-1/2	NO	NONE
	CALCIUM SILICATE	2	NO	(P)(K)(A)(SS)
1/2 TO 1-1/4 ONLY	FLEXIBLE ELASTOMERIC	3/4	NO	NONE

**EQUIPMENT INSULATION SCHEDULES:****INTERIOR EXPOSED DOMESTIC COLD WATER EQUIPMENT, TANKS, AND PUMPS**


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MATERIAL	FORM	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD- APPLIED JACKET
GLASS FIBER	BLOCK OR BOARD	1	YES	(P)(K)(A)(SS)
CELLULAR GLASS	BLOCK	1-1/2	YES	(P)(K)(A)(SS)
FLEXIBLE ELASTOMERIC	SHEET	3/4	YES	NONE

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**INTERIOR EXPOSED DOMESTIC HOT WATER EQUIPMENT, TANKS, AND PUMPS**


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MATERIAL	FORM	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD- APPLIED JACKET
GLASS FIBER	BLOCK	2	NO	(A)(SS)
CELLULAR GLASS	BLOCK	2	NO	(A)(SS)
CALCIUM SILICATE	BLOCK	2	NO	(A)(SS)

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**INTERIOR EXPOSED CHILLED AND DUAL-TEMP WATER EQUIP,  
TANKS, PUMPS, AND HEAT EXCHANGERS  
(35 TO 100 DEG F)**


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MATERIAL	FORM	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD- APPLIED JACKET
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GLASS FIBER	BLOCK	2-1/2	YES	(A)(SS)
CELLULAR GLASS	BLOCK	3	YES	(A)(SS)

**INTERIOR EXPOSED HEATING WATER EQUIPMENT,  
TANKS, PUMPS, AND HEAT EXCHANGERS  
(100 TO 250 DEG F)**

MATERIAL	FORM	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD- APPLIED JACKET
GLASS FIBER	BLOCK OR BOARD	2	NO	(A)(SS)
CELLULAR GLASS	BLOCK	2	NO	(A)(SS)
CALCIUM SILICATE	BLOCK	2	NO	(A)(SS)

**INTERIOR EXPOSED BOILER FLUES AND BREECHINGS**

MATERIAL	FORM	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD- APPLIED JACKET
CALCIUM SILICATE	BLOCK	4	NO	(A)(SS)

**DUCT SYSTEMS INSULATION SCHEDULE**

**INTERIOR CONCEALED HVAC SUPPLY AND RETURN DUCTS AND PLENUMS**

MATERIAL	FORM	THICKNESS IN	VAPOR BARRIER	FIELD- APPLIED
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		INCHES	REQ'D	JACKET
GLASS FIBER	BLANKET	1-1/2	YES	NONE

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**INTERIOR EXPOSED HVAC SUPPLY AND RETURN DUCTS AND PLENUMS**

MATERIAL	FORM	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD- APPLIED JACKET
GLASS FIBER	BOARD-RECT.	1-1/2	YES	NONE
GLASS FIBER	PIPE-ROUND	1-1/2	YES	NONE

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**EXTERIOR CONCEALED HVAC SUPPLY AND RETURN DUCTS AND PLENUMS**

MATERIAL	FORM	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD- APPLIED JACKET
GLASS FIBER	BOARD-RECT.	2	YES	NONE
GLASS FIBER	PIPE-ROUND.	2	YES	NONE
CELLULAR GLASS	BOARD-RECT.	3	YES	NONE
GLASS FIBER	PIPE-ROUND.	3	YES	NONE
FLEXIBLE ELASTOMERIC	SHEET.	2	YES	NONE

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**INTERIOR EXPOSED HVAC SUPPLY FANS,  
AIR HANDLING UNITS, CASINGS, AND PLENUMS**

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MATERIAL	FORM	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD- APPLIED JACKET
GLASS FIBER	BOARD	2	YES	NONE

END OF SECTION

## SECTION 15410

## PLUMBING PIPING

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

## 1.2 SUMMARY:

- A. This Section includes plumbing piping systems to a point 5 feet outside the building. Systems include the following:
  - 1. Potable water distribution, including cold- and hot-water supply and hot-water circulation.
  - 2. Drainage and vent systems, including sanitary and storm.
- B. Related Sections: The following Sections contain requirements that relate to this section.
  - 1. Division 15 Section "Basic Mechanical Materials and Methods for piping joining materials, joint construction, and installation requirements not specified in this Section.
  - 2. Division 15 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
  - 3. Division 15 Section "Plumbing Specialties" for plumbing system components.

## 1.3 SYSTEM PERFORMANCE:

Provide components and installation capable of producing piping systems with the following minimum working pressure ratings, except where indicated otherwise:

- A. Water Distribution Systems, Below Ground: 150 psig.
- B. Water Distribution Systems, Above Ground: 125 psig.
- C. Soil, Waste, and Vent Systems: 10-foot head of water.

- D. Storm Drainage Systems: 10-foot head of water.
- E. Storm Sewage, Pumped Piping Systems,: 75 psig.

#### 1.4 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for the following plumbing piping products:
  - 1. Couplings and fittings for grooved end steel pipe and grooved end ferrous fittings.
  - 2. Couplings and fittings for grooved end copper pipe and grooved end copper fittings.
- C. Water samples, test results, and reports specified in "Field Quality Control" and Cleaning "Articles.
- D. Coordination drawings, drawn accurately to scale and coordinating penetrations.

#### 1.5 QUALITY ASSURANCE:

- A. Comply with the provisions of ASME B31.9 "Building Services Piping" for materials, products, and installation.
- B. Provide listing/approval stamp, label, or other marking on piping made to specified standards.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturer's offering products that may be incorporated in the work include, but are not limited to the following:
  - 1. Couplings for Grooved-End Steel Pipe and Grooved-End Ferrous Fittings:
    - a. Grinnell Supply Sales Co., Grinnell Corp.
    - b. Gustin Bacon Div., Tyler Pipe.

- c. Mech-Line Div., James Hardie Industries Ltd.
  - d. Sprink, Inc., James Hardie Industries Ltd.
  - e. Stockham Valves & Fittings, Inc.
  - f. Victaulic Co. of America.
2. Couplings for AWWA Size, Grooved-End Ductile Iron Pipe and Fittings:
  - a. Gustin Bacon Div., Tyler Pipe.
  - b. Victaulic Co. of America.
3. Couplings for Grooved-End Copper Pipe and Grooved-End Copper Fittings: Victaulic Co. of America.
4. Mechanically Formed Outlet Procedure: T-Drill Industries, Inc..

## 2.2 PIPES AND TUBES:

- A. General: The application of the following pipe, tube, and fitting materials and joining methods required for plumbing piping systems are indicated in Part 3 Article "Pipe and Fittings Applications."
- B. Hard Copper Tube: ASTM B 88, Types K,L, and M water tube, drawn temper.
- C. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.
- D. Copper Drainage Tube: ASTM B 306, Type DWV, drawn temper.
- E. Steel Pipe: ASTM A 53, Type S, Grade A, Schedule 40, seamless, galvanized, carbon steel pipe. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53 or ASTM A 106, Schedule 40, seamless, galvanized, carbon steel pipe.
- F. Ductile Iron Pipe: AWWA C151, Classes 50 and 51, mechanical joint and push-on joint, with AWWA C104 cement-mortar lining.
- G. Flanged Ductile Iron Pipe: AWWA C115, ductile iron barrel, Class 150 or 300 iron alloy threaded flanges, with AWWA C104 cement mortar lining.
- H. Hub and Spigot, Cast Iron Soil Pipe: ASTM A 74, Service Class.
- I. Hubless, Cast-Iron Soil Pipe: CISPI 301.
- J. Polyethylene (PE) Plastic Pipe: AWWA C901, IDR or DR, in combination with PE Compound Number, as required to give pressure rating (PR) not less than 160 psig, plain ends.

- K. Poly(Vinyl Chloride) (PVC) Plastic, DWV Pipe: ASTM D 2665; Schedules 40, plain ends.

### 2.3 PIPE FITTINGS AND TUBE FITTINGS:

- A. Wrought-Copper Solder-Joint Pressure Fittings: ASME B16.22.
- B. Cast-Copper-Alloy, Solder-Joint Pressure Fittings: ASME B16.18.
- C. Wrought-Copper and Bronze, Grooved End Fittings: ASTM B75 Tube and ASTM B 584 Bronze Castings.
- D. Wrought-Copper Solder-Joint DWV Drainage Fittings: ASME B16.29.
- E. Cast-Copper Alloy, Solder-Joint, DWV Drainage Fittings: ASME B16.23.
- F. Wrought-Copper, Solder-Joint, Sovent Drainage Fittings: ASME B16.43.
- G. Cast-Copper Alloy, Solder-Joint, Sovent Drainage Fittings: ASME B16.32.
- H. Copper Tube Grooved End Mechanical Fittings: ASTM B.75. copper tube and ASTM B 584 bronze castings.
- I. Bronze Flanges: ASME B 16.24, Classes 150 and 300.
- J. Copper Unions: ASME B 16.18, cast-copper-alloy body, hexagonal stock, with ball-and -socket joint, metal-to-metal seating surfaces, and solder-joint, threaded, or solder-joint and threaded ends. Threaded Ends: Threads conforming to ASME B 1.20.1.
- K. Mechanically Formed Outlets: Manufacturer's standard written procedure for forming tee-branch outlet from pipe and tube.
- L. Malleable Iron Unions: ASME B 16.39, Classes 150 and 300, hexagonal stock, with ball-and-socket joint, metal-to-metal bronze seating surfaces, and female threaded ends having threads conforming to ASME B 1.20.1.
- M. Galvanized, Cast-Iron Threaded Fittings: ASME B16.4, Classes 125 and 250, standard pattern, with threads conforming to ASME B 1.20.1.
- N. Galvanized, Cast-Iron Threaded Drainage Fittings: ASME B16.12, recessed drainage pattern, with threads conforming to ASME B 1.20.1.
- O. Steel Pipe, Grooved End Fittings: ASTM A 47 malleable-iron, ASTM A 106 steel, or ASTM A 536 ductile iron, galvanized, grooved-end fittings designed to

accept couplings for grooved or shouldered joints.

- P. Ductile-Iron Pipe, Grooved-End Fittings: ASTM A 47 malleable-iron or ASTM A 536 ductile-iron, AWWA-pipe-size, grooved-end fittings having cement lining or FDA-approved interior coating, designed to accept AWWA C606 couplings, for AWWA grooved joints.
- Q. Cast-iron Threaded Flanges: ASME B16.1, Classes 125 and 300.
- R. Dielectric Unions: Threaded or solder connections as required to suit application; constructed to isolate dissimilar metals, prevent galvanic action, and prevent corrosion.
- S. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze wire reinforced protective jacket; minimum 150 psig working pressure, maximum 250 deg F operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

#### 2.4 JOINING MATERIALS:

Solder Filler Metal: ASTM B 32, 95-5 Tin Antimony.

#### 2.5 GENERAL DUTY VALVES:

General Duty valves (i.e., gate, globe, check, ball and butterfly valves) are specified in Division 15 Section "Valves." Special duty valves are specified below by their generic name; refer to Part 3 Article "Valve Application" for specific uses and applications for each valve specified.

#### 2.6 SPECIAL DUTY VALVES:

Balance Cocks: 400 psi WOG, 2 piece bronze, ball valve, handle, memory stop, with threaded end connections conforming to ASME B1.20.1.

#### 2.7 PIPING SPECIALTIES:

- A. Water Hammer Arresters: Bellows type, with stainless steel casing and bellows, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201.
- B. Basket Strainers: Cast-iron body, 125 psi flanges, bolted-type or yoke-type cover

with removable noncorrosive perforated strainer basket having 1/8-inch perforations and lift out handle.

- C. Hose Connections: Hose connections shall have garden hose thread outlets conforming to ASME B 1.20.7.
- D. Hose Bibbs: Bronze body with chrome-or nickel-plated finish, with renewable composition disc, wheel handle, 3/4 inch solder inlet, hose outlet.
- E. Recessed Nonfreeze Wall Hydrants: Cast-bronze, with chrome plated face, tee handle key, vacuum breaker, 3/4 inch inlet, and hose outlet. Bronze casing shall be length to suit wall thickness.
- F. Vacuum Breakers: Hose connection vacuum breakers shall conform to ASSE Standard 1011, with finish to match hose connection.
- H. Backflow Preventers: Reduced pressure principal assembly consisting of shutoff valves on inlet and outlet and strainer on inlet. Assemblies shall include test cocks and pressure differential relief valve located between 2 positive seating check valves and comply with requirements of ASSE Standard 1013.
- I. Relief Valves: Sizes for relief valves shall be in accordance with ASME Boiler and Pressure Vessel Codes for indicated capacity of the appliance for which installed. Combined Pressure-Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Temperature relief valves shall be factory set at 210 deg F, and pressure relief at 150 psi.

## PART 3 - EXECUTION

### 3.1 EXAMINATION:

Examine rough-in requirements for plumbing fixtures and other equipment with water connections to verify actual locations of piping connections prior to installation.

### 3.2 PIPE APPLICATIONS:

- A. Install Type L, drawn copper tube with wrought copper fittings and solder joints for pipe sizes 4 inches and smaller, above ground, within building. Install Type K, annealed temper copper tube for pipe sizes 4 inches and smaller, with no joints, below ground.
- B. Water piping in sizes 2-1/2 inch to 6 inches may be Type L drawn copper tube

with roll-grooved ends and mechanical couplings, above ground, within building.

### 3.3 PIPING INSTALLATION:

- A. General Location and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and all branch connections.
- C. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- F. Install piping tight to slabs, beams, joists, columns walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- H. Install drains at low points in mains risers, and branch lines consisting of a tee fitting, 3/4-inch ball valve, and short 3/4 inch threaded nipple and cap.
- I. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6" shall be steel; pipe sleeves 6" and larger shall be sheet metal.
- J. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained. Refer to Division 7 for special sealers and materials.
- K. Install piping with 1/32-inch-per foot (1/4 percent) downward slope towards drain point.

### 3.4 HANGERS AND SUPPORTS:

- A. General: Hanger, support, and anchor devices conforming to MSS SP-69 are specified in Division 15 Section "Supports and Anchors." Conform to the table below for maximum spacing of supports:
- B. Pipe Attachments: Install the following:
  - 1. Adjustable steel clevis hangers, MSS Type 1, for individual horizontal runs less than 20 feet in length.
  - 2. Adjustable roller hangers, MSS Type 43, and spring hangers, MSS Type 41 with Type 49, for individual horizontal runs 20 feet and longer.
  - 3. Pipe roll, complete MSS Type 44 for multiple horizontal runs, 20 feet or longer, support on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Install hangers for horizontal piping with the following maximum spacing and minimum rod sizes:

<u>Nom. Pipe Size - In.</u>	<u>Copper Tube Max. Span - Ft.</u>	<u>Min. Rod Dia. - In.</u>
Up to 3/4	5	3/8
1	6	3/8
1-1/4	7	3/8
1-1/2	8	3/8
2	8	3/8
1-1/2	9	1/2
3	10	1/2
3-1/2	11	1/2
4	12	1/2
5	13	1/2
6	14	5/8

- 6. Support vertical steel pipe and copper tube at each floor.

3.5 PIPE AND TUBE JOINT CONSTRUCTION:

- A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual".
- B. Grooved-End Joints: Prepare pipe and tubing and install in accordance with manufacturer's installation instructions.

### 3.6 SERVICE ENTRANCE:

- A. Extend water distribution piping to connect to water service piping, of size and in location indicated for service entrance to building.
- B. Install sleeve and mechanical sleeve seal at penetrations through foundation wall for watertight installation.
- C. Install shutoff valve at service entrance inside building; complete with strainer, pressure gage, and test tee with valve.

### 3.7 INSTALLATION OF WATER METER:

Install water meter in accordance with utility company's installation instructions and requirements.

### 3.8 VALVE APPLICATIONS:

General-Duty Valve Applications: The drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

- A. Shut-off duty: Use gate, ball, or butterfly valves.
- B. Throttling duty: Use globe, or ball valves.

### 3.9 INSTALLATION OF VALVES:

- A. Sectional Valves: Install sectional valves on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures or equipment connections, and elsewhere as indicated. For sectional valves 2 inches and smaller, use gate or ball valves; for sectional valves 2-1/2 inches and larger, use gate or butterfly valves.
- B. Shutoff Valves: Install shutoff valves on inlet of each plumbing equipment item, on each supply to each plumbing fixture, and elsewhere as indicated. For shutoff valves 2 inches and smaller, use gate or ball valves; for shutoff valves 2-1/2 inches and larger, use gate or butterfly valves.
- C. Drain Valves: Install drain valves on each plumbing equipment item, located to drain equipment completely for service or repair. Install drain valve at the base of each riser, at low points of horizontal runs, and elsewhere as required to drain distribution piping system completely. For drain system and equipment use 3/4 inch hose end drain valves.

- D. Check Valves: Install swing check valves on discharge side of each pump and elsewhere as indicated.
- E. Hose Bibbs: Install where indicated.
- F. Wall Hydrants: Install where indicated with vacuum breaker.

### 3.10 INSTALLATION OF PIPING SPECIALTIES:

- A. Install backflow preventers at each connection to mechanical equipment and systems and in compliance with the plumbing code and authority having jurisdiction. Locate in same room as equipment being connected. Install air gap fitting and pipe relief outlet drain without valves to nearest floor drain.
- B. Install pressure-regulating valves with inlet and outlet shutoff valves and balance cock bypass, Install pressure gage on valve outlet.

### 3.11 EQUIPMENT CONNECTIONS:

- A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by plumbing code.
- B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated. Provide shutoff valve and union for each connection; provide drain valve on drain connection. For connections 2-1/2 inches and larger, use flanges instead of unions.

### 3.12 FIELD QUALITY CONTROL:

- A. Inspections: Inspect water distribution piping as follows:
  - 1. Do not enclose, cover or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.
  - 2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
    - a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.



- containing at least 50 parts per million of chlorine. Isolate (valve off) the system or part thereof for 24 hours.
- c. Drain the system or part thereof of the previous solution and refill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for 3 hours.
  - d. Following the allowed standing time, flush the system with clean, potable water until chlorine does not remain in the water coming from the system.
  - e. Submit water samples in sterile bottles to the Tulsa City – County Health Department, Environmental Health Services Laboratory for testing. Samples shall be taken in compliance the Environmental Health Services Laboratory instructions for taking samples. Cost of all testing is the responsibility of the Contractor.
  - f. Repeat the procedure if biological examination made by the authority shows evidence of contamination.
- B. Prepare reports for all purging and disinfecting activities. Provide copies of all test reports made by the Environmental Health Services Laboratory.

### 3.14 COMMISSIONING:

- A. Fill the system. Check to determine the system is not air bound and is completely full of water.
- B. Before operating the system, perform these steps:
  1. Close drain valve, hydrants an, and hose bibbs.
  2. Open valves to full open position.
  3. Remove and clean strainers.
  4. Check pumps for proper direction of rotation. Correct improper wiring.
  5. Lubricate pump motors and bearings.

END OF SECTION

SECTION 15440  
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 15 Sections apply to this Section:
  - 1. "Basic Mechanical Requirements."
  - 2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY:

This section includes plumbing fixtures and trim, fittings, and accessories, appliances, appurtenances, equipment, and supports associated with plumbing fixtures.

1.3 DEFINITIONS:

- A. Accessible: Describes a plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped people.
- B. Accessory: Device that adds effectiveness, convenience, or improved appearance to a fixture but is not essential to its operation.
- C. Appliance: Device or machine designed and intended to perform a specific function.
- D. Appurtenance: Device or assembly designed to perform some useful function when attached to or used with a fixture.
- E. Equipment: Device used with plumbing fixtures or plumbing systems to perform a certain function for plumbing fixtures but is not part of the fixture.
- F. Fitting: Fitting installed on or attached to a fixture to control the flow of water

into or out of the fixture.

- G. Fixture: Installed receptor connected to the water distribution system, that receives and makes available potable water and discharges the used liquid or liquid-borne wastes directly or indirectly into the drainage system. The term "Fixture" means the actual receptor, except when used in a general application where the terms "Fixture" and "Plumbing Fixture" include associated trim, fittings, accessories, appliances, appurtenances, support, and equipment.
- H. Roughing-In: Installation of piping and support for the fixture prior to the actual installation of the fixture.
- I. Support: Device normally concealed in building construction, for supporting and securing plumbing fixtures to walls and structural members. Supports for urinals, lavatories, and sinks are made in types suitable for fixture construction and the mounting required. Categories of supports are:
  - 1. Chair Carrier: Support for wall hung fixture, having steel pipe uprights that transfer weight to the floor.
  - 2. Chair Carrier, Heavy Duty: Support for wall hung fixture, having rectangular steel uprights that transfer weight to the floor.
- J. Trim: Hardware and miscellaneous parts, specific to a fixture and normally supplied with it required to complete fixture assembly and installation.

#### 1.4 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Sections.
- B. Product data for each type of plumbing fixture specified, including fixture and trim, fittings, accessories, appliances, appurtenances, equipment, supports, construction details, dimensions of components, and finishes.
- C. Wiring diagrams for field-installed wiring of electrically operated units.

#### 1.5 QUALITY ASSURANCE:

- A. Regulatory Requirements: Comply with requirements of ANSI Standard A117.1, "Buildings and Facilities - Providing Accessibility and Usability for Physically Handicapped People," with respect to plumbing fixtures for the physically handicapped.

- B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled, as defined in the National Electrical Code, Article 100.
- C. Design Concept: The drawings indicate types of plumbing fixtures and are based on the specific descriptions, manufacturers, models, and numbers indicated. Plumbing fixtures having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions, operation, color or finish, or other characteristics are minor and do not change the design concept or intended performance as judged by the Contracting Officer. Burden of proof for equality of plumbing fixtures is on the proposer.

#### 1.6 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver plumbing fixtures in manufacturer's protective packing, crating, and covering.
- B. Store plumbing fixtures on elevated platforms in a dry location.

#### 1.7 EXTRA MATERIALS:

Deliver extra materials to Contracting Officer. Furnish extra materials described below matching products installed, packaged with protective covering for storage, and identified with labels clearly describing contents.

- A. Faucet Cartridges and O-rings: Furnish quantity of identical units not less than 5 percent of amount of each installed.
- B. Flushometer Repair Kits: Furnish quantity of identical units not less than 5 percent of amount of each flushometer installed.
- C. Toilet Seats: Furnish quantity of identical units not less than 5 percent of amount of each type of toilet seat installed.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, products that may be provided in each category include but are not limited to one of the following:

1. China Fixtures:
  - a. American Standard
  - b. Crane
  - c. Eljer
  - d. Kohler
2. Stainless Steel:
  - a. Elkay
  - b. Just Sinks
3. Fiberglass Enclosures:
  - a. American Standard
  - b. Aqua Glass Corp.
  - c. Kohler Co.
4. Electric Water Coolers and Drinking Fountains:
  - a. Halsey Taylor
  - b. Haws
  - c. Oasis
  - d. Elkay.
5. Faucets, and Fittings:
  - a. Delta
  - b. Moen
  - c. Chicago Faucets
  - d. Elkay
  - e. T&S Brass
6. Flush Valves:
  - a. Sloan
  - b. Delany.
7. Basins:
  - a. Fiat Products, Inc.
  - b. Williams
8. Closet Seats:
  - a. Olsonite

- b. Beneke
- c. Church.

9. Fixture Carriers and Hangers:

- a. Wade
- b. Zurn
- c. Jones Mfg (Jonespec)
- d. J.R. Smith

2.2 PLUMBING FIXTURES, GENERAL:

- A. Provide plumbing fixtures, trim, fittings, other components, and supports as listed in the "Plumbing Fixture Schedule".
- B. For the purpose of identification only, one Manufacturer's model numbers are used throughout the schedule on the Drawings.

2.3 CHINA FIXTURES:

All China fixtures shall be of the best grade vitreous ware without pit holes and blemishes. The Contracting Officer reserves the right to reject any pieces which, in his opinion, are faulty. All fixtures fitting against walls shall have ground backs.

2.4 TRIM:

Exposed trim shall be chrome plated. Faucet trim bodies shall be brass if not specifically listed in the schedule with bodies of other materials. Plastic bodies, handles, and drains are not approved. All faucet sets shall be furnished with copper tube inlets or threaded brass inlet shanks. All trim shall fit the mounting configuration of the plumbing fixture installed.

2.5 PLUMBING FIXTURE SERVICE VALVES:

Provide valves with loose key stops and flexible, chrome plated risers shall be provided on all lavatories, sinks, tank type water closets, drinking fountains, and as noted in the "Plumbing Fixture Schedule".

2.6 STAINLESS STEEL SINKS:

Standard use stainless steel sinks shall be 20-gauge, type 302 stainless steel with 1-3/4"

radius coved bowl corners, self-rimming, seamless, polished surfaces, and fully undercoated.

## 2.7 CLOSET SEATS:

Refer to "Plumbing Fixture Schedule" for seat type and materials.

## 2.8 CARRIERS AND HANGERS:

All plumbing fixture supports shall have mounting brackets, holes and slots matching the specific Manufacturer purchased for the project. The Contractor shall verify that no modifications to the support or fixture are required for installation.

## PART 3 - EXECUTION

### 3.1 EXAMINATION:

- A. Examine rough-in for potable cold water and hot water supplies and soil, waste, and vent piping systems to verify actual locations of piping connections prior to installing fixtures.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 APPLICATION:

Install plumbing fixtures and specified components, in accordance with designations and locations indicated on Drawings.

### 3.3 INSTALLATION OF PLUMBING FIXTURES:

- A. Heights: Set fixtures at heights as directed and approved by the Contracting Officer.
- B. All fixtures shall be set true and level and in proper alignment with respect to walls and floors.
- C. Fixtures shall be evenly spaced or as dimensioned on the Architectural Drawings.

- D. Install supplies in proper alignment with fixtures and with each other.
- E. Install flush valves in alignment with the fixture, without horizontal or vertical offsets.
- F. Install all fixture supports before wall finish is applied.
- G. Grout wall and floor mounted fixtures watertight where the fixtures are in contact with walls and floors.
- H. Caulk deck-mounted trim at the time of assembly, including fixture and casework mountings. Caulk self-rimming sinks installed in casework.
- I. All fixtures shall be cleaned before setting and the installation shall be left ready for use.

#### 3.4 CONNECTIONS:

Piping installation requirements are specified in other sections of Division 15. The Drawings indicate general arrangement of piping fittings and specialties. The following are specific connection requirements:

- A. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other sections of Division 15.
- B. Install piping connections indicated between appliances and equipment specified in other sections, direct connected to plumbing piping systems.

#### 3.5 FIELD QUALITY CONTROL:

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.

#### 3.6 ADJUSTING AND CLEANING:

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

- B. Adjust water pressure at drinking fountains, electric water coolers, and faucets, shower valves, and flushometers having controls, to provide proper flow and stream.
- C. Replace washers of leaking and dripping faucets and stops.
- D. Clean fixtures, fittings, and spout and drain strainers with manufacturers' recommended cleaning methods and materials.
- E. Review the data in Operating and Maintenance Manuals. refer to Division 1 Section "Project Closeout.

3.7 PROTECTION:

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities, except when approved in writing by the Contracting Officer.

END OF SECTION

SECTION 15453  
PLUMBING PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this Section.
- B. Requirements of the following Division 15 Sections apply to this section:
  - 1. "Basic Mechanical Requirements."
  - 2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY:

- A. This Section includes the following types of plumbing pumps:
  - 1. Compact in-line recirculators.
  - 2. Submersible sump pumps.
- B. Related Sections: The following sections contain requirements that relate to this section: Division 15 Section "HVAC Pumps" for hydronic system centrifugal pumps.

1.3 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data, including certified performance curves, weights (shipping, installed, and operating), furnished specialties, and accessories, plus installation and start-up instructions.
- C. Wiring diagrams detailing wiring for power, signal, and control systems; differentiating between manufacturer-installed wiring and field-installed wiring.

- D. Maintenance data for plumbing pumps, for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 15 Section "Basic Mechanical requirements."

### 1.3 QUALITY ASSURANCE:

- A. Hydraulic Institute Compliance: Design, manufacture, and install plumbing pumps in accordance with "Hydraulic Institute Standards."
- B. National Electrical Code Compliance: Components shall comply with NFPA 70 "National Electrical Code."
- C. UL Compliance: Plumbing pumps shall be listed and labeled by UL and comply with UL Standard 778 "Motor Operated Water Pumps."
- D. NEMA Compliance: Electric motors and components shall be listed and labeled NEMA.
- E. SSPMA Compliance: Test and rate sump and sewage pumps in accordance with the Sump and Sewage Pump Manufacturers Association (sspma)
- F. Single Source Responsibility: Obtain plumbing pumps of the same type from a single manufacturer.
- G. Design Criteria: The Drawings indicate sizes, profiles, connections, and dimensional requirements of plumbing pumps and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered, provided that deviations in dimensions and profiles do not change the design concept or intended performance as judged by the Contracting Officer. The burden of proof for equality of plumbing pumps is on the proposer.

### 1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Store pumps in a dry location.
- B. Retain shipping flange protective covers and protective coatings during storage.
- C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS:

Products: Subject to compliance with requirements, provide one of the following manufacturers.

### A. Compact Inline Recirculator Pumps:

- a. Armstrong Pumps, Inc.
- b. Bell & Gossett, ITT.
- c. Taco, Inc.

### B. Sump Pumps:

- a. Aurora Pumps.
- b. Federal Pump Corp.
- c. Weil Pump Company
- d. Weinman, Mueller Pump.

## 2.2 PUMPS, GENERAL:

- A. Pumps and circulators: factory assembled and factory tested.
- B. Preparation for shipping: After assembly and testing, clean flanges and exposed machine metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screw in plugs.
- C. Motors: Conform to NEMA standards; single multiple, or variable speed with type of enclosure and electrical characteristics as indicated; have built-in thermal-overload protection and grease-lubricated ball bearings. Select motors that are non-overloading within full range of the pump performance curve.
- D. Apply factory finish paint to assembled, tested units prior to shipping.

## 2.3 COMPACT INLINE RECIRCULATOR PUMPS:

- A. General Description: Leakproof, inline, sealess, volute-type pump. Pump and motor shall be assembled on a common shaft in a single hermetically sealed unit, without stuffing boxes or mechanical seals. Accomplish sleeve bearings lubrication and motor cooling by circulating pumped liquid through the motor section. Isolate motor section from motor stator windings with a thin corrosion-resistant, nonmagnetic, alloy liner. Pumps shall be rated for 125 psig working

pressure and 225 deg F continuous water temperature.

- B. Casings: Cast bronze, with stainless steel liner and static O-ring seal to separate motor section from motor stator, and flanged piping connections.
- C. Impeller: Overhung, single suction, closed or open nonmetallic impeller.
- D. Pump Shaft and Sleeve: Stainless steel shaft with carbon steel bearing sleeve.
- E. Motors: Multi-speed.

#### 2.4 SUBMERSIBLE SUMP PUMPS:

- A. General Description: Pumps shall be simplex, vertical, centrifugal, direct connected, end suction, single stage, bronze fitted, complete with integral inlet strainer, operating controls and sump cover.
- B. Casing: Cast iron with integral cast-iron inlet strainer and legs to elevate the pump to permit flow into the impeller. Discharge companion flange shall be arranged for vertical discharge and suitable for plain-end pipe connection.
- C. Impeller: Statically and dynamically balanced, open or semi-open, overhung, single suction, fabricated from cast bronze conforming to ASTM B 584, keyed to shaft and secured by a locking cap-screw.
- D. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
- E. Seals: Double mechanical seals.
- F. Motor: Hermetically sealed, capacitor start, with built-in overload protection, with 10-foot, 3-conductor, waterproof cable and grounding plug.
- G. Basin: Welded steel with inlet connections.
- H. Cover: Steel plate, round cover, access opening and openings for power cord, discharge and vent piping.
- I. Controls:
  - 1. Panel: Factory assembled NEMA 1 duplex pump control panel with hinged door, fused disconnect switch, magnetic starter with overload protection, overload reset button, Test, Off, Auto switch, door mounted alarm bell, numbered and wired terminal strip.
  - 2. Switches: Three mercury float switches mounted to discharge pipe

constructed of non-corrosive, corrosion resistant material, hermetically sealed, available in normally closed or normally open configurations. NEMA Type 6 submersible, suitable for operation in liquids up to 140 degrees F.

3. Sequence of control:
  - a. Switch #1 (lowest mounted) closes control-holding circuit on liquid rise.
  - b. Switch #2 (middle mounted) closes and starts pump on liquid rise.
  - d. Switch #3 (highest mounted) closes alarm circuit on liquid rise to indicate high water alarm.
  - e. Switch #3 opens alarm circuit on liquid fall to silence high water alarm.
  - f. Pump continues to operate until float switch #1 opens the control holding circuit

## PART 3 - EXECUTION

### 3.1 EXAMINATION:

- A. Examine areas, equipment foundations, and conditions with Installer present, for compliance with requirements for installation and other conditions affecting performance of plumbing pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Examine rough in for plumbing piping systems to verify actual locations of piping connections prior to installation.

### 3.2 INSTALLATION:

- A. General: Comply with the manufacturer's written installation and alignment instructions.
- B. Install pumps in locations and arrange to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.
- D. Suspend inline pumps with all-thread hanger rod and vibration isolation independent from the piping system.
- E. Basins: Install sump pump basins in indicated locations and connect to drainage

lines. Brace interior of basin in accordance with manufacturer's instructions to prevent distortion or collapse during concrete placement. Refer to Division 3 for concrete work. Set cover over basin and fasten to top flange of basin. Install so cover is flush with finished floor.

### 3.3 CONNECTIONS:

- A. General: Install valves that are same size as the piping connecting the pump.
- B. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.
- C. Install a non-slam check valve and globe valve on the discharge side of pumps.

### 3.4 FIELD QUALITY CONTROL:

Check suction line connections for tightness to avoid drawing air into the pump.

### 3.5 COMMISSIONING:

- A. Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
- B. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.

END OF SECTION

SECTION 15460  
WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

This Section includes commercial gas-fired water heaters.

1.3 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories, and indicating dimensions, required clearances, and methods of assembly of components, and piping and wiring connections.
- C. Wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to water heaters. Include ladder type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.

1.4 QUALITY ASSURANCE:

- A. NSF Standards: Provide water heaters bearing NSF label.
- B. Electrical Component Standard: provide components complying with NFPA 70 "National Electrical Code."
- C. AGA Standards: Provide water heaters that bear the label of the American Gas Association.

- D. ASME Code Compliance: provide water heaters and safety relief valves that comply with ASME Boiler and Pressure Vessel Code and that bear the appropriate code symbols.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

Available Manufacturers: Subject to compliance with requirements, products which may be used include but are not limited to the following: Commercial Power Gas fired Water Heaters:

- A. Aldrich Co.
- B. Bock Water Heaters, Inc.
- C. PVI Industries, Inc.
- D. A.O. Smith Water Products Co. Div.; A.O. Smith Corp.

### 2.2 GAS WATER HEATER:

- A. Description: Automatic, commercial, power gas-fired, ASME labeled, 150-psig-rated tank, with integral controls, draft regulator, powered-gas burner, gas train including gas regulator, and relief valve.
- B. Insulation: Fiberglass, surrounding tank.
- C. Jacket: Steel, with baked-on enamel finish.
- D. Tank: Nickel-lined steel, with steel tubes clad with copper and nickel coated. Furnish drain and drain valve.
- E. Controls: Adjustable thermostat.
- F. Safety Controls: Equipped with automatic gas shutoff device to shut off entire gas supply in event of excessive temperature in tank, and pilot safety shutoff.
- G. Temperature and Pressure Relief Valve: ASME rated and labeled.
- H. Storage Capacity and Recovery rates as scheduled on the plans.

## PART 3 - EXECUTION

### 3.1 WATER HEATER INSTALLATION:

- A. Set and connect water heaters in accordance with manufacturer's written installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances. Orient so controls and devices needing servicing are accessible.
- B. Install thermometers on water heater inlet and outlet piping. Thermometers are specified in Division 15 Section "Meters and Gages."
- C. NFPA Compliance: Install gas-fired water heaters in compliance with NFPA 54, National Fuel Gas Code."

### 3.2 CONNECTIONS:

- A. Piping installation requirements are specified in other Sections of Division 15. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
  - 1. Install piping adjacent to equipment arranged to allow servicing and maintenance.
  - 2. Connect hot and cold water piping with shutoff valves and unions. Connect hot water circulating piping to unit with shutoff valve, check valve, and union. Extend relief valve discharge to closest floor drain.
    - a. Where water heater piping connections are dissimilar metals, make connections with dielectric fittings or dielectric unions specified in Division 15 "Basic Piping Materials and Methods."
    - b. Install vacuum relief valve in cold water inlet piping.
  - 3. Connect gas supply piping to burner with drip leg, tee, gas cock, and union; minimum size same as inlet connection. Arrange piping to allow servicing of unit.
    - a. Install vent piping from gas train pressure regulators and valves to outside the building. Terminate vent piping with brass screened vent cap fitting. Do not combine vents except with approval of local authority.
    - b. Install gas pressure regulators where indicated.
  - 4. Install drain as indirect waste to spill into open drain or over floor drain.

- B. Electrical Connections: Power wiring and disconnect switches are specified in Division 16.
- C. Vent Connections: Connect gas-fired water heater draft hood to the vent system. Unless otherwise indicated provide vent same size as outlet on heater. Comply with gas utility requirements. Vents are specified in Division 15 "Breechings, Chimneys, and Stacks."

### 3.3 FIELD QUALITY CONTROL:

- A. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide start-up service, and demonstrate and train maintenance personnel as specified below. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.
- B. Train maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.
  - 1. Review data in Operating and Maintenance Manuals. Refer to Division 1 Section "Project Closeout."
  - 2. Schedule training with at least 7 days, advance notice.

### 3.4 COMMISSIONING:

- A. Perform the following before start-up final checks:
  - 1. Fill water heaters with water.
  - 2. Piping systems test complete.
  - 3. Check for piping connections leaks.
  - 4. Check for adequate combustion air.
  - 5. Clear for clear vent.
  - 6. Test operation of safety controls and devices.
- B. Perform the following start-up procedures:
  - 1. Energize circuits.
  - 2. Adjust operating controls.

3. Adjust hot water temperature setting.

END OF SECTION

SECTION 15488  
NATURAL GAS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division Specifications sections, apply to this section.
- B. The requirements of the following Division 15 Sections apply to this Section:
  - 1. Basic Mechanical Requirements.
  - 2. Basic Mechanical Materials and Methods.
  - 3. Supports and Anchors.

1.2 SUMMARY:

- A. This Section includes distribution piping systems for natural gas and manufactured gas within the building and extending from the point of delivery to the connections with gas utilization devices. Piping materials and equipment specified in this section include:
  - 1. Pipe, fittings, and specialties.
  - 2. Special duty valves.
- B. Gas pressures for systems specified in this section are limited to 5 psig or less.
- C. Products installed under this Section includes gas meters which will be provided by the contractor.

1.3 DEFINITIONS:

- A. Pipe sizes used in this specification are Nominal Pipe Size (NPS).
- B. Gas distribution Piping: A pipe within the building which conveys gas from the point of delivery to the point of usage.

- C. Gas Service Piping: The pipe from the gas main or other source of supply including the meter, regulating valve, or service valve to the gas distribution system of the building served.
- D. Point of Delivery is the outlet of the service meter assembly, or the outlet of the service regulator (service shutoff valve when no meter is provided).

#### 1.4 SUBMITTALS:

- A. Product data for each gas piping specialty and special duty valve. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.
- B. Maintenance data for gas specialties and special duty valves, for inclusion in operating and maintenance manual specified in Division 1 and Division 15 Section "Basic Mechanical Requirements"
- C. Welders' certification certificates, certifying that welders comply with the quality requirements specified under "Quality Assurance" below.
- D. Test reports specified in Part 3 below.

#### 1.5 QUALITY ASSURANCE:

- A. Installer Qualifications: Installation and replacement of gas piping, gas utilization equipment or accessories, and repair, and servicing of equipment shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Contracting Officer.
- B. Qualifications for Welding Processes and Operators: Comply with the requirements of ASME Boiler and Pressure Vessel Code, "Welding and Brazing Qualifications.
- C. Regulatory Requirements: Comply with the requirements of the following codes:
  - 1. NFPA 54 - National Fuel Gas Code, for gas piping materials and components, gas piping installations, and inspection, testing and purging of gas piping systems.

## 2. BOCA Basic National Mechanical Code.

### 1.6 DELIVERY STORAGE AND HANDLING:

Handling Flammable Liquids: Remove and legally dispose of liquid from drips in existing gas piping and handle cautiously to avoid spillage or ignition. Notify the gas supplier. Handle flammable liquids used by the installer with proper precautions, and do not leave on the premises from the end of one working day to the beginning of the next.

### 1.7 SEQUENCING AND SCHEDULING:

- A. Notification of Interruption of Service: Except in the case of an emergency, notify all affected users when the gas supply is to be turned off.
- B. Work Interruptions: When interruptions in work occur while repairs or alterations are being made to an existing piping system, leave the system in safe condition.
- C. Coordinate the installation of pipe sleeves for foundation wall penetrations.

### 1.8 EXTRA MATERIALS:

Valve Wrenches: Furnish to Contracting Officer, with receipt, two valve wrenches for each type of gas valve installed, requiring same.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS:

Manufacturer: Subject to compliance with requirements, provide piping materials and specialties from one of the following: Gas Cocks:

- A. Jenkins Bros.
- B. Lunkenheimer Co.
- C. NIBCO, Inc.
- D. Powell Co.
- E. Stockham.

## 2.2 PIPE AND TUBING MATERIALS:

- A. General: Refer to "Part 3, Article "PIPE APPLICATION" for identification of systems where the below specified pipe and fitting material are used.
- B. Pipe, Above Grade: ASTM A 53 or A 106, Schedule 40, seamless black steel pipe.
- C. Pipe, Below Grade: Plastic Pipe conforming to ASTM D 2513. Plastic Pipe shall be marked "gas" and "ASTM D 2513.

## 2.3 FITTINGS:

- A. Malleable-Iron Fittings: ANSI B 16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B 1.20.1.
- B. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.
- C. Steel Flanges and Flanged Fittings: ANSI B 16.5, including bolts, nuts, and gaskets of the following material group, end connection and facing:
  - 1. Material Group 1.1
  - 2. End Connections: Butt Welding.
  - 3. Facings: Raised face.

## 2.4 PIPING SPECIALTIES

- A. Unions: ANSI B 16.39, Class 150 black malleable iron; female pattern; brass to iron seat; ground joint.
- B. Dielectric Unions: ANSI B 16.39, Class 250; malleable iron and cast bronze; with threaded or soldered end connections suitable for pipe to be joined; designed to isolate galvanic and stray current corrosion.
- C. Protective Coating: When piping will be in contact with material or atmosphere exerting corrosive action, (including underground piping), pipe and fittings shall be factory coated with poly-ethylene tape, having the following properties:
  - 1. overall thickness; 20 mils.
  - 2. synthetic adhesive.

3. water vapor transmission rate, 0.10 or less, gallons per 100 square inch.
4. water absorption, percent: 0.02 or less.
5. Prime pipe and fittings with a compatible primer prior to application of tape.

## 2.5 VALVES:

- A. General duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 15 Section "General Duty Valves." Special duty valves are specified in this Article by their generic name. Refer to Part 3 below, Article "VALVE APPLICATION" for specific uses and applications for each valve specified.
- B. Gas Cocks 2 Inch and Smaller: 150 psi WOG, bronze body, straightaway pattern, square head threaded ends.
- C. Gas Cocks 2-1/2 Inch and Larger: MSS SP-78; 175 psi, lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends.
- D. Solenoid Valves: aluminum body, 120 volts AC, 60 Hz, Class B continuous duty molded coil; NEMA 4 coil enclosure; electrically opened/electrically closed; dual coils; normally closed; UL and FM approved and labeled.

## PART 3 - EXECUTION

### 3.1 PREPARATION:

- A. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.
- B. Conform with the requirements in NFPA 54, for the prevention of accidental ignition.

### 3.2 PIPE APPLICATIONS:

Install steel pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger.

### 3.3 PIPING INSTALLATIONS:

- A. General: Conform to the requirements of NFPA 54 - National Fuel Gas Code.
- B. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Design locations and arrangements of piping take into consideration pipe sizing, flow direction, slope of pipe, expansion, and other design considerations. So far as practical, install piping as indicated.
- C. Seal pipe penetrations of fire barriers using fire barrier penetration sealers specified in Division 7 Section " Joint Sealers."
- D. Install pipe sleeve and seals at foundation wall penetrations, as specified in Division 15 Section "Basic Piping Materials and Methods."
- E. Drips and Sediment Traps: Install a drip leg at points where condensate may collect, at the outlet of the gas meter, and in a location readily accessible to permit cleaning and emptying. Do not install drips where condensation is likely to freeze. Construct drips and sediment traps using a tee fitting with the bottom outlet plugged or capped. Use a minimum of 3 pipe diameters in length for the drip leg. Use same size pipe for drip leg as the connected pipe.
- F. Use fittings for all changes in direction and all branch connections.
- G. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- H. Install piping free of sags or bends.
- I. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.
- J. Install piping tight to slabs, beams, joists, columns walls, and other permanent elements of the building. Allow sufficient space above removable ceiling panels to allow for panel removal.
- K. Locate groups of pipes parallel to each other, spaced to permit servicing of valves.
- L. Install gas piping at a uniform grade of 1/4 inch in 15 feet, upward to risers, and from the risers to the meter, or service regulator when meter is not provided, or the equipment.

- M. Make reductions in pipe sizes using an eccentric reducer fittings installed with the level side down.
- N. Connect branch outlet pipes from the top or sides of horizontal lines, not from the bottom.
- O. Hanger, supports, and anchors are specified in Division 15 Section "Basic Mechanical Materials and Methods." Conform to the table below for maximum spacing of supports:

Steel Pipe:

<u>SIZE (NPS)</u>	<u>SPACING IN FEET</u>	<u>MIN ROD SIZE-INCHES</u>
1/2	5	3/8
3/4 to 1-1/4	6	3/8
1-1/2 to 3 (horizontal)	12	1/2
all sizes (vertical)	every floor level	

- P. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required at flanged devices.
- Q. Install dielectric unions where piping of dissimilar metals are joined.
- R. Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.
- S. Install strainers on the supply side of each control valve, pressure regulating valve, solenoid valve, and elsewhere as indicated.
- T. Anchor piping to ensure proper direction of expansion and contraction. Install expansion loops and joints as indicated on the Drawings and specified in Division-15 Section "Basic Mechanical Materials and Methods."

### 3.04 PIPE JOINT CONSTRUCTION:

- A. Welded Joints: Comply with the requirements in ASME Boiler and Pressure Vessel Code, Section IX.
- B. Threaded Joints: Conform to ANSI B 1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:
  - 1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into

joint. Refer to NFPA 54, for guide for length of threads for field threading steel pipe.

2. Align threads at point of assembly.
  3. Apply appropriate tape or thread compound to the external pipe threads.
  4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.
  5. Damaged threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- C. Flanged joints: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricant on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

### 3.5 VALVE APPLICATION:

- A. General: The Drawings indicate valve types, locations, and arrangements.
- B. Shut-off duty: Use gas cocks specified in Part 2 above.

### 3.6 VALVE INSTALLATIONS:

- A. Install valves in accessible locations, protected from physical damage. Tag valves with metal tag attached with a metal chain indicating the piping systems supplied.
- B. Install a gas cock upstream from each gas pressure regulator. Where two gas pressure regulators are install in series in a single gas line, a manual valve is not required at the second regulator.
- C. Install pressure relief or pressure limiting devices so they can be readily operated to determine the pressure at which they will operate; and examined for leakage when in the closed position.

### 3.7 TERMINAL EQUIPMENT CONNECTIONS:

- A. Install gas cock upstream and within 6 feet of gas appliance. Install a union or

flanged connection downstream from the gas cock to permit removal of controls.

- B. Sediment Traps: Install a tee fitting with the bottom outlet plugged or capped as close to the inlet of the gas appliance as practical. Drip leg shall be a minimum of 3 pipe diameters in length.

### 3.8 ELECTRICAL BONDING AND GROUNDING:

- A. Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code."
- B. Do not use gas piping as a grounding electrode.
- C. Conform to NFPA 70 - "National Electrical Code," for electrical connections between wiring and electrically operated control devices.

### 3.9 FIELD QUALITY CONTROL

Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.

END OF SECTION

SECTION 15510  
HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.
- B. The following Division-15 Sections apply to this Section:
  - 1. Basic Mechanical Requirements.
  - 2. Basic Mechanical Materials and Methods.
  - 3. General Duty Valves.
  - 4. Supports and Anchors.

1.2 SUMMARY:

- A. This Section includes piping systems for hot water heating, chilled water-cooling, make-up water for these systems, blow-down drain lines, and condensate drain piping. Piping materials and equipment specified in this Section include:
  - 1. Pipes, fittings, and specialties;
  - 2. Special duty valves;
  - 3. Hydronic specialties.
- B. Related Sections: The following sections contain requirements that relate to this Section:
  - 1. Division 15 Section "General Duty Valves" for gate, globe, ball, butterfly, and check valves.
  - 2. Division 15 Section "Gages" for thermometers, flow meters, and pressure gages.

3. Division 15 Section "Mechanical Insulation" for pipe insulation.
4. Division 15 Section "HVAC Pumps" for pumps, motors, and accessories for hydronic systems.
5. Division 15 Section "Pneumatic Control System" for temperature control valves and sensors.

### 1.3 DEFINITIONS:

Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

### 1.4 SYSTEM DESCRIPTION:

- A. General: The hydronic piping systems are the "water-side" of an air-and-water or all-water heating and air conditioning system. The hydronic piping system specified in this Section is a 4-pipe, hot water and chilled water piping system. This system is classified by ASHRAE as a Low Temperature, Forced, and Recirculating system.
- B. 4-Pipe System: The 4-pipe system include independent chilled water and return piping mains in a closed loop, connecting boilers and chillers to the terminal heat transfer units by means of piping loops. Circulation is accomplished by constant volume pumps. Design flow rates and water temperatures are specified in the various equipment specifications and schedules. Control sequences and temperature-reset schedules are specified in the temperature control specifications.

### 1.5 SUBMITTALS:

- A. Product Data, including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions for each hydronic specialty and special duty valve specified. Furnish flow and pressure drop curves for diverting fittings and calibrated plug valves, based on manufacturer's testing.
- B. Maintenance Data for hydronic specialties and special duty valves, for inclusion in operating and maintenance manual specified in Division 1 and Division 15 Section " Basic Mechanical Requirements".
- C. Welders' certificates certifying that welders comply with the quality requirements specified in Quality Assurance below.
- D. Certification of compliance with ASTM and ANSI manufacturing requirements for pipe, fittings, and specialties.

- E. Reports specified in Part 3 of this Section.

#### 1.6 QUALITY ASSURANCE:

Regulatory Requirements: Comply with the provisions of the following:

- A. ASME B 31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
- B. Fabricate and stamp air separators and compression tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
- C. ASME "Boiler and Pressure Vessel Code", Section IX, Welding and Brazing Qualification" for qualifications for welding processes and operators.
- D. BOCA Basic Mechanical Code.

#### 1.7 SEQUENCING AND SCHEDULING:

- A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate the installation of pipe sleeves for foundation wall penetrations.

#### 1.8 EXTRA STOCK:

Maintenance Stock: Furnish a sufficient quantity of chemical for initial system start-up and for preventative maintenance for one year from Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS:

Manufacturer: Subject to compliance with requirements, provide hydronic piping system products from one of the following:

- A. Calibrated Plug Valves:

1. Bell & Gossett ITT; Fluid Handling Div.
  2. Taco, Inc.
- B. Pump Discharge Valves:
1. Amtrol, Inc.
  2. Armstrong Pumps, Inc.
  3. Bell & Gossett ITT; Fluid Handling Div.
  4. Taco, Inc.
- C. Safety Relief Valves:
1. Amtrol, Inc.
  2. Bell & Gossett ITT; Fluid Handling Div.
  3. Spirax Sarco.
  4. Watts Regulator Co.
- D. Pressure Reducing Valves:
1. Amtrol, Inc.
  2. Armstrong Pumps, Inc.
  3. Bell & Gossett ITT; Fluid Handling Div.
  4. Taco, Inc.
- E. Air Vents (manual and automatic):
1. Armstrong Machine Works.
  2. Bell & Gossett ITT; Fluid Handling Div.
  3. Hoffman Specialty ITT; Fluid Handling Div.
  4. Spirax Sarco.
- F. Air Separators:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett ITT; Fluid Handling Div.
4. Taco, Inc.

G. Compression Tanks:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett ITT; Fluid Handling Div.
4. Taco, Inc.

H. Pump Suction Diffusers:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett ITT; Fluid Handling Div.
4. Taco, Inc.

I. Chemical Feeder:

1. Culligan USA.
2. Vulcan Laboratories, Subsidiary of Clow Corp.
3. York Shipley, Inc.

J. Diverting Fittings:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett ITT; Fluid Handling Div.
4. Taco, Inc.

## K. Dielectric Unions

1. Perfection Corp.
2. Watts Regulator Co.

## L. Y-Pattern Strainers:

1. Armstrong Machine Works.
2. Hoffman Specialty ITT; Fluid Handling Div.
3. Metraflex Co.
4. Spirax Sarco.
5. Trane Co.
6. Watts Regulator Co.

## M. Basket Strainers:

1. Crane Co.
2. Metraflex Co.
3. Spirax Sarco.

## 2.2 PIPING AND TUBING MATERIALS:

- A. General: Refer to "Part 3 - Article "PIPE APPLICATIONS" for identification of where the below materials are used.
- B. Drawn Temper Copper Tubing: ASTM B 88, Type L.
- C. Annealed Temper Copper Tubing: ASTM B 88, Type K.
- D. Steel Pipe: ASTM A 120, Schedule 40, seamless, black steel pipe plane ends.

## 2.3 FITTINGS:

- A. Cast-Iron Threaded Fittings: ANSI B 16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ANSI B 1.20.1.

- B. Malleable-Iron Threaded Fittings: ANSI B 16.3, Class 150, standard pattern for threaded joints. Threads shall conform to ANSI B 1.20.1.
- C. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.
- D. Wrought-Copper Fittings: ANSI B16.22, streamlined pattern.
- E. Cast-Iron threaded Flanges: ANSI B 16.1, Class 125; raised ground face, bolt holes spot faced.
- F. Cast Bronze Flanges: ANSI B16.24, Class 150; raised ground face, bolt holes spot faced.
- G. Steel Flanges and Flanged Fittings: ANSI B 16.5, including bolts, nuts, and gaskets of the following material group, end connection and facing:
  - 1. Material Group: 1.1
  - 2. End Connections: Butt Welding.
  - 3. Facings: Raised face.
- H. Unions: ANSI B 16.39 malleable-iron, Class 150, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends. Threads shall conform to ANSI B 1.20.1.
- I. Dielectric Unions: Threaded or soldered end connections for the pipe materials in which installed; constructed to isolate dissimilar metals, prevent galvanic action, and prevent corrosion.
- J. Flexible Connectors: Stainless steel bellows with woven flexible bronze wire reinforcing protective jacket; minimum 150 psig working pressure, maximum 250 deg F operating temperature. Connectors shall have flanged or threaded end connections to match equipment connected; and shall be capable of  $\frac{3}{4}$ -inch misalignment.

#### 2.4 JOINING MATERIALS:

- A. Solder Filler Metals: ASTM B 32, 50-50, Tin-Lead for condenser water, chilled water, and make-up water and drain piping.
- B. Solder Filler Metals: ASTM B 32, 95-5 Tin Antimony, for heating hot water and low-pressure steam piping.
- C. Brazing Filler Metals: AWS A5.8, Classification BAg 1 (Silver).

WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.

- D. Welding materials: Comply with Section II, Part C. ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
- E. Gasket Material: thickness, material, and type suitable for fluid to be handled, and design temperatures and pressures.

## 2.5 GENERAL DUTY VALVES

General duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 15 Section "General Duty Valves." Special duty valves are specified below by their generic name; refer to Part 3 Article "VALVE APPLICATION" for specific uses and applications for each valve specified.

## 2.6 SPECIAL DUTY VALVES:

- A. Calibrated Plug Valves: 125 psig water working pressure, 250 deg F maximum operating temperature, bronze body, plug valve with calibrated orifice. Provide with connections for portable differential pressure meter with integral check valves and seals. Valve shall have integral pointer and calibrated scale to register degree of valve opening. Valves 2 inch and smaller shall have threaded connections and 2-1/2 inch and larger valves shall have flanged connections.
- B. Pump Discharge Valves: 175 psig working pressure, 300 deg F maximum operating temperature, cast-iron body, bronze disc and seat, stainless steel stem and spring, and "Teflon" packing. Valves shall have flanged connections and straight or angle pattern as indicated. Features shall include non-slam check valve with spring loaded weighted disc, and calibrated adjustment feature to permit regulation of pump discharge flow and shutoff.
- C. Pressure Reducing Valves: diaphragm operated, cast-iron or brass body valve, 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.
- D. Safety Relief Valves: 125 psig working pressure and 250 deg F maximum operating temperature; designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made

of brass and rubber. Select valve to suit actual system pressure and Btu capacity.

- E. Combined Pressure/Temperature Relief Valves: diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment. Safety relief valve designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber; 125 psig working pressure and 250 deg F maximum operating temperature. Select valve to suit actual system pressure and Btu capacity. Provide with fast fill feature for filling hydronic system.
- F. Automatic Flow Control Valves: Class 150, cast iron housing, stainless steel operating parts; threaded connections for 2 inch and smaller, flanged connections for 2-1/2 inch and larger. Factory set to automatically control flow rates within plus or minus 5 percent design, while compensating for system operating pressure differential. Provide quick disconnect valves for flow measuring equipment. Provide a metal identification tag with chain for each valve with the zone identification, valve model number, and rate flow in GPM.

## 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; and having 1/8 inch discharge connection and 1/2 inch inlet connection.
- B. Automatic Air Vent: designed to vent automatically with float principal; bronze body and nonferrous internal parts; 150 psig working pressure, 240 deg F operating temperature; and having 1/4 inch discharge connection and 1/2 inch inlet connection.
- C. Compression Tanks: size and number as indicated; construct of welded carbon steel for 125 psig working pressure, 375 deg F maximum operating temperature. Provide taps in bottom of tank for tank fitting; taps in end of tank for gage glass. Tank with taps constructed shall be tested and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 1. Furnish with the following fittings and accessories:
  - 1. Air Control Tank Fitting: cast-iron body, copper plated tube, brass vent plug, and stainless steel ball check (100 gallon unit only); sized for compression tank diameter. Design tank fittings for 125 psig working

pressure and 250 deg F maximum operating temperature.

2. Tank Drain Fitting: brass body, nonferrous internal parts; 125 psig working pressure and 240 deg F maximum operating temperature. Fitting shall be designed to admit air to the compression tank and drain water, plus close off the system.
  3. Gage Glass: full height and have dual manual shutoff valves, 3/4-inch diameter gage glass, and slotted metal glass guard.
- D. Air separator: welded black steel; ASME constructed and labeled for minimum 125 psig water working pressure and 375 F operating temperature; perforated stainless steel air collector tube designed to direct released air into compression tank; tangential inlet and outlet connections; screwed connections up to and including 2 inch NPS; flanged connections for 2-1/2 inch NPS and above; threaded blow down connection; sized as indicated for full system flow capacity.
- E. Pump Suction Diffusers: cast-iron body, with threaded connections for 2-inch and smaller, flanged connections for 2-1/2 inch and larger; 175 psig working pressure, 300 deg F maximum operating temperature; and complete with the following features:
1. Inlet vanes with length 2-1.2 times pump suction diameter or greater.
  2. Cylinder strainer with 3/16 inch diameter openings with total free area equal to or greater than five times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.
  3. Disposable fine mesh strainer to fit over cylinder strainer.
  4. Permanent magnet, located in flow stream, removable for cleaning.
  5. Adjustable foot support, designed to carry weight of suction piping.
  6. Blow down tapping in bottom; gage tapping in side.
- F. Chemical Feeder: bypass type chemical feeders of 5 gallon capacity, welded steel construction; 125 psig working pressure; complete with fill funnel and inlet, outlet, and drain valves. Chemicals shall be specifically formulated to prevent accumulation of scale and corrosion in piping system and connected equipment, developed based on a water analysis of make-up water.
- G. Diverting Fittings: cast-iron body with threaded ends, or wrought copper with solder ends; 125 psig working pressure, 250 deg F maximum operating temperature. Indicate flow direction on fitting.

- H. Y-Pattern Strainers: 125 psig working pressure cast-iron body (ASTM A 126, Class B), flanged ends for 2-1/2 inch and larger, threaded connections for 2 inch and smaller, bolted cover, perforated Type 304 stainless steel basket, and bottom drain connection.
- I. Basket Strainers: 125 psig working pressure; high tensile cast-iron body (ASTM A 126, Class B), flanged end connections, bolted cover, perforated Type 304 stainless steel basket, and bottom drain connection.

## PART 3 - EXECUTION

### 3.1 PIPE APPLICATIONS:

- A. Install Type L, drawn copper tubing with wrought copper fittings and solder joints for 1-1/2 inch and smaller, above ground, within building. Install Type K, annealed temper copper tubing for 1-1/2 inch and smaller without joints, below ground or below slabs.
- B. Install steel pipe with threaded joints and fittings for 2 inch and 2-1/2 inch, and with welded joints for 3 inch and larger.

### 3.2 PIPING INSTALLATIONS:

- A. Locations and arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and all branch connections.
- C. Install exposed piping at right angles or parallel to walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- E. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- F. Locate groups of pipes parallel to each other, spaced to permit applying full

insulation and servicing of valves.

- G. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.
- H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6" shall be steel; pipe sleeves 6" and larger shall be sheet metal.
- I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained. Refer to Division 7 for special sealers and materials.
- J. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.
- K. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.
- L. Install branch connections to mains using Tee fittings in main with take-off out the bottom of the main, except for up-feed risers, which have take-off out the top of the main line.
- M. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
- N. Install dielectric unions to join dissimilar metals.
- O. Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.
- P. Install flexible connectors at inlet and discharge connections to pumps (except inline pumps) and other vibration producing equipment.
- Q. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, inline pump, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers 2 inch and larger.
- R. Anchor piping to ensure proper direction of expansion and contraction.

### 3.3 HANGERS AND SUPPORTS:

- A. General: Hanger, supports, and anchor devices are specified in Division 15

Section "SUPPORTS AND ANCHORS." Conform to the table below for maximum spacing of supports:

- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet in length.
  - 2. Adjustable roller hangers and spring hangers for individual runs 20 feet or longer.
  - 3. Pipe roller complete - MSS Type 44 for multiple horizontal runs, 20 feet or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
- C. Install hangers with the following minimum rod sizes and maximum spacing:

Nom.	Pipe Size	Max. Span-Ft	Min. Rod Size-Inches
1		7	3/8
1-1/2		9	3/8
2		10	3/8
3		12	1/2
3-1/2		13	1/2
4		14	5/8
5		16	5/8
6		17	3/4
8		19	7/8

Support vertical runs at each floor.

### 3.4 PIPE JOINT CONSTRUCTION:

- A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual".
- B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual".
  - 1. CAUTION: Remove stems, seats and packing of valves and accessible internal parts at piping specialties before brazing.
  - 2. Fill the pipe and fittings during brazing, with an inert gas (i.e., nitrogen or carbon dioxide) to prevent formation of scale.

3. Heat joints using oxyacetylene torch. Heat to proper and uniform temperature.
- C. Threaded joints: Conform to ANSI B 1.20.1, tapered pipe threads for field cut threads. Join pipefittings and valves as follows:
1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
  2. Align threads at point of assembly.
  3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
  4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded. Damaged threads: Do not use pipe with threads that are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- D. Welded Joints: Comply with the requirement in ASME Code B 31.9-"Building Services Piping."
- E. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

### 3.5 VALVE APPLICATIONS:

- A. General Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:
1. Shut-off duty: use gate, ball, and butterfly valves.
  2. Throttling duty: use globe and ball valves.
  3. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.
  4. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- B. Install calibrated plug valves on the outlet of each heating or cooling element and elsewhere as required to facilitate balancing.

- C. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.
- D. Install check valves on each pump discharge and elsewhere as required to control flow direction.
- E. Install pump discharge valves with stem in upward position; allow clearance above stem for check mechanism removal.
- F. Install safety relief valves on hot water generators, and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge to floor without valves. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 for installation requirements.
- G. Install pressure-reducing valves on hot water generators, and elsewhere as required to regulate system pressure.

### 3.6 HYDRONIC SPECIALTIES INSTALLATION:

- A. Install manual air vents at high points in the system, at heat transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points in the system, heat transfer coils, and elsewhere as required for system air venting.
- C. Install dip tube fittings in boiler outlet. Run piping to compression tank with 1/4 inch per foot (2 percent) upward slope towards tank. Connect boiler outlet piping.
- D. Install inline air separators in pump suction lines. Run piping to compression tank with 1/4 inch per foot (2 percent) upward slope towards tank. Install drain valve on units 2 inch and larger.
- E. Install combination air separator/strainer in pump suction lines. Run piping to compression tank with 1/4 inch per foot (2 percent) upward slope towards tank. Install blow-down piping with gate valve; extend to nearest drain.
- F. Install pump suction diffusers on pump suction inlet. Adjust foot support to carry weight of suction piping. Install nipple and ball valve in blow down connection.
- G. Install pump discharge valves in horizontal or vertical position with stem in upward position. Allow clearance above stem for check mechanism removal.
- H. Install shot-type chemical feeders in each hydronic system where indicated; in

upright position with top of funnel not more than 48 inches above the 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.

- I. Install compression tanks above air separator. Install gage glass and cocks on end of tank. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank. Support tank as detailed on the Drawings. In the absence of details provide support from the floor or structure above sufficient for the weight of the tank, piping connections, and fittings plus weight of water assuming a full tank of water. Do not overload building components and structural members.
- J. Install diaphragm-type compression tanks on floor as indicated. Vent and purge air from hydronic system, charge tank with proper air charge to suit system design requirements.

### 3.7 FIELD QUALITY CONTROL:

- A. Preparation for testing: Prepare hydronic piping in accordance with ASME B 31.9 and as follows:
  - 1. Leave joints including welds uninsulated and exposed for examination during the test.
  - 2. Provide temporary restraints for expansion joints, which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
  - 3. Flush system with clean water. Clean strainers.
  - 4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
  - 5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.
- B. Testing: Test the hydronic piping as follows:
  - 1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is

safe for workmen and compatible with the piping system components.

2. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of that liquid.
3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to insure that it is tight and that low-pressure filling lines are disconnected.
4. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B 31.9, Code For Pressure Piping, Building Services Piping.
5. After the hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

### 3.8 ADJUSTING AND CLEANING:

- A. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.
- B. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- C. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing. Chilled water systems shall be filled with a 1 to 1 ratio of water and glycol containing a rust inhibitor.

### 3.9 COMMISSIONING:

- A. Fill system and perform initial chemical treatment.
- B. Check expansion tanks to determine that they are not air bound and that the

system is completely full of water.

- C. Before operating the system perform these steps:
1. Open valves to full open position. Close coil bypass valves.
  2. Remove and clean strainers.
  3. Check pump for proper direction of rotation. Correct improper wiring.
  4. Set automatic fill valves for required system pressure.
  5. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
  6. Set temperature controls so all coils are calling for full flow.
  7. Check operation of automatic bypass valves.
  8. Check and set operating temperatures of boilers, and chillers to design requirements.
  9. Lubricate motors and bearings.

END OF SECTION

## SECTION 15540

## HVAC PUMPS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 15 Sections apply to this section:
  - 1. "Basic Mechanical Requirements."
  - 2. "Basic Mechanical Materials and Methods."

## 1.2 SUMMARY:

- A. This Section includes the following types of HVAC pumps. Base-mounted, close coupled, end-suction pumps.
- B. Related Sections: The following sections contain requirements that relate to this section: Division 15 Section "Motors" for electric motors connections, and accessories.

## 1.3 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data, including certified performance curves of selected models indicating selected pump's operating point, weights (shipping, installed, and operating), furnished specialties, and accessories.
- C. Wiring diagrams detailing wiring for power, signal, and control systems, differentiating between manufacturer-installed wiring and field-installed wiring.
- D. Maintenance data for HVAC pumps for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 15 Section "Basic Mechanical Requirements."

### 1.3 QUALITY ASSURANCE:

- A. Hydraulic Institute compliance: Design, manufacture, and install HVAC pumps in accordance with "Hydraulic Institute Standards."
- B. National Electrical Code Compliance: Provide components complying with NFPA 70 "National Electrical Code."
- C. UL Compliance: Provide HVAC pumps which are listed and labeled by U., and comply with UL Standard 778 "Motor Operated Water Pumps."
- D. NEMA Compliance: Provide electric motors and components that are listed and labeled NEMA.
- E. Single Source Responsibility: Obtain HVAC pumps from a single manufacturer.

### 1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Store pumps in a dry location.
- B. Retain shipping flange protection covers and protective coatings during storage.
- C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- D. Comply with Manufacturer's rigging instructions for handling.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS:

Products: Subject to compliance with requirements, provide one of the following: Base-Mounted, Close-Coupled, End-Suction Pumps:

### 2.2 PUMPS, GENERAL:

- A. Pumps and Circulators: Factory-assembled and factory-tested. Fabricate casings to allow removal and replacement of impellers without necessity of disconnecting piping. Type, sizes, and capacities shall be as indicated.
- B. Preparation for Shipping: After assembly and testing, clean flanges and exposed

machined metal surfaces and treat with an anticorrosion compound. protect flanges, pipe openings, and nozzles.

- C. Motors: Conform to NEMA Standard MG-1, general purpose, continuous duty, Design B, except Design C where required for high starting torque; single, multiple, or variable speed with type of enclosure and electrical characteristics as indicated; have built-in thermal overload protection, and grease-lubricated ball bearings. Select motors that are non-overloading within the full range of the pump performance curve.
- D. Apply factory finish paint to assembled, tested units prior to shipping.

### 2.3 BASE-MOUNTED, CLOSE-COUPLED, END-SUCTION PUMPS:

- A. General Description: Pumps shall be base-mounted, centrifugal, close-coupled, end-suction, single-stage, bronze-fitted, radially split case design, and rated for 175 psig working pressure and 225 deg F continuous water temperature.
- B. Casing Construction: Cast iron, with flanged piping connections, and threaded gage tappings at inlet and outlet flange connections.
- C. Impeller Construction: Statically and dynamically balanced, closed, overhung, single-suction, fabricated from cast bronze conforming to ASTM B 584, keyed to shaft and secured by a locking capscrew.
- D. Wear Rings: Replacement, bronze.
- E. Pump Shaft and Sleeve Bearings: Steel shaft, with bronze sleeve. Provide flinger on motor shaft between motor and deals to prevent liquid that leaks past pump seals from entering the motor bearings.
- F. Seals: Mechanical seals consisting of flushed seals consisting of carbon steel rotating ring, stainless steel spring, ceramic seat, and flexible bellows and gasket.
- G. Motor: Direct-mounted to the pump casing with supporting legs as an integral part of motor enclosure.

## PART 3 - EXECUTION

### 3.1 EXAMINATION:

- A. Examine areas, equipment foundations, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions

affecting performance of HVAC pumps.

- B. Examine rough-in for piping systems to verify actual locations of piping connections prior to installation.
- C. Examine equipment foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 EQUIPMENT BASES:

Construct concrete equipment pads as follows:

- A. Form concrete pads using framing lumber with form release compounds. Chamfer top edge and corners of pad.
- B. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves using manufacturer's installation template.
- C. Place concrete and allow to cure before installation of pumps. Use Portland Cement conforming to ASTM C150, 4,000 psi compressive strength, and normal weight aggregate.

### 3.3 INSTALLATION:

- A. General: Comply with the manufacturer's written installation and alignment instructions.
- B. Install pumps in locations and arranged to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.
- D. Set base-mounted pumps on concrete foundation. Disconnect coupling halves before setting. Do not reconnect couplings until the alignment operations have been completed.
  - 1. Support pump base plate on rectangular metal blocks and shims, or on metal wedges having a small taper, at points near the foundation bolts to provide a gap of 3/4 to 1-1/2 inches between the pump base and the foundation for grouting.

2. Adjust the metal supports or wedges until the shafts of the pump and driver are level. Check the coupling faces and suction and discharge flanges of the pump to verify that they are level and plumb.

### 3.4 ALIGNMENT:

- A. Align pump and motor shafts and piping connections after setting on foundations, after grout has been set and foundations bolts have been tightened, and after piping connections have been made. Adjust alignment of pump and motor shafts for angular and parallel alignment by one of the two methods specified in the Hydraulic Institute "Centrifugal Pumps - Instructions for Installation, Operation and Maintenance."
- B. After alignment is correct, tighten the foundation bolts evenly, but not too firmly. Fill the base plate completely with nonshrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts. Alignment tolerances shall meet manufacturer's recommendations.

### 3.5 CONNECTIONS:

- A. General: Install valves that are the same size as the piping connecting the pump.
- B. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.
- C. Install a triple duty valve on the discharge side of base-mounted, end-suction pumps.
- D. Install a pump suction diffuser and gate valve on the suction side of base-mounted, end-suction pumps.
- E. Install flexible connectors on the suction and discharge side of each base-mounted pump. Install flexible connectors between the pump casing and the discharge valves, and upstream from the pump suction diffuser.
- F. Install pressure gages on the suction and discharge of each pump at the integral pressure gage tapings provided.
- G. Electrical wiring and connections are specified in Division 16 sections.
- H. Control wiring and connections are specified in other Division 15 sections.

3.6 FIELD QUALITY CONTROL:

Check suction lines connections for tightness to avoid drawing air into the pump.

3.7 COMMISSIONING:

- A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up.
  - 1. Lubricate oil-lubricated bearings.
  - 2. Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
- B. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

END OF SECTION

## SECTION 15575

## BREECHINGS, CHIMNEYS, AND STACKS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 15 Sections apply to this section:
  - 1. "Basic Mechanical Requirements."
  - 2. "Basic Mechanical Materials and Methods."

## 1.2 SUMMARY:

This Section specifies double wall metal vents and accessories for gas-fired appliances.

## 1.3 SUBMITTALS:

- A. Product Data: Submit product data including materials, dimensions, weights, and accessories.
- B. Quality Control Submittals: Certificates: Submit certificates of materials compliance with specified ASTM, UL, and ASHRAE requirements.

## 1.3 QUALITY ASSURANCE:

- A. NFPA: Comply with NFPA 211 "Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances."
- B. UL: Comply with applicable portions of UL safety standards; provide products which have been UL listed and labeled.
- C. ASHRAE: Comply with the ASHRAE Equipment Handbook, Chapter 27, for Chimney, Gas Vent, and Fireplace Systems, material requirements and design

criteria.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS:

Manufacturer: Subject to compliance with requirements, provide Type B double wall gas vents of one of the following:

- A. American Metal Products Co.; Div. of Masco Corp.
- B. General Products Co., Inc.
- C. Hart & Cooley Mfg. Co.
- D. Selkirk Metalbestos.
- E. Metal-Fab Inc.

### 2.2 DOUBLE WALL METAL VENTS:

- A. Description: Double wall gas vents up to 24" diameter, UL listed for Type B, consisting of an inner pipe of sheet aluminum, and outer pipe of galvanized sheet steel, with the following minimum thicknesses:

<u>Size</u>	<u>Inner Pipe</u>	<u>Outer Pipe</u>
Round, up to 6"	0.012"	28 gage
Round, 7" to 18"	0.014"	28 gage
Round, 20" to 24"	0.018"	28 gage
Oval, up to 4"	0.012"	28 gage
Oval, 5" to 6"	0.014"	28 gage

- B. Description: Double wall gas vents above 24" diameter; UL listed as "Building Heating Appliance Chimney" for continuous operation at 1000 deg F., consisting of an inner pipe of type 304 stainless steel of .035" thickness, and an outer pipe of aluminized sheet steel of .034" thickness.
- C. Accessories: UL-Labeled tees, elbows, increasers, draft hood connectors, metal cap with bird barrier, adjustable roof flashing, storm collar, support assembly, thimbles, fire stop spacers, and fasteners, fabricated of similar materials and designs as vent pipe straight sections.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF DOUBLE WALL CONNECTORS, BREECHINGS AND VENTS:

- A. Install Type B gas vents in accordance with manufacturer's installation instructions and UL listing. Maintain minimum clearances from combustibles specified in UL listing.
- B. Support vents at intervals recommended by the manufacturer to support the weight of the vent and all accessories, without exceeding loading of appliances.

### 3.2 INSTALLATION OF DAMPERS:

Install barometric and thermostatically operated dampers in accordance with manufacturer's instructions. Locate as close to draft hood collar as possible.

### 3.3 ADJUSTING AND CLEANING:

Clean breeching internally during installation, to remove dust and debris. Clean external surfaces.

### 3.4 PROTECTION:

Temporary Closure: At ends of breechings and chimneys which are not completed or connected to equipment, provide temporary closure which will prevent entrance of dust and debris until installations are complete.

END OF SECTION

SECTION 15620  
FUEL FIRED HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

- A. This Section includes the following: Gas-fired unit heaters.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Division 15 Section "Breechings, Chimneys, and Stacks" for vents for heaters
  - 2. Division 15 Section "Electric Control Systems" for control of heaters.

1.3 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data including weights, dimensions, metal gages, and data on features and components. Include plan and elevation views of units, minimum clearances, and data on ratings and capacities.
- C. Maintenance data for products for inclusion in "Operating and Maintenance manual" specified in Division 1.
- D. Wiring diagrams from manufacturer's detailing requirements for electrical power and control wiring for heaters. Include ladder-type wiring diagrams for interlock and control wiring required for field installation. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.

#### 1.4 QUALITY ASSURANCE:

Comply with NFPA 70, "National Electrical Code."

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS:

Manufacturers: Subject to compliance with requirements, provide products by one of the following for Unit Heaters, Gas, Propeller Fan:

- A. Dunham-Bush, Inc.
- B. Hastings Industries, Inc.
- C. Lennox Industries, Inc.
- D. Modine Mfg. Co.
- E. Reznor.
- F. Sterling Heating Equipment Div.
- G. The Trane Co.

#### 2.2 GAS FIRED UNIT HEATER, CONVENTIONAL:

- A. General: Comply with ANSI Z83.8, "Gas Unit Heaters."
- B. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.
- C. Venting Provisions: Gravity.
- D. Burners: Cast iron or aluminized steel with stainless-steel inserts.
- E. Automatic Fan Thermal Switch: Delays fan start until discharge air is heated, Delays fan shutdown until air cools to comfort threshold.
- F. Summer Fan Relay: Connected to permit remote 24 V a.c. on-off switching of unit fan independently of heater.

- G. Heat Exchanger: Aluminized steel.
- H. Unit Fan Type: Propeller
- I. Automatic Gas Control: Single-stage, 24 V a.c. valve.
- J. Ignition: Electronically controlled spark with flame sensor.
- K. Discharge Louvers: Independently adjustable horizontal blades.

### 2.3 TEMPERATURE CONTROL:

Sensors, Components and Wiring: Specified in Division 15 Section "Electric Control Systems."

### 2.4 FINISHES:

External Casings and Cabinets: Baked enamel over corrosion-resistant treated surface.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND CONNECTION:

- A. Install and connect gas-fired heaters and associated fuel and vent features and systems in accordance with NFPA 54, applicable local codes and regulations, and manufacturer's printed installation instructions.
  - 1. Connect gas piping in accordance with Division 15 Section "Natural Gas Systems."
  - 2. Connect vents in accordance with Division 15 Section "Breechings, Chimneys and Stacks."
- 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 plumb and level. Mounting heights and unit locations shall be field verified prior to installation to provide necessary head clearances and clearance of obstructions in path of discharge airflow.
- C. Install controls as specified in Division 15 Section "Electric Control System."

3.2 COMMISSIONING:

- A. Test functions, operations, and control sequences and protective features. Adjust to assure operation is in accordance with design.
- B. Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.03 CLEANING AND ADJUSTING:

- A. Cleaning: Upon completion of installation, inspect heaters and associated components. Remove paint splatters and other spots, dirt and debris. Touch up scratches and mars of finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.
- B. Adjusting: Make burner and other unit adjustments for optimum heating performance and efficiency. Adjust heat distribution features, including louvers, vanes shutters, dampers, and reflectors, to provide optimum heat distribution for objects, personnel, and spaces served.

END OF SECTION

## SECTION 15683

## RECIPROCATING CHILLERS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.
- B. The following Division-15 Sections apply to this Section:
  - 1. Basic Mechanical Requirements.
  - 2. Basic Mechanical Materials and Methods.

## 1.2 SUMMARY:

- A. Extent of reciprocating chiller work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of reciprocating chillers specified in this section include the following:  
Outdoor air-cooled.
- C. Refer to other Division 15 sections for concrete pads, piping, piping specialties, pumps, and valves, which are required external to the reciprocating chillers for installation; not work of this section.

## 1.3 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data, including rated capacities for chillers indicated, weights (shipping, installed, and operating), furnished specialties and accessories; and rigging, installation, and start-up instructions.
- B. Wiring Diagrams: Submit manufacturer's electrical; requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

- C. Maintenance Data: Submit maintenance data and parts list for each reciprocating chiller, control, and accessory; including "trouble-shooting" maintenance guide. Include this data and product data in maintenance manual; in accordance with the requirements of Division 1 and Division 15 Section " Basic Mechanical Requirements".

#### 1.4 QUALITY ASSURANCE:

Regulatory Requirements: Comply with the provisions of the following:

- A. ARI Compliance: Test and rate reciprocating chillers in accordance with ARI Std 590, "Standard for Reciprocating Water-Chilling Packages."
- B. ASHRAE Compliance: Construct and install reciprocating chillers in accordance with ASHRAE Std 15, Safety Code for Mechanical Refrigeration". Provide Energy Efficiency Ratio (EER) for reciprocating chillers not less than prescribed by ASHRAE Std 90A, "Energy Conservation in New Building Design".
- C. NEC Compliance: Comply with applicable NEC requirements pertaining to electrical power and control wiring for construction and installation of reciprocating chillers.
- D. ANSI Compliance: Comply with ANSI B9.1 safety code requirements pertaining to unit construction of reciprocating chillers.

#### 1.5 DELIVERY STORAGE AND HANDLING:

- A. Handle reciprocating chillers and components properly to prevent damage, breaking, denting and scoring. Do not install damaged reciprocating chillers or components; replace with new. Comply with manufacturer's rigging and installation instructions for unloading reciprocating chillers, and transporting them to final location.
- B. Store reciprocating chiller and components in clean dry space. Protect from weather, dirt fumes, water, construction debris, and physical damage. Storage temperatures for unit controls are not to exceed 115 deg. F.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS:

Manufacturer: Subject to compliance with requirements, provide Outdoor air-cooled reciprocating chillers from one of the following:

- A. Bohn Heat Transfer Div; Gulf + Western Mfg. Co.
- B. Carrier Corporation.
- C. Trane Company.
- D. York Div; Borg-Warner Corporation.

## 2.2 OUTDOOR AIRCOOLED RECIPROCATING CHILLERS:

- A. General: Provide factory-assembled and tested outdoor air-cooled reciprocating liquid chillers as indicated, consisting of compressors, evaporator, condensers, thermal expansion valves, and control panels. Provide capacity and electrical characteristics as scheduled.
- B. Refrigerant: Provide full operating charge of refrigerant and oil.
- C. Housing: Provide manufacturer's standard equipment housing construction, corrosion protection coating, and exterior finish. Provide removable panels and/or access doors for inspection and access to internal parts and components.
- D. Evaporator: Provide shell-and-tube design with seamless copper tubes roller expanded into tube sheets. Design, test, and stamp for refrigerant side working pressure of 225 PSIG minimum, and water side working pressure of 150 PSIG minimum, in accordance with ASME Pressure Vessel Code. Provide one water pass with series of internal baffles. Insulate with 1/2" minimum flexible unicellular insulation with maximum K-value of 0.28. Provide water drain connection and bulb wells for temperature controller and low temperature cutout.
  - 1. Heater Tapes: Provide electrical resistance heater tape on evaporator to protect against freezing at -20 deg. F ambient at no-flow condition.
  - 2. Multiple-Compressor Units: Provide independent multiple refrigerant circuits with gasketed evaporator heads.
- E. Condenser: Construct coils with configured aluminum fins mechanically bonded to seamless copper tubing. provide integral sub-cooling circuit with liquid accumulators. Leak test coils with air under water at 425 PSIG air pressure. provide protective grilles over exposed coil faces.

1. Multiple-Compressor Units: Provide multiple circuited condenser coils.
  2. Condenser Fans: Provide propeller fans, direct or belt driven, draw-through design, statically and dynamically balanced. Provide permanently lubricated ball-bearing motors with overload protection. Provide protective grille over air discharge.
  3. Low Ambient Control: Provide head pressure control, designed to operate at temperatures down to 0 deg. F.
- F. Compressors: Provide direct drive RPM as specified by plans, multi-cylinder reciprocating compressors with crankcase heater; either semi-hermetic or hermetic, but with minimum steps of capacity control as scheduled, provided by cylinder unloading or compressors on vibration isolators within chiller housing. Lubrication: Provide oil pump, oil filter, oil level sight glass, and oil charging valve.
- G. Capacity Modulation: Provide step-control by means of cylinder unloading and/or compressor staging, from return water temperature.
- H. Refrigerant Circuit: Provide for each refrigerant circuit the following:
1. Liquid line solenoid valve.
  2. Filter dryer.
  3. Liquid line sight glass. Thermal expansion valve.
  4. Insulated suction line.
  5. Suction and discharge valves.
- I. Control Panels: Provide weather-tight control panels, factory-wired for external connection only. Provide the following controls:
1. Power controls for starter.
  2. Control power transformer for 115V control voltage.
  3. Terminal strip.
  4. Pump-down control cycle.
  5. Compressor starter relay.

6. Reset relay.
  7. Non-recycling compressor overload relay.
  8. High-pressure cutout.
  9. Low-pressure cutout.
  10. Oil pressure cutout, except for low oil pressure compressor systems.
  11. Low-temperature cutout.
  12. Chilled water temperature controller.
- J. Accessories: Provide the following accessories:
1. Suction and discharge gages.
  2. Oil pressure gages except for hermetic compressors.
  3. Vibration isolators of the following type: Equipment base and vertically restrained spring isolators.
  4. Remote control panel with provisions for starting, stopping, and resetting unit.
  5. External stop/start capability.
  6. Remote running and alarm indicating contacts.
  7. External chilled water control.

### PART 3 - EXECUTION

#### 3.1 INSPECTION:

Installer must examine areas and conditions under which reciprocating chillers are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

#### 3.2 INSTALLATION OF RECIPROCATING CHILLERS:

- A. General: Install reciprocating chillers in accordance with manufacturer's written instructions. Install units plumb and level, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- B. Support: Install roof mounted units on structural steel mechanical equipment stand. Anchor unit to stand with removable type fasteners. Construct mechanical equipment stand as indicated, and in accordance with NRCA Handbook of Accepted Roofing Knowledge, Detail "N".
- C. Chilled Water Piping: Refer to Division 15 section "Hydronic Piping" Connect inlet to evaporator with controller bulb well, shutoff valve, thermometer, strainer, flow switch, flexible pipe connector, pressure gage, and union or flange.
- D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- E. Control: Furnish field installed automatic temperature control requirements to Control Installer. Field installed automatic temperature controls are not work of this section.
- F. Provide services of manufacturer's factory-trained service representative to start-up reciprocating chillers. Include in start-up procedures, testing controls, demonstration of compliance with requirements, and replacement of damaged or malfunctioning controls and equipment.

### 3.3 TRAINING:

Provide services of manufacturer's technical representative for one 8-hour day to instruct maintenance personnel in operation and maintenance of reciprocating chillers. The Contractor shall contact the Contracting Officer and Base Civil Engineer's office to schedule the training date.

END OF SECTION

SECTION 15830  
TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.
- B. Requirements of the following Division-15 Sections apply to this Section:
  - 1. "Basic Mechanical Requirements."
  - 2. "Basic Mechanical Materials and Methods."
  - 3. "Motors."

1.2 SUMMARY:

- A. This Section includes fan coil terminal units for indoor installation.
- B. Related Sections: The following sections contain requirements that relate to this Section: Division 15 Section "Mechanical Insulation" for field applied equipment insulation.

1.3 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each fan coil unit indicated, showing dimensions, capacities, ratings, performance characteristics, gages and finishes of materials, and installation instructions.
- C. Shop drawings from manufacturer detailing dimensions, required clearances, components, and location and size of each field connection.

- D. Wiring diagrams detailing wiring for power and controls and differentiating between manufacturer-installed wiring and field-installed wiring.
- E. Field quality control test reports specified in Part 3 of this Section
- F. Maintenance Data for fan coil units for inclusion in operating and maintenance manual specified in Division 1 and Division 15 Section " Basic Mechanical Requirements".

#### 1.4 QUALITY ASSURANCE:

- A. ARI Compliance: Test and rate fan coil units in accordance with ARI Standard 440 "Room Fan Coil Air Conditioners".
- B. UL Compliance: Construct and install fan coil units in compliance with UL 883 "Safety Standards for Fan Coil Units and Room Fan Heater Units".

#### 1.5 DELIVERY, STORAGE AND HANDLING:

- A. Handle terminal units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal units or components; replace with new.
- B. Store terminal units and components in a clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading terminal units, and moving them to final location.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturer's offering products that may be incorporated in the work include, but are not limited to one of the following:

- A. Airtherm Manufacturing Co.
- B. Carrier Air Conditioning

- C. Dunham-Bush, Inc.
- D. McQuay Air Conditioning.
- F. The Trane Co.
- G. York International Corp.

## 2.2 FAN COIL UNITS:

- A. General: Provide fan coil units having cabinet sizes, and in locations indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coils, fan-board, drain pan assembly, fans, housing, motor, filter, and insulation.
- B. Chassis: Construct chassis of galvanized steel with flanged edges.
- C. Insulation: Faced, heavy density glass fiber.
- D. Coils: Construct of 5/8" seamless copper tubes mechanically bonded to configured aluminum fins. Design for 300 psi working pressure, and leak test at 300 psi under water.
- E. Auxiliary Heating Coils: Construct of 7/16" seamless copper tubes mechanically bonded to configured aluminum fins. Design for 300 psi working pressure.
- F. Drain Pans: Construct of galvanized steel. Insulate with polystyrene or polyurethane insulation. Provide drain connection.
- G. Fans: Provide centrifugal forward curved double width wheels of reinforced fiberglass, in galvanized steel fan scrolls.
- H. Motors: Provide motors with integral thermal overload protection. Run test motors at factory in assembled unit prior to shipping. Provide quickly detachable motor chords.
- I. Filters: Provide per manufacturers recommendations.

## PART 3 - EXECUTION

### 3.1 INSPECTION:

Examine areas and conditions under which terminal units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

### 3.2 INSTALLATION OF FAN COIL UNITS:

- A. General: Install fan coil units as indicated, and in accordance with manufacturer's installation instructions.
- B. Locate fan-coil units as indicated, coordinate with other trades to assure correct recess size for recessed units
- C. Install piping as indicated.
- D. Protect units with protective covers during balance of construction.

### 3.3 ELECTRICAL WIRING:

General: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 16 Sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

### 3.4 CONNECTIONS:

- A. Piping connections:
  - 1. Connect piping to air-handling units with flexible connectors.
  - 2. Connect condensate drain pans as shown on the drawings.
- B. Duct installations and connections are specified in other Division 15 sections. Make final duct connections with flexible connections.
- C. Electrical Connections: The following requirements apply:
  - 1. Electrical power wiring is specified in Division 16.
  - 2. Temperature control wiring and interlock wiring is specified in Division 15 Section "Electronic Control Systems."

3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.5 ADJUSTING AND CLEANING:

- A. Adjust water coil flow with control valves to full coil flow to indicated gpm.
- B. Clean unit cabinet interiors to remove foreign material and construction dirt and dust, Vacuum clean fan wheel, fan cabinet, and coils entering air face.
- C. Install clean filters.

END OF SECTION

## SECTION 15854

## CENTRAL-STATION AIR-HANDLING UNITS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.
- B. Requirements of the following Division-15 Sections apply to this Section:
  - 1. "Basic Mechanical Requirements."
  - 2. "Basic Mechanical Materials and Methods."
  - 3. "Motors."

## 1.2 SUMMARY:

- A. This Section includes constant volume, central station air handling units with coils for indoor installation.
- B. Related Sections: The following sections contain requirements that relate to this Section: Division 15 Section "Mechanical Insulation" for field applied equipment insulation.

## 1.3 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each central-station air-handling unit indicated, including the following:
  - 1. Certified fan performance curves with system operating conditions indicated.
  - 2. Certified fan sound power ratings.

3. Certified coil performance ratings with system operating conditions indicated.
  4. Motor ratings and electrical characteristics plus motor and fan accessories.
  5. Materials gages and finishes.
  6. Filters with performance characteristics.
  7. Dampers, including housings, linkages, and operators.
- C. Shop drawings from manufacturer detailing dimensions, required clearances, components, and location and size of each field connection.
  - D. Wiring diagrams detailing wiring for power and controls and differentiating between manufacturer-installed wiring and field-installed wiring.
  - E. Field quality control test reports specified in Part 3 of this Section
  - F. Maintenance Data for central station air-handling units for inclusion in operating and maintenance manual specified in Division 1 and Division 15 Section " Basic Mechanical Requirements".

#### 1.4 QUALITY ASSURANCE:

- A. NFPA Compliance: Central-station air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. UL Compliance: Electric coils, along with the complete central-station air-handling unit, shall be listed and labeled by Underwriters Laboratories.
- C. ARI Certification: Central-station air-handling units and their components shall be factory tested in accordance with the applicable portions of ARI 430 - Standard for Central-Station Air-Handling Units and shall be listed and bear the label of the Air-Conditioning and Refrigeration Institute.

#### 1.5 DELIVERY, STORAGE AND HANDLING:

- A. Lift and support units with the manufacturer's designated lifting or supporting points.
- B. Disassemble and reassemble units as required for movement into the final

location following manufacturer's written instructions.

- C. Deliver central station air handling units as a factory assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

#### 1.6 SEQUENCING AND SCHEDULING:

- A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad.
- B. Coordinate the size and location of structural steel support members.

#### 1.7 EXTRA MATERIALS:

- A. Furnish one additional complete set of filters for each central-station air-handling unit.
- B. Furnish one additional complete set of belts for each central-station air-handling unit.
- C. Furnish one additional gasket for each sectional joint of each central-station air-handling unit.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS:

Manufacturer: Subject to compliance with requirements, provide products from one of the following:

- A. Airtherm Manufacturing Co.
- B. American Air Filter Co.
- C. Bohn Heat Transfer.
- D. Carrier Air Conditioning
- E. Dunham-Bush, Inc.

F. McQuay Air Conditioning.

G. The Trane Co.

H. York International Corp.

## 2.2 MANUFACTURED UNITS:

A. General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, damper plenums, filters, drip pans, and mixing dampers.

B. Motor and Electrical Components: Refer to Division 15 Section "Motors."

## 2.3 CABINET:

A. Materials: Formed and reinforced galvanized steel panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Insulation: Comply with NFPA Standard 90A for insulation.

1. Type: Coated, glass fiber insulation, 1 inch thick and having a minimum density of 1-1/2 pcf.

2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from and including the cooling coil section.

C. Access Panels and Doors: Same materials and finishes as cabinet and complete with hinges, latches, handles, and gaskets. Fan section shall have inspection and access panels and doors sized and located to allow periodic maintenance and inspections.

D. Single Wall, Drain Pans: Formed sections of galvanized sheet steel. Fabricate pans in sizes and shapes to collect condensate from cooling coils (including coil piping and return bends) when units are operating at the maximum cataloged face velocity across the cooling coil.

1. Drain Connections: Both ends of the pan.

2. Pan top surface coating: Elastomeric compound.

3. Units with stacked coils shall have an intermediate drain pan or a drain through to collect condensate from top coil.

## 2.4 FANS SECTION:

- A. Testing Requirements: The following factory tests are required:
1. General: Sound power level ratings shall comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings From Laboratory Test Data" and shall be the results of tests made in accordance with AMCA Standard 300 "Test Code for Sound Rating." Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.
  2. Unit's fans performance ratings for flow rate, pressure, power, air density, speed of rotation, and efficiency shall be factory tested and ratings established in accordance with AMCA Standard 210/ASHRAE Standard 51 - Laboratory Methods of Testing Fans for Rating.
- B. Fan Section Construction: Fan Section shall be equipped with a formed steel channel base for integral mounting of fan, motor, and casing panels. The fan scroll, wheel, shaft, bearings, and motor shall be mounted on a structural steel frame with frame mounted on base with vibration isolators.
- C. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower. Fan wheel shall be double-width, double inlet type with forward-curved blades. Forward curved blade wheels shall be galvanized steel or bonderized steel painted with baked enamel finish. Fan shaft shall be solid steel, turned, ground, and polished. Fan wheels shall be keyed to the shaft.
- D. Shaft Bearings: Grease lubricated ball bearings selected for 200,000 hours' average life, with grease fittings extended to an accessible location outside the fan section.
- E. Fan Drives: Designed for 1.4 service factor and factory mounted with final alignment and belt adjustment made after installation.
1. Belt Drives: Motors and fan wheel pulleys shall be adjustable pitch for use with motors up to and including 15 HP and fixed pitch for use with motors larger than 15 HP.
  2. Motors mounted on the outside of the fan cabinet shall have steel belt guards.

## 2.5 MOTORS:

- A. Torque Characteristics: Sufficient to accelerate the driven loads satisfactorily.

- B. Motor Sizes: Minimum size as indicated. If not indicated, large enough so that the driven load will not require the motor to operate in the service factor range.
- C. Temperature Rating: 50 deg C maximum temperature rise at 40 deg C ambient for continuous duty at full load (Class A Insulation).
- D. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
- E. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design B.
  - 1. Bases: Adjustable.
  - 2. Bearings: The following features are required:
    - a. Ball or roller bearings with inner and outer shaft seals.
    - b. Grease lubricated.
    - c. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust loads.
  - 3. Enclosure Type: The following features are required:
    - a. Open drip-proof motors where satisfactorily housed or remotely located during operation.
    - b. Guarded drip-proof motors where exposed to contact by employees or building occupants.
  - 4. Overload protection: Built-in, automatic reset, thermal overload protection.
  - 5. Noise Rating: Quiet.
  - 6. Efficiency: Energy efficient motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, Test Method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors" in accordance with IEEE Standard 112, Test Method B.
  - 7. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction and special features.
- F. Starters, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 16.

## 2.6 COILS:

- A. Testing Requirements: The following factory tests are required: Coil Performance Tests: Cooling and heating coils, except sprayed surface coils, shall be factory tested for rating in accordance with ARI 410 - Standard For Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. Coil Sections: Common or individual insulated, galvanized steel casings for heating and cooling coils. Coil section shall be designed and constructed to facilitate removal of coil for maintenance and replacement and to assure full airflow through coils.
- C. Coils, General: Drainable, rigidly supported across the full face of the coil, and pitched to allow drainage.
  - 1. Fins: Aluminum or copper, constructed from flat plate with belled collars for tubes. Fins shall be bonded to tubes by mechanically expanding copper tubes.
  - 2. Tubes: Seamless copper.
  - 3. Coil Casing: Galvanized steel.
  - 4. Headers for Water Coils: Steel or cast iron, with connections for drain valve and air vent and threaded piping connections.

## 2.7 DAMPERS:

- A. General: Leakage rate when tested in accordance with AMCA Standard 500 - Test Method for Louvers, Dampers and Shutters, shall not exceed 2 percent of air quantity calculated at 2,000 fpm face velocity through damper and 4.0 inches w.g. pressure differential. Damper operators are specified in Division 15 Section "Electric Controls Systems."
- B. Mixing Boxes: Parallel-blade dampers in a reinforced galvanized steel cabinet. Damper blades shall be galvanized steel mechanically fastened to steel operating rod. Connect operating rods for each set of dampers together with a common linkage and interconnect linkages so dampers operate simultaneously and in the opposite direction (one opens when the other closes).

## 2.8 FILTERS:

- A. General: Filters shall comply with NFPA Standard 90A "Standard for the

Installation of Air Conditioning and Ventilating Systems."

- B. Filter Section: Cabinet material and finish shall match the air-handling unit cabinet, with filter media holding frames arranged for flat or angular orientation. Section shall have access doors on both sides of the unit.
- C. Disposable Filters: Provide disposable type air filters 2 inches thick, consisting of viscous coated fibers with filtering media encased in fiberboard cell sides having perforated metal grids on each face to provide media support. Airflow resistance with clean media shall not exceed 0.10-inch w.g. at face velocity of 300 fpm, and filter arrestance efficiency of 70 to 82 percent based on ASHRAE Test Standard 52 - Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION:

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, housekeeping pads, and other conditions affecting performance of central-station air-handling units.
- B. Examine rough in for steam, hydronic, condensate drainage piping and electrical to verify actual locations of connections prior to installation.
- C. Do not proceed until unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION GENERAL:

- A. Install central station air-handling units level and plumb, in accordance with manufacturer's written instructions. Support floor mounted units on concrete equipment bases using housed spring isolators. Secure units to anchor bolts installed in concrete equipment base.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

#### 3.3 EQUIPMENT BASES:

Construct concrete equipment pads as follows:

- A. Coordinate size of equipment bases with actual unit sizes provided. Construct base 4 inches larger in both directions than the overall dimensions of the supported unit.
- B. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
- C. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.
- D. Place concrete and allow curing before installation of units. Use Portland cement conforming to ASTM C 150, 4,000 psi compressive strength, and normal weight aggregate.

### 3.4 CONNECTIONS:

- A. Piping installation requirements are specified in other Division 15 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:
  - 1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.
  - 2. Connect piping to air-handling units with flexible connectors.
  - 3. Connect condensate drain pans as shown on the drawings.
- B. Duct installations and connections are specified in other Division 15 sections. Make final duct connections with flexible connections.
- C. Electrical Connections: The following requirements apply:
  - 1. Electrical power wiring is specified in Division 16.
  - 2. Temperature control wiring and interlock wiring is specified in Division 15 Section "Electrical Control Systems."
  - 3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

### 3.5 FIELD QUALITY CONTROL:

Manufacturer's Field Inspection: Arrange and pay for a factory-authorized service representative to perform the following:

- A. Inspect the field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
- B. Prepare a written report on findings and recommended corrective actions.

### 3.6 ADJUSTING, CLEANING AND PROTECTING:

- A. Adjust water coil flow with control valves to full coil flow to indicated gpm.
- B. Adjust damper linkages for proper damper operation.
- C. Clean unit cabinet interiors to remove foreign material and construction dirt and dust, vacuum clean fan wheel, fan cabinet, and coils entering air face.

### 3.7 COMMISSIONING:

- A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
  - 1. Remove shipping blocking and bracing.
  - 2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed on motors, starters, and disconnects.
  - 3. Perform cleaning and adjusting specified in this Section.
  - 4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operations. reconnect fan drive system, align belts, and install belt guards.
  - 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
  - 6. Set outside-air and return-air mixing dampers to minimum outside air setting.
  - 7. Comb coil fins for parallel orientation.
  - 8. Install clean filters.

9. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
  10. Disable automatic temperature control operators.
- B. Starting procedures for central station air-handling units:
1. Energize motor and verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM. Replace fan motor and motor pulleys as required to achieve design conditions.
  2. Measure and record motor electrical values for voltage and amperage.
- C. Shut unit down and reconnect automatic temperature control operators.
- D. Refer to Division 15 Section "Testing, Adjusting and Balancing" for procedures for air handling system testing, adjusting, and balancing.

### 3.8 DEMONSTRATION:

- A. Demonstration services: Arrange and pay for a factory-authorized service representative to train maintenance personnel on the following:
1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
  2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Contract Closeout" and Division 15 Section "Basic Mechanical requirements."
- B. Schedule training with at least 7 days advance notice.

END OF SECTION

SECTION 15870  
POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division-15 Sections apply to this Section:
  - 1. "Basic Mechanical Requirements."
  - 2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY:

- A. This Section includes the following types of power ventilators.
  - 1. Ceiling mounted ventilators.
  - 2. Roof mounted exhausters.
- B. Related Sections: The following sections contain requirements that relate to this Section:
  - 1. Division 15 Section "Electronic Control Systems" for control devices.
  - 2. Division 15 Section "Sequence of Operations" for control sequence descriptions.
  - 3. Division 15 Section "Testing, Adjusting, and Balancing" for air-handling systems testing, adjusting, and balancing requirements and procedures.

1.03 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

- B. Product data for selected models, including specialties, accessories, and the following:
  - 1. Certified fan performance curves with system operating conditions indicated.
  - 2. Certified fan sound power ratings.
  - 3. Motor ratings and electrical characteristics plus motor and fan accessories.
  - 4. Materials gages and finishes, including color charts.
  - 5. Dampers, including housings, linkages, and operators.
- C. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of each field connections.
- D. Wiring diagrams detailing wiring for power and controls and differentiating between manufacturer-installed wiring and field-installed wiring.
- E. Maintenance Data for power ventilators for inclusion in operating and maintenance manual specified in Division 1 and Division 15 Section " Basic Mechanical Requirements".

#### 1.4 QUALITY ASSURANCE:

- A. UL Compliance: Fans shall be designed, manufactured, and tested in accordance with UL 705 "Power Ventilators."
- B. NEMA Compliance: Motors and electrical accessories shall comply with NEMA Standards.
- C. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

#### 1.5 DELIVERY, STORAGE AND HANDLING:

- A. Lift and support units with manufacturer's designated lifting or supporting points.
- B. Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.

- C. Deliver fan units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

#### 1.5 SEQUENCING AND SCHEDULING:

- A. Coordinate the installation of roof curbs, equipment supports, and roof penetrations.
- B. Coordinate the size and location of structural steel support members.

#### 1.6 EXTRA MATERIALS:

Furnish one additional complete set of belts for each belt driven fan.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturer's offering products that may be incorporated in the work include, but are not limited to one of the following

- A. Ceiling Mounted Ventilators:
  - 1. Ammerman Company, Inc.
  - 2. Carnes Company, Inc.
  - 3. Cook (Loren) Co.
  - 4. Greenheck Fan Corp.
  - 5. Essick Air Products, Breidert.
  - 6. ILG Industries, Inc.
  - 7. Jenn Industries, Inc.
- B. Centrifugal Roof Ventilators:
  - 1. Ammerman Company, Inc.

2. Carnes Company, Inc.
3. Central Blower Co.
4. Cincinnati Fan and Ventilator Co.
5. Cook (Loren) Co.
6. Essick Air Products, Breidert.
7. Greenheck Fan Corp.
8. ILG Industries, Inc.
9. Jenn Industries, Inc.

## 2.2 SOURCE QUALITY CONTROL:

Testing Requirements: The following factory tests are required:

- A. Sound Power Level Ratings: Comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans in accordance with AMCA Standard 300 "Test Code for Sound Rating." Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51 - Laboratory Methods of Testing Fans for Rating.

## 2.3 FANS, GENERAL:

- A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished with indicated capacities and characteristics.
- B. Fans and Shafts: Statically and dynamically balanced and designed to for continuous operation at the maximum rated fan speed and motor horsepower. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.
- C. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation. Service factor: 1.4.
- D. Belts: Oil-resistant, non-sparking, and non-static.

- E. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions. Belt Guards: Provide steel belt guards for motors mounted on the outside of the fan cabinet.
- F. Shaft Bearings: Provide type indicated, having a median life "Rating Life" (AFBMA L<sub>50</sub>) of 200,000, calculated in accordance with AFBMA Standard 9 for ball bearings and AFBMA Standard 11 for roller bearings.
- G. Factory Finish: The following finishes are required:
  - 1. Sheet Metal Parts: Prime coating prior to final assembly.
  - 2. Exterior Surfaces: Baked enamel finish coat after assembly.

#### 2.4 CENTRIFUGAL ROOF VENTILATORS:

- A. General: Provide direct or belt driven roof ventilators as scheduled on the Drawings. Fan housing shall be heavy gauge aluminum mounted upon rigid support structure compatible with standard insulated roof curb. Drive assembly and wheel shall be removable without dismantling the fan housing.
- B. Fan: Fan wheel shall be centrifugal blower type, statically and dynamically balanced. Fan wheel and inlet cone shall be constructed of aluminum and the wheel shall overlap spun inlet venturi.
- C. Motor and Drive Assembly: Motors and drives shall be isolated from the exhaust air stream. Motors shall be heavy duty with permanently lubricated, sealed ball bearings. Belt drive models shall have wheel shaft mounted in heavy duty, permanently sealed pillow block ball bearings. Pulleys shall be fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final air balance. Motor and drive assembly shall be mounted on vibration isolators. Voltages as scheduled on the Drawings.
- D. Accessories: Factory curb with built-in insulation and cant; aluminum backdraft damper with parallel blades set to pivot in non-corrosive bearings, blade linkage with adjustable counter-balance, vinyl or felt blade tips.

#### 2.5 CEILING MOUNTED VENTILATORS:

- A. General Description: Centrifugal fan designed for installation in ceiling, wall, or concealed inline applications.

- B. Housing: Galvanized steel lined with acoustical insulation.
- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- D. Grille: Stainless steel, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- E. Electrical requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories: Manufacturer's standard roof jack, wall cap, and transition fittings as indicated.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION:

Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, roof curbs, equipment supports, and other conditions affecting performance of fans.

#### 3.2 INSTALLATION, GENERAL:

- A. General: Ventilating and exhaust fans not having integral vibration isolation shall be mounted on or suspended by vibration isolators. Where ductwork is connected to fans, Contractor shall provide UL labeled flexible duct connections.
- B. Curbs: Set roof mounted fans on factory or field built curbs and connect to ductwork as shown on the Drawings. Fans manufactured for sloped roofs to be flashed into roofing per Manufacturer's instructions. Flash, counterflash, caulk, and seal water tight per Manufacturer's instructions and Architectural details.
- C. Install fans in accordance with Manufacturer's instruction and accepted methods.

END OF SECTION

SECTION 15891  
METAL DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 15 Sections apply to this section:
  - 1. "Mechanical General Provisions."
  - 2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY:

- A. This Section includes rectangular, ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 2 inches to plus 10 inches water gage.
- B. Types: The types of ductwork specified in this Section include the following:
  - 1. Air conditioning supply and return air systems
  - 2. Outdoor air supply systems
  - 3. Mechanical exhaust systems
  - 4. Air relief systems

1.3 DEFINITIONS:

Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:

- A. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All

other duct surface connections made on the perimeter are deemed to be joints.

- B. Joints: Joints include girth joints; branch and sub-branch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

#### 1.4 SYSTEM PERFORMANCE REQUIREMENTS:

The duct system design, as indicated has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the dust system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

#### 1.5 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:
  - 1. Sealing Materials.
  - 2. Fire Stopping Materials.
- C. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 15 Section "Basic Mechanical Requirements and Division 1.

#### 1.6 QUALITY ASSURANCE:

- A. NFPA Compliance: Comply with the following NFPA Standards: NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.
- B. SMACNA Standards: Comply with Sheet Metal and Air Conditioning Contractors National Association (SMACNA) recommendations for fabrication, construction, details, and installation procedures, except as otherwise indicated on the Drawings or in these Specifications.

- C. ASHRAE Standards: Comply with American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommendations, except as otherwise indicated on the Drawings or in these Specifications.

## PART 2 - PRODUCTS

### 2.1 SHEET METAL MATERIALS:

- A. Sheet Metal, General: Provide sheet metal in thickness indicated, packaged and marked as specified in ASTM A 700.
- B. Galvanized Sheet Steel: Lock forming quality, ASTM A 527, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.
- C. Carbon Steel Sheets: ASTM A 366, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.
- D. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts.
- E. Tie Rods: Galvanized steel, 1/4 inch minimum diameter for 36 inch length or less; 3/8 inch minimum diameter for lengths longer than 36 inches.

### 2.2 SEALING MATERIALS:

- A. Joint and Seam Sealants, General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.
- B. Joint and Seam Sealant: One-part, no sag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 75 percent solids.
- C. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

### 2.3 FIRESTOPPING:

- A. Fire Resistant Sealant: Provide two-part, foamed in place, firestopping silicone

sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

- B. Products: Subject to compliance with requirements, provide one of the following:
1. "Dow Corning Fire Stop Foam"; Dow Corning Corp.
  2. "Pensil 851"; General Electric Co.

#### 2.4 HANGERS AND SUPPORTS:

- A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4 inches thick.
- B. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod. Straps and Rod Sizes: Conform with Table 4-1 in SMACNA HVAC Duct Construction Standards, 1985 Edition, for sheet steel width and gage and steel rod diameters.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes conforming to ASTM A36. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.

#### 2.5 RECTANGULAR DUCT FABRICATION:

- A. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards" Tables 1-3 through 1-19, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.
1. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
  2. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains and discolorations.

- B. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:
1. Supply Ducts: 2 inches water gage.
  2. Outside Air Ducts: 1-inch water gage.
  3. Return Ducts: 1-inch water gage, negative pressure.
  4. Exhaust Ducts: 1-inch water gage, negative pressure.
- C. Cross breaking or Cross Beading: Cross break or bead duct sides that are 19 inches and larger and are 20 gage or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standard," Figure 1-4, unless they are lined or are externally insulated.

## 2.6 RECTANGULAR DUCT FITTINGS:

Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal; Duct Construction Standard," 1985 Edition, Figures 2-1 through 2-10.

## 2.7 ROUND DUCT FABRICATION

Round Ducts: Fabricate round ducts 2" pressure class or less using seam types identified in SMACNA "HVAC Duct Construction Standards," 1985 Edition, Figure 3-1, RL-1, RL-4, or RL-5. Seams Types RL-3 may be used if spot-welded on 1-inch intervals. Comply with SMACNA "HVAC Duct Construction Standards," Table 3-2 for galvanized steel gages.

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION, GENERAL:

- A. Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification indicated.
- B. Install ducts with the fewest possible joints.
- C. Use fabricated fittings for all changes in directions, changes in size and shape,

and connections.

- D. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
- E. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.
- H. Install insulated ducts with 1-inch clearance outside of insulation.
- I. Conceal ducts from view in finished and occupied spaces by locating in mechanical; shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.
- J. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- K. Electrical Equipment Spaces: Route ductwork to avoid passing through electrical equipment spaces and enclosures.
- L. Non-Fire-Rated Partition Penetration: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2 inches.

### 3.2 SEAM AND JOINT SEALING:

- A. General: Seal duct seams and joints as follows:
  - 1. Pressure Classification 2 Inch Water Gage: All transverse joints and fitting connections sealed. Snaplock seams sealed; other type seams: not more than one unsealed longitudinal seam on the perimeter.
  - 2. Pressure Classification Less than 2 Inch Water Gage: All transverse joints sealed. Snaplock fittings sealed; Maximum of two unsealed longitudinal seams on the perimeter.

- B. Seal externally insulated ducts prior to insulation installation.

### 3.3 HANGING AND SUPPORTING:

- A. Install rigid rectangular metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards," Tables 4-1 through 4-3 and Figures 4-1 through 4-8.
- B. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.
- C. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated.

### 3.4 CONNECTIONS:

- A. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 15 Section "Duct Accessories."
- B. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figures 2-7 and 2-8.
- C. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figures 2-16 through 2-18.
- D. Terminal Units Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figure 2-19.

### 3.5 CLEANING:

- A. General: Clean ductwork internally, section-by-section of dust and debris as it is installed. The ductwork system shall be completely cleaned prior to operation of any fans connected to the duct system. Clean external surfaces of foreign substances which might cause corrosive deterioration of the metal, or, where ductwork is to be painted, might interfere with painting or cause paint damage.
- B. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at the time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent the entrance of dust and debris until such time that connections are to be completed.

END OF SECTION

SECTION 15910  
DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

Drawings and general Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY:

- A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this section.
- B. Types of ductwork accessories required for project include the following:
  - 1. Dampers.
    - a. Low pressure manual dampers.
    - b. Control dampers.
    - c. Counterbalanced relief dampers.
  - 2. Fire dampers
  - 3. Extractors and Turning vanes
  - 4. Ductwork hardware
  - 5. Access doors
  - 6. Flexible connections

1.3 QUALITY ASSURANCE:

- A. SMACNA Compliance: Comply with applicable portions of Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) "Low Velocity Duct Construction Standards".

- B. ASHRAE Standards: Comply with American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
- C. UL Compliance: Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers".
- D. NFPA Compliance: Comply with applicable portions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.

#### 1.4 SUBMITTALS:

Product Data: Submit manufacturer's technical data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions.

#### PART 2 - PRODUCTS:

##### 2.1 MANUFACTURER:

Manufacturer: Subject to compliance with requirements, provide dampers of one of the following:

- A. Dampers:
  - 1. Air Balance, Inc.
  - 2. Airguide Corp.
  - 3. American Warming and Ventilating, Inc.
  - 4. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
  - 5. Louvers & Dampers, Inc.
  - 6. Penn Ventilator Co.
  - 7. Ruskin Mfg. Co.
- B. Fire Dampers:

1. Air Balance, Inc.
  2. American Warming and Ventilating, Inc.
  3. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
  4. Louvers & Dampers, Inc.
  5. Penn Ventilator Co.
  6. Phillips-Aire
  7. Ruskin Mfg. Co.
- C. Extractors & Turning Vanes:
1. Aero Dyne Co.
  2. Airsan Corp.
  3. Anemostat Products Div.; Dynamics Corp. of America.
  4. Barber-Colman Co.
  5. Duro Dyne
  6. Environmental Elements Corp.; Subs. Koppers Co., Inc.
  7. Hart & Cooley Mfg. Co., Inc.
  8. Souther, Inc.
- D. Duct Hardware:
1. Ventfabrics, Inc.
  2. Young Regulator Co.
- E. Duct Access Doors:
1. Air Balance Inc.
  2. Duro Dyne Corp.
  3. Register & Grille Mfg. Co., Inc.

4. Ruskin Mfg. Co.
5. Ventfabrics, Inc.
6. Zurn Industries, Inc.; Air Systems Div.

F. Flexible Connections:

1. American/Elgen Co.; Energy Div.
2. Duro Dyne Corp.
3. Flexaust (The) Co.
4. Ventfabrics, Inc.

2.2 DAMPERS:

- A. Low Pressure Manual Dampers: Provide dampers of single blade type or multi-blade type, constructed in accordance with SMACNA "HVAC Duct Construction Standards".
- B. Control Dampers: Refer to Division section "Temperature Control Systems" for control dampers; not work of this section.
- C. Counterbalanced Relief Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to relieve at indicated static pressure. Construct blades of 16-gage aluminum., provide 1/2" diameter ball bearings, 1/2" diameter steel axles spaced on 9" centers. Construct frame of 2"x 1/2"x 1/8" steel channel for face areas 25 sq. ft. and under; 4"x 1-1/4"x 16-ga channel for face areas over 25 sq. ft. Provide galvanized steel finish on frame with aluminum touch-up.

2.3 FIRE DAMPERS:

Fire Dampers: Provide fire dampers, of types and sizes indicated. Construct casings of 11-gage galvanized steel with bonded red acrylic enamel finish. Provide fusible link rated at 160 to 165 deg F. unless otherwise indicated. Provide damper with positive lock in closed position, and with the following additional features: Damper Blade Assembly: Curtain type.

2.4 EXTRACTORS AND TURNING VANES:

- A. Manufactured Extractors: Provide extractors with adjustable blades furnished with operator type indicated, with gang-operated galvanized steel or .040 aluminum curved blades on 1" centers synchronized to remain parallel. Operation shall be as follows as indicated on the drawings.
  - 1. Type 1: Push-Pull Double Wire, Locked with Sheet Metal Screw.
  - 2. Type 2: 3/8-inch Square rotating shaft. Furnish shaft length required.
  - 3. Type 3: Key-Operated screw. Access through air outlet face.
- B. Manufactured Turning Vanes: Provide turning vanes constructed of 1-1/2" wide curved blades set at 3/4" o.c., supported with bars perpendicular to blades set at 2" o.c., and set into side strips suitable for mounting in ductwork.

## 2.5 DUCT HARDWARE:

General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:

- A. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.
- B. Quadrant Locks: Provide for each damper, and extractor operated by square rotating shaft, a quadrant lock on one end of shaft; and end bearing plate on other end for damper and extractor lengths over 12 inches. Provide extended quadrant locks and extended bearing plates for externally insulated ductwork.

## 2.6 DUCT ACCESS DOORS:

- A. General: Provide where indicated, duct access doors of size indicated.
- B. Construction: Construct of same or greater gage as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle type latches for larger doors.

## 2.7 FLEXIBLE CONNECTIONS:

General: Provide duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped

into duct flanges for attachment to duct and equipment. Make airtight joint. Provide thirty ounce or glass fabric lined with insulation, and coated on both sides with neoprene, complete with attachment accessories, "Vent-Glass" by Vent-Fabrics, Inc. or approved equal. Connections shall not be less than 4" long, shall have suitable metal collar frame on each end, and shall be made with at least 1" slack material.

## 2.8 SPLITTER DAMPERS:

General: Splitter dampers shall be not less than 16-gauge. Splitter dampers shall be 1-1/2 times the width of narrowest duct leaving split, except not less than 12" long, and shall have not more than 1/4" less height than duct in which it is installed. Splitter dampers having area less than 2.25 square feet shall be adjusted by means of a locking quadrant mounted on end of shaft. Splitter dampers having larger area shall be adjusted by means of one or more push rods in accordance with Fig. 2-5, SMACNA "Low Velocity Duct Construction Standards".

## PART 3 - EXECUTION

### 3.1 INSPECTION:

Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

### 3.2 INSTALLATION OF DUCTWORK ACCESSORIES:

- A. General: Install all duct accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Install turning vanes in square or rectangular 90 deg elbows in supply, return, outside air and exhaust air systems, and elsewhere as indicated.
- C. Access Doors: Install access doors to open against system air pressure, with latches operable from either side, except where the duct is too small for person to enter. Provide access to each fire damper link to permit resetting.
- D. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

### 3.3 FIELD QUALITY CONTROL:

Operate installed ductwork accessories to demonstrate compliance with requirements. Check for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakfree performance.

### 3.4 ADJUSTING AND CLEANING:

- A. Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action. Final positioning of manual dampers is specified in Division 15 section "Testing Adjusting, and Balancing".
- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

### 3.5 EXTRA STOCK:

Furnish extra fusible links to Contracting Officer, one link for every 10 installed of each temperature range; obtain receipt.

END OF SECTION

## SECTION 15932

## AIR OUTLETS AND INLETS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.
- B. Types of air outlets and inlets required for the project include the following:
  - 1. Ceiling air diffusers.
  - 2. Grilles and registers.
  - 3. Louvers.
- C. Refer to other Division 15 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this section.
- D. Refer to other Division 15 sections for balancing of air outlets and inlets; not work of this section.

## 1.3 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
  - 1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".
  - 2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance

with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.

3. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".
4. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.
5. NFPA Compliance: Comply with National Fire Protection Association (NFPA) Standard No. 90A, as applicable to air diffuser construction and installation.

#### 1.4 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
  1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
  2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
  3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.
- B. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

#### 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver air outlets and inlets wrapped in factory-fabricated fiberboard type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.
- B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURER'S

Available Manufacturers: Subject to compliance with requirements, manufacturer's offering products that may be incorporated in the work include, but are not limited to, the following:

- A. Metalaire
- B. Titus
- C. Krueger
- D. Carnes
- E. Barber Coleman.

### 2.2 CEILING AIR DIFFUSERS:

- A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, and type indicated; constructed of materials and components, and with finishes as indicated and as required for a complete installation.
- B. Performance: Provide ceiling air diffusers that have, as a minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems, which will contain each type of ceiling air diffuser.
- D. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule.

### 2.3 REGISTERS AND GRILLES

- A. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, and type indicated; constructed of materials and components, and with finishes as indicated and as required for a

complete installation.

- B. Performance: Provide registers and grilles that have, as a minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Ceiling and Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent ceiling and wall systems, and that are specifically manufactured to fit into ceiling and wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction that will contain each type of ceiling air diffuser.
- D. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as listed on diffuser schedule.

## 2.4 LOUVERS:

- A. General: Except as otherwise indicated, provide manufacturer's standard louvers where shown; of sizes, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide louvers that have minimum free area, and maximum pressure drop for each type as listed in manufacturer's current data, complying with louver schedule.
- C. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate that will contain each type of louver.
- D. Materials: Construct of aluminum extrusions, ASTM B221, Alloy 6063-T52. Weld units or use stainless steel fasteners.
- E. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

## PART 3 - EXECUTION

### 3.1 INSPECTION:

Examine areas and conditions under which air outlets and inlets are to be installed. Do

not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

- A. General: Install air distribution devices in accordance with Manufacturer's written instructions and recognized industry practices to ensure that products serve intended functions.
- B. Coordination: Coordinate with other trades, including ductwork and ductwork accessories, as necessary to interface air distribution devices properly with other Work.
- C. Locate ceiling air diffusers, registers, and grilles, as indicated on plans. Unless otherwise indicated, locate units in center of acoustical ceiling modules.

3.3 SPARE PARTS:

Furnish to Contracting Officer, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

END OF SECTION

## SECTION 15970

## TEMPERATURE CONTROL SYSTEM

## PART 1 - GENERAL

## 1.1 REQUIREMENTS

- A. Furnish a system of electric/electronic temperature controls as hereinafter specified and shown on drawings. The temperature control system shall be furnished and validated by "tac" formerly known as Control Systems International. System to be compatible with existing Oklahoma Air National Guard system.
- B. The contractor shall provide all material required for the control system. This shall include all thermostats, temperature sensors, damper actuators, automatic dampers and accessories necessary to make a complete functioning system.
- C. The contractor shall install the temperature control system and provide all temperature control wiring including the power wiring associated with the temperature control devices.
- D. The temperature controls system supplier shall provide complete working diagrams for the control system. Diagrams will include wiring diagrams with numbered terminal identification for all field installed wiring and a description of operation. Control diagrams on the plans show the quality and function required for each sub-system. Alternative control designs may be submitted for approval. All drawings shall be submitted to the contracting officer for approval before work is commenced. One copy shall be framed under glass after work is complete and mounted in the mechanical room. In addition, the control manufacturer shall provide operational and maintenance instructions to the Contracting Officer after the job is complete.
- E. After completion of the installation, the contractor shall adjust all control devices, control valves, motors, and other equipment provided under the contract. He shall place them in complete operating condition subject to approval of the contracting officer. The control system herein specified shall be free from defects in workmanship and material under normal use and service. If, within twelve (12) months from the date of acceptance, any of the equipment herein described is found to be defective in workmanship or material, it shall be repaired or replaced without cost to the Government.

## 1.2 WORK INCLUDED

- A. Complete system of automatic controls
- B. Electronic control system control valves
- C. Electronic control system
- D. Control devices, components, wiring and material.
- E. Interconnection with existing control systems.
- F. Instructions for Facility operating and maintenance personnel.

### 1.3 RELATED WORK

- A. Section 15910: Ductwork Accessories
- B. Division 16: Electrical

### 1.4 SUBMITTALS

- A. Submit in accordance with Division 1 and Section 15010.
- B. Provide valve schedules, which show sizes, dimensions and arrangements.
- C. Provide complete operators manuals including detailed system schematic drawings with all control devices schedules along with complete detail wiring diagrams showing proper electrical interface to equipment furnished. Drawings must be coordinated with type equipment installed on the project (standards and/or typicals not acceptable). Sequence of operations shall be written on the drawings. Data sheets for each piece of control equipment shall be incorporated in the operators' manual.

### 1.5 SCOPE

Furnish and install a SDDC system for control of heating and/or air conditioning systems with sensors, thermostats, relays, electric switches, electronic switches, control valves, and other necessary facilities as called for by drawings and specifications or as required for a complete operable control system.

## PART 2 - OPERATION

## 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer and type: “tac” – I/Net 2000
- B. Substitutions: Written approval required seven (7) days prior to bid date. Request for approval required detailed brochure including data on all devices with any deviations from specifications fully described in written form.

## 2.2 CONTROL SYSTEMS

- A. Control system and equipment shall be as hereinafter specified and as called for by the diagram, schedules and information on drawings. All instruments shall be fully adjustable as to setpoint, sensitivity ratio and reset ranges. The contractor shall furnish, install and adjust all equipment required for dose regulation of temperatures and conditions and shall guarantee operation for a period of one year after final approval of the building project. Complete diagrams and details of control equipment and operation shall be submitted to the Contracting Officer before starting the work.
- B. One copy of approved diagrams shall be laminated and mounted on a wall where directed by the Contracting Officer.

## 2.3 SYSTEM REQUIREMENTS

- A. Furnish and install complete control system including interface with all new and existing equipment and checkout and system validation.
- B. Installation by personnel employed by automatic temperature company specified in Paragraph 2.01 A
- C. Work Under Other Sections:
  - 1. All automatic valves, separable wells, pressure taps, flow devices, and all pipe mounted pressure and temperature gauges, etc- shall be Installed under conditions and requirements of sections of this specification describing the work.
  - 2. All electronic damper operators, and any access doors or other approved means of access through ducts allowing access to temperature control devices Installed inside ductwork shall be installed under conditions and requirements of Sections 15891 and 15910. Coordinate location of and provide free space and future access to damper actuators.

3. All electrical wiring and wiring connections required for the proper operation of the temperature control and building automation systems shall be provided under conditions and requirements of Division 16 Work.

## 2.4 THERMOSTATS, CONTROLLERS, TRANSMITTERS, DETECTORS, HUMIDISTAT, SENSORS

- A. High Temperature Detection: Electric high temperature thermostats shall have a bimetal type-sensing element with at least a 10" insertion length. These thermostats shall be two-position manual reset type.
- B. Ionizations Smoke Detectors: Furnish and Install in return air of all air handling units UL listed self contained duct type smoke detectors with sampling tubes extending across duct. For units with a capacity over 15,000 CFM, install self contained smoke detectors in both return air and supply air duct Smoke detectors shall be wired to shut down fan when sensing products of combustion.
- C. Duct Controllers and Transmitters: Bulbs in mixed air, discharge ducts and at coil discharges shall be averaging type. In ducts or plenums over six feet (6') wide, averaging bulbs shall be of at least seventeen feet (17') in length.
- D. Humidity Sensors
  1. Humidity sensors shall be of the solid-state type using hygroscopic plastic as the sensing element. The sensor shall vary the output voltage with a change in relative humidity. Sensors shall have a minimum accuracy of +3% RH at 70 degrees F.
  2. Sensors shall be designed for wall or duct mounting as required for the application.
- E. Temperature Sensors
  1. Temperature sensors shall be of the treated thermistor type. Thermistors shall be treated with series and parallel resistors to fix the span, provide linearity, and ensure interchangeability. Untreated thermistors are not acceptable. Resolution shall be 1.0 degree F. for display and 0.25 degrees F. for control. Repeatability shall be 0.25 degrees F.
  2. Temperature sensors may also be of the Platinum RTD element type for accuracy, linearity, and resolution.
  3. Sensors shall be designed for wall, pipe, or duct mounting as required for the application.

4. Room sensors shall be neutral color, high Impact ASS plastic, with a brushed aluminum faceplate.

## 2.5 AUTOMATIC CONTROL VALVES

Contractor shall be responsible for selection of proper automatic control valves including size, pressure rating, flow-coefficient, shutoff rating and allowable leakage factor. Select all automatic control valves required by the control sequences, control diagrams and input/output summaries. All valves installed for two-position operation and/or three-position operations shall be line size. Modulating water valves shall be sized not to exceed 34.5 kPa (5 PSI) maximum pressure drop.

- A. Modulating single-seated straight-through valves shall be provided with equal-percentage contoured throttling plugs. Stems shall be stainless steel. Valves 65 mm (2-1/2 inches) and larger shall be cast iron body Class 150 flanged valves.
- B. Modulating single-seated straight-through valves in sizes less than 40 mm (2 inch) shall have female NPT inlet and outlet connection. Valve body and plug shall be brass with a 1725 kPa (250 PSIG) pressure rating. Stem shall be stainless steel. Provide renewable disc and back seating feature. Flow characteristics shall be equal percentage.
- C. Electric/electronic valve operators shall be provided for each automatic valve and shall be of sufficient capacity to operate the valve under all conditions, and to guarantee tight close-off of valves, as specified, against system pressure encountered. Each operator shall be full-proportioning or two-positions type as specified under sequence of control and shall be provided with spring-return for normally closed or normally open position, as indicated on the drawings, for fire, freeze, or moisture protection upon power interruption. Valve operators shall be equal to Belimo AF24-SR-US, NF24-SR-US, or equal. Valve operators shall meet the following requirements:

1.	Power Supply	24 VAC +/- 20% 50/60 Hz 24 VAC +/- 10%
2.	Overload Protection	Electronic throughout 0-95° rotation
3.	Input Impedance	100k ohm (0.1mA), 500 ohm
4.	Operating range	2 to 10 VDC, 4 to 20 mA
5.	Feedback output U	1 to 20 VDC (max. 0.5 mA) for 95°
6.	Angle of rotation	95°, adjustable 30 to 95° w/ accessories
7.	Torque	As required (60 in-lb minimum)

8.	Direction of rotation	Spring return reversible with CW/CCW mounting control direction selected by switch. CW=CW with a decrease in signal. CCW=CCW with a decrease in signal.
9.	Position indicator	Visual indicator, 0 to 95° (0° is spring return position)
10.	Housing	NEMA Type 2/IP54
11.	Housing Material	Zinc Coated Metal
12.	Agency Listings	UL 873 listed, CSA 4813 0 certified, CE
13.	Servicing	Maintenance Free
14.	Quality standard	ISO 9001

## 2.6 LOW TEMPERATURE DETECTION (Freeze Stat)

All electric low temperature thermostats shall have 20' low point sensitive elements (not averaging type) installed to serpentine the entire coil face area. The element shall be installed in the mixed air stream on the entering air side of the coil. The elements shall be two-position type responding to the lowest temperature sensed along 10 inches of its length. The 40 deg. F. stats shall be manual reset.

## 2.7 ELECTRIC DAMPER ACTUATORS

Electric damper actuators shall be Belimo Model NM24 PWM or equal. Actuators will be of the modulating variety unless otherwise specified. Actuators shall include spring return. Actuators shall meet the following requirements:

1.	Power Supply	24 VAC +/- 20% 50/60 Hz
2.	Mounting Position	Not Sensitive to position
3.	Input Impedance	1.5k $\Omega$
4.	Operating range	4 ranges externally selectable: 0.59 to 2.93 sec 0.1 to 25.5 sec 0.02 to 5.0 sec

		0.02 to 6.0 sec
5.	Feedback output U	2...10 VDC, 0.7 mA max
6.	Angle of rotation	0...95°, adjustable stops
7.	Torque	min 75 in-lb (8 Nm)
8.	Direction of rotation	Reversible with switch L-R
9.	Position indicator	Clip on indicator
10.	Housing Type	NEMA 2
11.	Housing Mat'l rating	UL 94V-0 (Flammability rating)
12.	Agency Listings	UL 873 listed, CSA 4813 02 certified
13.	Servicing	Maintenance Free
14.	Quality standard	ISO 9001
15.	Control signal 'Y'	Pulse width modulating signal
16.	Mounting strap	anti-rotation T-Type included

## 2.8 CONTROL AIR DAMPERS

Furnish automatically controlled low leakage opposed blade volume damper in locations shown on drawings. Dampers shall be constructed of 13 gauge galvanized sheet steel frame and double 22 gauge galvanized sheet steel blades. Provide synthetic bearings and square or hexagonal axles. Round axles are not acceptable. Notch the exposed ends of damper axles to indicate damper position where damper axles are attached to electric actuators. Blades shall have synthetic elastomer seals along entire blade length. Damper air leakage shall be less than 1/2% (based on 2000 fpm and 4 inch w.g. static pressure). Dampers shall be electrically operated, see paragraph 2.7 of this section.

## 2.9 COMMUNICATIONS

- A. Use dedicated fiber optic lines from existing fiber optic chassis in Building 313 to control panel in mechanical room.
- B. Communications lines to be provided by base Contracting Officer.

## 2.10 MISCELLANEOUS EQUIPMENT

The control manufacturer shall furnish all two-position relays, capacity relays, pneumatic sequencing relays, plus all other controls necessary to meet the Specifications and provide for properly operating automatic control system. All electric-pneumatic or pneumatic-electric switches and relays must be UL listed and of a type to meet current and voltage requirements of the particular application.

## 2.11 CONTROL PANELS

- A. Provide CSI 7716 Process Control Unit (PCU) and DDC panels as required for a complete system of control and monitoring.
- B. Provide local panels of unitized cabinet type to house PCU's, Pilot relays (E-P switches), diverting valves and other ATC devices where required.
- C. Control panels shall be mounted on vibration free walls or free standing steel angle supports. Panels shall be mounted in an accessible location approximately 4 feet above floor level in the general area of the equipment being served.
- D. Fabricated panels shall be of extruded aluminum alloy frames with enamel-baked finish on front face panel and hinged key-lock door.
- E. Each panel shall be identified with a nametag. Include working proposed to be used on nametags with submittal data. Each device mounted on face of panel shall be identified with engraved descriptive nametag.

## 2.12 STAND ALONE DDC PANELS

- A. General: Stand alone DDC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each stand-alone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached point list.
- B. Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases including:
  - 1. Control processes -
  - 2. Energy Management Applications

3. Alarm Management
  4. Historical/Trend Data for all points
  5. Maintenance Support Applications
  6. Custom Processes
  7. Operator I/O
  8. Dial-up Communications
  9. Manual Override Monitoring
- C. Point types: Each DDC panel shall support the following types of point inputs and outputs:
1. Digital Inputs for status/alarm contacts
  2. Digital Outputs for on/off equipment control
  3. Analog Inputs for temperature, pressure, humidity, flow and position measurements
  4. Analog Outputs for valve and damper position control, and capacity control of primary equipment
  5. Pulse Inputs for pulsed contact monitoring
- D. Expandability: The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators. The system architecture shall support 10% expansion capacity of all types of DDC panels, and all point types included in the initial installation.
- E. Serial Communication Port~: Stand alone DDC panels shall provide at least two RS-232C serial data communication ports, a RS-485 LAN port, and a TTL port for simultaneous operation of multiple operator I/O devices such as industry standard printers, laptop workstations, PC workstations, and panel mounted or portable DDC panel Operator's Terminals. Stand-alone DDC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.
- F. Hardware Override Switches: As indicated in the point schedule, the operator shall have the ability to manually override automatic or centrally executed commands at the DDC panel via local, point discrete, on board hand/off/auto operator override switches for binary control points and gradual switches for analog control type points. These override switches shall be operable whether the panel is powered or not.

- G. Hardware Override Monitoring: DDC panels shall monitor the status or position of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited. DDC panels shall also collect override activity information for daily and monthly reports.
- H. Local Status Indicator ~mo~.: The DDC panel shall provide local status indication for each binary Input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
- I. Integrated On-Line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel, and shall not require the connection of an operator I/O device.
- J. Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all Field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.
- K. Powerfail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all stand alone DDC panels to prevent the loss of database or operating system software. Non-Volatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention. Should DDC panel memory be lost for any reason, the user shall have the capability of reloading the DDC panel via the local area network, via the local RS-232C port, or via telephone line dial-in.

## 2.13 SYSTEM SOFTWARE FEATURES

- A. General
  1. All necessary software to form a complete operating system as described in this specification shall be provided.
  2. The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher-level computer for execution.
- B. Control Software Description:

1. Pre-Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms:
    - a. Two-Position Control
    - b. Proportional Control
    - c. Proportional plus Integral Control
    - d. Proportional, Integral, plus Derivative Control
    - e. Automatic Control Loop Tuning
  2. Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one hour period.
  3. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
  4. Powerfail Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.
- C. Energy Management Applications: DDC Panels shall have the ability to perform any or all of the following energy management routines:
1. Time of Day Scheduling
  2. Calendar Based Scheduling
  3. Holiday Scheduling
  4. Temporary Schedule Overrides
  5. Optimal Start
  6. Optimal Stop
  7. Night Setback Control
  8. Heating/Cooling Interlock
  9. Cold Deck Reset

10. Hot Deck Reset
  11. Hot Water Reset
- D. All programs shall be executed automatically with the need for operator Intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Execution portion of this specification.
- E. Custom Process Programming Capability: DDC panels shall be able to execute custom, job- specific processes defined by the user, to automatically perform calculations and special control routines.
- F. Process Inputs and Variables: It shall be possible to use any of the following in a custom process:
1. Any system-measured point data or status
  2. Any calculated data
  3. Any results from other processes
  4. User-Defined Constants
  5. Arithmetic functions (+, -, \*, /, square root, exp, etc.)
  6. Boolean logic operators (and, or, exclusive or, etc.)
  7. On-delay/Off-delay/One-shot timers

## 2.16 SEQUENCE OF OPERATION

Refer to drawings for description and schematic control diagrams.

## PART 3 - EXECUTION

- 3.1 Contractor shall furnish complete operating instructions manual and training for facility operating personnel (minimum 8 hours).
- 3.2 System shall have complete two-year warranty against material or workmanship failures.
- 3.3 Inspection: Examine areas and conditions under which temperature control

systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

END OF SECTION

## SECTION 15985

## SEQUENCE OF OPERATION

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 15 Sections apply to this section:
  - 1. "Basic Mechanical Requirements."
  - 2. "Basic Mechanical Materials and Methods."

## 1.2 DESCRIPTION OF WORK:

- A. Sequence of operation is hereby defined as the manner and method by which controls function. requirements for each type of control system operation are specified in this section.
- B. Operating equipment, devices, and system components required for control systems are specified in other Division 15 Controls' sections of these specifications.

## 1.3 SUBMITTALS:

- A. Shop Drawings: Submit shop drawings for each system automatically controlled, containing the following information:
  - 1. Schematic flow diagram of system showing fans, pumps, coils, dampers, valves, and control devices.
  - 2. Label each control device with setting or adjustable range of control.
  - 3. Indicate factory and field wiring.
  - 4. Indicate each control panel required, with internal and external wiring clearly indicated. Provide detail of panel face, including controls,

instruments, and labeling. Include verbal description of sequence of operation.

- B. Maintenance data: Include copy of shop drawings in each maintenance manual; in accordance with requirements of Division 1.

## PART 2 - PRODUCTS (not applicable to this section)

## PART 3 - EXECUTION

### 3.1 TERMINAL UNITS' CONTROL SEQUENCE:

Unit Heater Control: Provide single-temperature room thermostat to cycle gas burner controls and fan motor to maintain constant space temperature. Provide switch on thermostat to allow continuous fan operation.

### 3.2 VENTILATION CONTROL SEQUENCES:

Exhaust Fan Control: Energize exhaust fans noted as "ATC" on drawings during occupied cycle and de-energize during un-occupied cycle. When exhaust fan is activated, activate associated make-up air fan.

### 3.3 AIR HANDLING UNITS CONTROL SEQUENCES:

- A. Safety Controls for Air Handling Units: Provide low-limit controller to prevent mixed air from falling below 45 deg. F or temperature selected.
  - 1. Provide manual double pole fire stat in return air and discharge air of units greater than 2,000 CFM to stop fan on high temperature and to provide signal for fire alarm system.
  - 2. Provide freeze stat serpentine across leaving side of water coil adjacent to outside air connection. De-energize unit fan when temperature falls to 35 deg. F and close outside air damper.
- B. Single-Zone Air Handling Units w/o Preheat Coils; Control System Description: The air handling system consists of a supply fan, economizer dampers, filter, heating coil, and cooling coil. General sequence of operation is as follows:
  - 1. Supply fan off. When the fan is off, the cooling-coil valve and the outside-air and relief-air dampers are closed, and the return air damper is

- open. the heating-coil valve remains under space-temperature control.
2. Supply fan operating. When the fan is on, the control dampers and the cooling-coil valve are operated as required by the system's operational modes. The control dampers are positioned for full recirculation of air, positioned to introduce minimum outside air, or modulated to maintain space temperature. The cooling coil valve is either closed, or modulated to maintain space temperature.
  3. Control of the supply fan. Unless the fan is stopped as the result of a safety shutdown, it is on or off as required by the control system mode of operation.
  4. Safety shutdown of the fan. The control system shuts down the fan if there is a low temperature condition, or if smoke is detected.
  5. Low temperature detection. On a fall in temperature to its set point, a low temperature protection thermostat stops the supply fan. To restart the fan, the thermostat and the control panel must be manually reset.
  6. Smoke Detection. Duct-smoke detectors stop the supply fan whenever either detects the presence of smoke. To restart the fan, the smoke detectors and control panel must be manually reset.
  7. Filter Condition. Filter condition is monitored by a pressure gauge and differential-pressure switch. When the rise in pressure-drop across the filter reaches the switch set point, the switch turns on a pilot light.
  8. Economizer control. When the system does not need full return air circulation, the dampers are set at minimum position until the economizer controller closes both its process variable (PV) and deviation (DEV) contacts. The economizer controller closes its PV contacts when the return air temperature indicates the building requires cooling rather than heating. The economizer controller closes its DEV contacts when the outside air temperature is sufficiently below the return air temperature to be effective for cooling. When both these contacts close, the dampers are modulated as part of the space temperature control.
  9. Space temperature control. On a rise in space temperature, the heating coil valve is modulated toward closed. On a further rise in temperature, the outside air and relief air dampers are modulated from minimum position toward fully open while the return air damper is modulated toward fully closed. On a still further rise in space temperature, the cooling coil valve is modulated toward open. The reverse occurs on a fall in temperature.

10. Unoccupied mode of operation. Throughout the unoccupied mode, the outside air and relief air dampers and the cooling coil valve remain closed, and the return air damper remains open. The supply fan is cycled by the system's night thermostat to maintain its low-limit space-temperature set point.
11. Ventilation delay mode of operation. During the ventilation delay mode, the dampers remain as they were throughout the unoccupied mode, and the supply fan runs continuously. Until the ventilation delay mode ends, return air is circulated, to bring the space to comfort conditions using a minimum of energy. Heating coil and cooling coil valves are under space temperature control.
12. Occupied mode of operation. The supply fan runs continuously, and the outside air and relief air dampers are at a minimum position or are under space temperature control as previously described.

#### 3.4 REFRIGERATION EQUIPMENT CONTROL SEQUENCES:

Chiller Control: Provide electrical signal connection to factory installed control package. Provide flow switch to prevent chiller from operating when chiller water is not flowing. Provide for automatic start and automatic summer/winter changeover.

END OF SECTION

## SECTION 15990

## TESTING, ADJUSTING &amp; BALANCING

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

Drawings and General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

## 1.2 SUMMARY:

- A. This Section specifies the requirements and procedures for total mechanical systems (both new and existing) testing adjusting and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.
- B. Test, adjust and balance the following mechanical systems:
  - 1. Supply air systems.
  - 2. Return air systems.
  - 3. Exhaust and make-up air systems.
  - 4. Hydronic Systems.
  - 5. Verify temperature control system operation.
  - 6. Test systems for proper vibration levels.

## 1.3 DEFINITIONS:

- A. Systems testing adjusting and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:
  - 1. The balance of air and water distribution.

2. Adjustment of total system to provide design quantities.
  3. Electrical measurement.
  4. Verification of performance of all equipment and automatic controls.
  5. Vibration measurement.
- B. Test: To determine quantitative performance of equipment.
- C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).
- D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.
- E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
- F. Report Forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.
- G. Terminal: The point where the controlled fluid enters or leaves the distribution system. These are supply inlets on water terminals, supply outlets on air terminals, return outlets water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- H. Main: Duct or pipe containing the system's major or entire fluid flow.
- I. Submain: Duct or pipe containing part of the systems' capacity and serving two or more branch mains.
- J. Branch main: Duct or pipe serving two or more terminals.
- K. Branch: Duct or pipe serving a single terminal.
- 1.4 SUBMITTALS:
- A. Engineer and Technician Data: Submit proof that the Test and Balance Engineer assigned to supervise the procedures meet the qualifications specified below.
- B. Procedures and Agenda: Submit a synopsis of the testing, adjusting and balancing procedures and agenda proposed to be used for this project.

- C. Maintenance Data: Submit maintenance and operating data that include how to test, adjust, and balance the building systems. Include this information in maintenance data specified in Division 1 and Section 15010.
- D. Sample Forms: Submit sample forms, if other than those standard forms prepared by NEBB are proposed.
- E. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; and are accurate representation of how the systems have been installed; are an accurate representation of how the systems are operating at the completion of the testing, adjusting and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:
1. Draft Reports: Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
  2. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 3 complete sets of final reports.
  3. Report Format: Report format: Report forms shall be those standard forms prepared by the referenced standard form each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
    - a. General Information and Summary
    - b. Air Systems
    - c. Hydronic Systems
    - d. Temperature Control Systems
    - e. Special Systems
    - f. Vibration Control.
  4. Report Contents: Provide the following minimum information, forms and

data:

- a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Contracting Officer, and Project. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the seal and name address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of instrumentations used for the procedures along with the proof of calibration.
  - b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.
- F. Calibration Reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

#### 1.5 QUALITY ASSURANCE:

- A. Test and Balance Engineer's Qualifications: A Professional Engineer (either on the Installer's staff or an independent consultant), registered in the state in which the services are to be performed, and having at least 3-years of successful testing, adjusting and balancing experience o projects with testing and balancing requirements similar to those required for this project.
- B. Codes and Standards:
  1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
  2. ASHRAE: ASHRAE Handbook, current revision, Testing, Adjusting, and Balancing.
- C. Prebalancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the Contracting Officer. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting and balancing.

#### 1.6 PROJECT CONDITIONS:

Systems Operation: Systems shall be fully operational prior to beginning procedures.

#### 1.7 SEQUENCING AND SCHEDULING:

- A. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems.
- B. Test, adjust and balance air-conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 5 deg F wet bulb temperature of maximum summer design condition, and within 10 deg F dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

#### PART 2 - PRODUCTS

Not used.

#### PART 3 - EXECUTION

##### 3.1 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING:

Before operating the system, perform these steps:

- A. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
- B. Check filters for cleanliness.
- C. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
- D. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
- E. Determine best locations in main and branch ductwork for most accurate duct traverses.
- F. Place outlet dampers in full open position.
- G. Prepare schematic diagrams of system 'as-built' ductwork and piping layouts to

facilitate reporting.

- H. Lubricate all motors and bearings.
- I. Check fan belt tension.
- J. Check fan rotation.

### 3.2 PRELIMINARY PROCEDURES FOR HYDRONIC SYSTEM BALANCING:

Before operating the system, perform these steps:

- A. Open valves to full open position. Close coil bypass valves.
- B. Remove and clean all strainers.
- C. Examine hydronic systems and determine if water has been treated and cleaned.
- D. Check pump rotation.
- E. Clean and set automatic fill valves for required system pressure.
- F. Check expansion tanks to determine that they are not air bound and that the system is full of water.
- G. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
- H. Set temperature controls so all coils are calling for full flow.
- I. Check operation of automatic bypass valves.
- J. Check and set operating temperatures of chillers to design requirements.
- K. Lubricate all motors and bearings.

### 3.3 MEASUREMENTS:

- A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
- B. Provide instruments meeting the specifications of the referenced standards.

- C. Use only those instruments that have the maximum field measuring accuracy and are best suited to the function being measured.
- D. Apply instrument as recommended by the manufacturer.
- E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.
- F. When averaging values, take a sufficient quantity of readings that will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
- G. Take all reading with the eye at the level of the indicated value to prevent parallax.
- H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuating readings.
- I. Take measurements in the system where best suited to the task.

#### 3.4 PERFORMING TESTING, ADJUSTING AND BALANCING:

- A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.
- B. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- C. Patch insulation, ductwork, and housings, using materials identical to those removed.
- D. Seal ducts and piping, and test for and repair leaks.
- E. Seal insulation to reestablish integrity of the vapor barrier.
- F. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or suitable , permanent identification materials.
- G. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

### 3.5 TESTING FOR VIBRATION:

- A. Test and adjust mechanical systems for vibration in accordance with the detailed instructions of the referenced standards.
- B. Vibration and Alignment: Read and record vibration and measure and record alignment for all water circulating pumps, water chillers, air-handling units, and fans which have motors larger than 10 HP. Include shaft alignment, equipment vibration, bearing housing vibration, foundation vibration, building structure vibration, and other tests as directed by the Contracting Officer. Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various unwanted frequencies and standard reporting forms. Maximum vibration at any point listed above, or specified, shall not exceed 2 mils on fans, and 2 mils on pumps unless otherwise specified. Equipment Manufacturers shall certify in writing that the field readings that do not exceed the maximum specified are acceptable to them.

### 3.6 RECORD AND REPORT DATA:

- A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.
- B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

### 3.7 DEMONSTRATION:

- A. Train the maintenance personnel on troubleshooting procedures and testing, adjusting, and balancing procedures. Review with the maintenance personnel, the information contained in the Operating and Maintenance Data specified in Division 1 and Section 15010.
- B. Schedule training through the Contracting Officer with at least 7 days prior notice.

END OF SECTION