# SECTION 20 0553

# MECHANICAL IDENTIFICATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes:
   1. Equipment Nameplates.
   2. Valve Tags.
   3. Valve and Equipment Directories.
   4. Pipe Identification.
   5. Ceiling Markers.

### 1.2 REFERENCES

A. Codes and Standards:
   1. See section 20 0000 - Mechanical General Requirements.
   2. ANSI/ASME A13.1-2015 (American Society of Mechanical Engineers) - Scheme for the Identification of Piping Systems.
   3. ANSI Z535.1-2017 - Safety Colors.

### 1.3 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Provide equipment nameplates, valve tags and labels for the mechanical systems provided under this contract.
   2. Provide labels for piping. Paint exposed piping and pipe insulation in utility and mechanical rooms.

### 1.4 SUBMITTALS

A. Refer to Section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:
   1. Master Schedule of Equipment:
      a. Submit master schedule of equipment, components, and systems that will be tagged and labeled for the project.
      b. Include the proposed method of labeling to be implemented (nameplate, tag, label/marker, etc.), legend (“Domestic Cold Water,” “PMP-1,” etc.) and letter/background colors.
      c. Match legend to Contract Document legend, abbreviations, and schedule symbols. Use standard mechanical identification products when available.
   2. Equipment Directories: Submit separate proposed “Equipment Directories” (subset of the master schedule) for each mechanical room that includes the equipment located within the applicable space. Include system name, fluid or medium type, and normal operating properties and ranges.

3. Valve Directories: Submit separate proposed "Valve Directories" (subset of the master schedule) for each mechanical room that includes the valves located within the applicable space. Include valve designations, a brief description and normal position (open (NO), closed (NC), balanced to X GPM). For Example:

| Valve Designator | Description | Normal Position |
|---|---|---|
| H-101 | BLR-1 Supply Isolation | NO |
| H-102 | BLR-1 Return Isolation | NO |
| H-103 | BLR-1 Flow Balance | 150 GPM |
| P-100 | Domestic Water Service Isolation | NO |
| P-201 | Supply Strainer Flush Valve | NC |
| ETC. | | |

C. Installation, Operation and Maintenance (IO&M) Manuals:
1. Provide completed, typed "Master Schedule of Equipment."
2. Provide completed, typed "Equipment Directories."
3. Provide completed, typed "Valve Directories" with balance valve settings obtained from the final balance report.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Marking Services Incorporated (MSI).

B. Seton Identification Products.

C. Craftmark.

D. Approved equal.

### 2.2 EQUIPMENT NAMEPLATES

A. Plastic Engraved Equipment Nameplates:
1. Minimum letter height: 3/4 inch.
2. Tag size: Minimum 2 inches high, length to fit equipment tag lettering requirements. Provide uniform size for similar types of equipment.
3. Plastic thickness: 1/16 inch minimum.
4. Fastening method:
   a. Mounting holes.
   b. Adhesive backing may be provided for labeling equipment where drilling holes is not feasible, with the pre-approval of the Contracting Agency.
5. Color coding: As designated by the Contracting Agency. If specific direction is not provided, select white letters on black background.
6. Legend: As designated by the Contracting Agency. If specific direction not provided, match scheduled equipment symbols.

## 2.3 VALVE TAGS

A. General:
   1. Small equipment, such as in-line pumps may be identified with tags in lieu of nameplates if inadequate room is available.
   2. Provide service indicator on top line of tag, using system abbreviations provided in Part 3 Pipe Identification Table.
   3. Provide valve number on bottom line of tag. Start valve numbering with “001” for each legend series/service indicator. Assign valve numbers in a logical sequence from the source (i.e. service water entry point, gas meter service isolation) or heat source (boiler or water heater supply) and continue numbering outward to the most remote terminal connection point.

B. Plastic Engraved Tags:
   1. Round, 1-1/2 inches diameter, engraved plastic.
   2. Text stamped and filled black:
      a. 1/4 inch service indicator on top.
      b. 1/2 inch valve number below.
   3. Beaded chain tag fasteners.
   4. Provide tag color coding to match pipe marker coding or as designated by the Contracting Agency.

C. Brass Stamped Tags:
   1. Round, 1-1/2 inches diameter, brass with smooth edges.
   2. Text stamped and filled black:
      a. 1/4 inch service indicator on top.
      b. 1/2 inch valve number below.
   3. Beaded chain tag fasteners.

## 2.4 PIPE IDENTIFICATION, MARKING

A. Identify both service and flow direction.

B. Colors and Lettering: Conform to ANSI/ASME A13.1; see tables under Article 3.2E below.

C. Plastic Pipe Labels:
   1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering.
   2. Larger sizes may have maximum sheet size with plastic nylon ties or straps.

D. Plastic Tape Pipe Labels: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

## 2.5 CEILING MARKERS

A. Description:
   1. 7/8-inch diameter, color-coded.
   2. Metal push tacks or 0.030” rigid vinyl, pressure sensitive stickers.

B. Color code as follows:

1. HVAC equipment: Yellow.
2. Plumbing valves: Green.
3. Non potable water and waste water valves: Orange.
4. Heating/cooling valves: Blue.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to be painted or directly receive adhesive labels.

B. Install identifying devices after completion of coverings and painting.

3.2 INSTALLATION

A. Do not install identifying devices over factory installed equipment labels.

B. Locate identifying devices in clear view for simple identification.

C. Tag automatic controls, instruments, and relays. Key these to control system schematic drawings.

D. Frame and install approved equipment and valve directories in each mechanical room, at a location designated by the Contracting Agency.

E. Pipe Identification:
1. Identify piping, concealed or exposed, using ANSI A13.1 compliant pipe labels. Identify both service and flow direction in accordance with the following table.

| Abbreviation | Legend | Color (Letters/Background) |
|---|---|---|
| CW | Domestic Cold Water | White/Green |
| HW | Domestic Hot Water | White/Green |
| HWC | Domestic Hot Water Circulation | White/Green |
| HWS | Heating Water Supply | White/Green |
| HWR | Heating Water Return | White/Green |
| GHS | Glycol Heating Supply | White/Green |
| GHR | Glycol Heating Return | White/Green |
| LPS | Low Pressure Steam | White/Green |
| CR | Condensate Return | White/Green |
| RL | Refrigeration - Liquid | Black/Orange |
| RS | Refrigeration - Suction | Black/Orange |
| NG | Natural Gas | Black/Yellow |
| PG | Propane | Black/Yellow |

| Abbreviation | Legend | Color (Letters/Background) |
|---|---|---|
| FOS | Fuel Oil Supply | White/Brown |
| FOR | Fuel Oil Return | White/Brown |
| ARV | Acid Resistant Vent | Black/Orange |
| ARW | Acid Resistant Waste | Black/Orange |
| W | Sanitary Drain | White/Green |
| V | Sanitary Vent | White/Green |
| RL, ORL | Rain Leader, Overflow Rain Leader | White/Green |
| SD | Storm Drain | White/Green |
| FW | Fire Suppression Water | White/Red |
| CA | Compressed Air | White/Blue |

2. Pipe label letters shall be a minimum of 1/2" high and increase with pipe diameter as follows:

| Pipe Outside Diameter | Letter Height |
|---|---|
| 0.75" to 1.25" | 0.5" |
| 1.5" to 2" | 0.75" |
| 2.5" to 6" | 1.25" |
| 8" to 10" | 2.5" |
| over 10" | 3.5" |

3. Install labels in unobstructed view and aligned with horizontal or vertical axis of piping as appropriate. For piping located above the normal line of vision, place labels below the horizontal centerline of the pipe for clear unobstructed view from below.
4. Install labels not to exceed 20 foot intervals along straight piping runs (including risers and drops), close to valves, adjacent to changes in direction and branches, on each side of pipe penetrations through walls or floors, and at each access panel.

END OF SECTION 20 0553

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# SECTION 20 0700

# MECHANICAL INSULATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes: Specific requirements, products and methods of execution which relate to the insulation of ducts, fittings, equipment, pipes and other surfaces of the mechanical installation.

B. Related Sections:
1. 20 0000 - Mechanical General Requirements
2. 22 1100 - Domestic Water Piping and Specialties
3. 22 1300 - Sanitary Waste and Vent Piping and Specialties
4. 23 2113 - Hydronic Piping and Specialties
5. 23 3100 - Ducts and Accessories

### 1.2 REFERENCES

A. See section 20 0000 - Mechanical General Requirements.

B. ASHRAE 90.1 - 2010 Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. NFPA 90A - 2002 Standard for the Installation of Air Conditioning and Ventilating Systems.

D. NFPA 90B - 2006 Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

E. MSS Standard Practice SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

### 1.3 DESCRIPTION

A. Provide thermal insulation for ventilation system ductwork and building service piping.

B. Provide insulation for exposed ADA plumbing fixture piping.

### 1.4 SUBMITTALS

A. See Section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Qualifications: Submit manufacturer and Applicator qualifications.

1.5 QUALITY ASSURANCE

A. See section 20 0000 - Mechanical General Requirements.

1.6 DELIVERY, STORAGE AND HANDLING

A. See section 20 0000 - Mechanical General Requirements.

1.7 WARRANTY

A. See section 20 0000 - Mechanical General Requirements.

PART 2 - PRODUCTS

2.1 FIRE RATING OF MATERIALS

A. Provide insulation products used aboveground in building with burning characteristics in compliance with NFPA Standards 90A and 90B: Flame Spread 25, Fuel Contributed 50, Smoke Developed 50. Tested according to UL 723, ASTM E84, or NFPA 255.

B. Insulation specified for use underground and aboveground away from the building might have other burning characteristics. Use such products only where specifically required.

2.2 FIBERGLASS INSULATION

A. Piping: Provide insulation products as follows:
   1. Thermal conductivity K equals 0.24 at 100 degrees F mean temperature, ASTM C335.
   2. Factory applied vapor-barrier, flame retardant all service jacket and tape, with permeability rating equal to 0.02 perms, ASTM E 96.
   3. Temperature limits for fiberglass pipe insulation: 350 degrees F, unless otherwise indicated.
   4. Manufacturers: Johns Manville, Owens Corning, Knauf Fiber Glass, or approved equal.

B. Ductwork: Provide insulation products as follows:
   1. Flexible insulation: Average thermal conductivity K equals 0.24 at 75 degrees F mean temperature at 1.5 pounds per cubic feet (PCF) density, ASTM C335.
   2. Rigid insulation: Average thermal conductivity K equals 0.24 at 75 degrees F mean temperature at 3.0 PCF density, ASTM C518.
   3. Factory-applied vapor barrier flame-retardant Foil-Scrim-Kraft (FSK) or all-service jacket and tape, with permeability rating equal to 0.02 perms, ASTM E 96.
   4. Temperature limits for fiberglass duct insulation: 250 degrees F unless otherwise indicated.
   5. Manufacturers: Johns Manville, Owens Corning, Certainteed, Knauf Fiber Glass, or approved equal.

## 2.3 FLEXIBLE FOAM PLASTIC

A. Thermal Conductivity: 0.27.

B. Water Vapor Transmission: 0.08.

C. Flame-spread rating of 25 or less and a smoke-developed rating of 50 or less as tested by ASTM E 84.

D. Manufacturer: Armaflex, Aerotube, Rubatex.

## 2.4 FIXTURE INSULATION ASSEMBLY

A. Protective, molded, fire-resistant foam insulation, single piece insulation manufactured specifically for plumbing fixture supplies and drains.

B. 4.5 PCF foam with insulation R factor 2, white fire retardant polyurethane integral skin, twist fasteners.

C. Manufacturer: Skal+Gard, Model SG-100B, TCI Products, or approved equal.

## 2.5 CANVAS JACKETING

A. Insulating Lagging Canvas: Eight ounces per square yard minimum, fire-retardant material complying with fire ratings specified above. Manufacturer: Chas Harmon "Osnaberg", Claremont Company Inc., “Claretex”, or approved equal.

B. Lagging Adhesive: Plastic synthetic resin emulsion adhesive; watertight, mildew resistant, fire retardant. Manufacturer: Childers Chil-Perm CP, Foster® Sealfas® coating 30-36, or approved equal.

## 2.6 METAL JACKETING

A. 27 gauge (U.S. Standard) heavy corrugated aluminum.

B. Preformed fitting covers.

## 2.7 PVC JACKETING

A. 20 mil thick, white, PVC jacketing.

B. Plenum rated; flame spread less than 25 and smoke developed rating less than 50 per ASTM E84.

C. Manufacturer: Speedline 25/50 Smoke-Safe PVC or equal.

## 2.8 COATINGS

A. Coatings: UL labeled.

B. On cold or dual service lines, use vapor barrier type coatings.

## 2.9 PREFORMED FITTING COVERS

A. One piece pre-molded PVC jacketing and fitting covers specifically designed for the service intended.

B. Install per manufacturer's instructions and secure with manufacturer's color matching PVC tape.

C. Manufacturer: J-M “Zeston”, TeeCee, Proto, Certainteed.

## 2.10 VALVE WRAPS

A. Insulate valves with removeable flexible valve wraps.

B. Manufacturer: No Sweat Valve Wraps or equal.

# PART 3 - EXECUTION

## 3.1 GENERAL

A. Do not apply insulation materials until surfaces to be covered are clean and dry and foreign material such as rust, dirt, etc. is removed. Keep insulation clean and dry during installation and during the application of any finish.

B. Do not install the insulation on pipe fittings and pipe joints until the piping has been tested and approved.

C. Do not install the insulation on ducts or fittings until the ductwork has been tested and approved.

D. Do not apply under conditions of excessive humidity or at temperatures below 50 degrees F or above 100 degrees F.

E. Provide insulation support blocks, shields, and transitions for hangers, supports, anchors, and guides. Coordinate insulation requirements through rated assemblies and Listing penetration’s requirements.

F. Adjust hangers, guides, anchors, and supports after insulation installation has been approved.

## 3.2 PIPE INSULATION

A. Cold Piping:
   1. Includes rainwater piping, domestic cold water, plumbing, and other vents through roof, and other cold piping to zero degrees F.
      a. Insulate aboveground rain leaders from the roof drain to the point pipe penetrates building skin or below grade. Cover underside of roof drain.
      b. Insulate plumbing vents from three feet below the under deck of the roof to the termination above the roofline.
   2. Insulate with sectional fiberglass and provide a completely sealed vapor barrier. Provide insulation thickness per Insulation Thickness Table.

3. Insulate valves, unions, flanges, fittings, tanks, vessels, air separators, heat exchangers, and similar components, except where indicated otherwise.
4. Insulate refrigeration piping with flexible foam type insulation. Provide metal jacketing for exterior piping.

B. Hot Piping:
1. Includes domestic hot water supply and recirculation, and hydronic heating.
2. Insulate with sectional fiberglass. Provide insulation thickness per Insulation Thickness Table.
3. Insulate valves, unions, flanges, fittings, tanks, vessels, air separators, heat exchangers, steam and process vents, and similar components, except where indicated otherwise.

C. Provide metal jacket on piping insulation for piping exterior to the building.

D. Provide PVC jacketing on piping below six feet zero inches above floor in mechanical rooms.

E. Insulation Thickness Table (units are in inches):

| Fluid Design Operating Temperature Range | Less than 1 | 1 to <1-1/2 | 1-1/2 to <4 | 4 to <8 | 8 and up |
|---|---|---|---|---|---|
| Heating Systems (Water and Glycol Solutions) and Domestic (Hot Water and Hot Water Circulation): | | | | | |
| 141 °F to 200 °F | 1.5 | 1.5 | 2 | 2 | 2 |
| 105 °F to 140 °F | 1.5 | 1.5 | 2 | 2 | 2 |
| Refrigerant Systems: | | | | | |
| 40 °F to 60 °F | 0.5 | 0.75 | 0.75 | 0.75 | - |
| Below 40 °F | 0.5 | 0.75 | 0.75 | 0.75 | - |
| Domestic Cold Water: | | | | | |
| All | 1 | 1 | 1.5 | 1.5 | 1.5 |
| Rain leaders, Plumbing vents through roof: | | | | | |
| All | 1 | 1 | 1.5 | 1.5 | 1.5 |

## 3.3 TECHNIQUE FOR APPLICATION TO PIPES

A. Close longitudinal joints of pipe insulation firmly and butt insulation sections firmly together. Neatly and smoothly adhere laps and butt strips.

B. Clean the contact area on jacket for adhesive lap strips and butt strips so it is free from fingerprints, oil, construction dust and other contaminants. Clean surfaces with tack rags, methanol, or other suitable agent before attempting to adhere the strip. Apply pressure to adhesive strip with suitable tool immediately after adhering. Remove insulation with inadequately sealed joints and install new sections. Outwardly clinching staples may be used to reinforce joints.

C. Continuously seal vapor barriers. If staples are used at laps, seal the entire length of stapled lap with adhesive jacket tape applied as specified above for laps and butts. Sectionalize vapor barrier by sealing ends of insulation sections at not more than 25 feet intervals, to prevent moisture migrating lengthwise. Apply butt strips over joint as above.

D. Provide double insulation thickness on piping in outside walls and within five feet of vehicle doors or other large openings.

E. Except as indicated, locate pipe hangers and rollers outside insulation. Provide insulation saddles or sheet metal shields around insulation. On pipes two inches and larger, within the area of each insulation shield, use calcium silicate or cellular glass on the lower half of the insulation, equal in thickness to adjacent insulation.

F. Where piping is installed outdoors, provide two-layer glass cloth and four-layer weatherproof vapor barrier adhesive coating, in addition to jacket specified.

## 3.4 TECHNIQUE FOR APPLICATION TO PIPE FITTINGS, EQUIPMENT, AND VALVES

A. Insulate fittings, valves, and flanges to the same thickness as the pipe insulation.

B. Any of the following methods of insulation are acceptable:
   1. Blanket Wrap: Wrap the fitting with compressed glass fiber blanket. Wire the blanket securely in place and cover with a smooth layer of insulating/finishing cement. Cover with glass mesh tape, adhering it with an adhesive coating.
   2. Fabricated Segments: Cut mitered segments from pipe insulation that has the same wall thickness as adjacent pipe insulation to form a cover which will fit snugly around the fitting. Wire the segments firmly in place and seal the joints with insulating/finishing cement. Apply adhesive coating and wrap with glass mesh tape, then apply another layer of the same coating over the whole assembly.
   3. Cement: Apply insulating or insulating/finishing cement, molding it to the contour of the fitting. When area is large, apply an under layer of cement, wrap this with glass mesh tape, then apply an outer layer of cement. If the insulation is not concealed the exposed surface of insulating/finishing cement shall have a final glass mesh tape wrap embedded in adhesive.

C. In each of the listed methods, to protect the insulation against contact damage, apply an adhesive coating when the cement is completely dry and hard, then wrap with glass mesh tape. Apply another coating of adhesive over the whole assembly.

D. In each of the listed methods, pre-formed fitting covers may be substituted for the tape and adhesive covering specified. Cement and tape fitting covers on cold piping to provide a positive vapor barrier.

E. Removable insulation blankets of comparable insulation value for valves and where equipment require frequent adjustments or maintenance shall be provided; identify and coordinate during submittal process.

F. After insulation has been installed adjust hangers for proper fit, maintain pipe grade and support.

## 3.5 DUCT THERMAL INSULATION REQUIREMENTS

A. Insulate ductwork as follows:
   1. Insulate outside air intake ducts from air intake louver connection to equipment connections (including insulated isolation damper frame) with 2-inch rigid or semi-rigid board insulation.
   2. Insulate exhaust and relief ducts from point of discharge to and including back draft damper support frame with 2-inch rigid or semi-rigid board insulation.
   3. Supply air ductwork: Insulate ventilation system supply ductwork from AHU connections to VAV terminal unit inlet connections with 1-1/2" inch thick fiberglass insulation.
   4. Lined ductwork: Provide external duct insulation only when indicated in addition to duct lining.

B. Insulation Type and Finish:
   1. Rigid or semi-rigid board where canvas or metal jacket is specified. May also be used in place of blanket insulation where practical.
   2. Blanket insulation where rigid board is not specified or indicated. Proper installation is critical. Loose joints and sagging insulation shall require re-insulation of entire branch or main duct before acceptance and during warranty period.
   3. Fiberglass or canvas jacket over board insulation in mechanical and boiler rooms less than 10 feet above finish floor, where exposed in finished rooms and where indicated. Seal jacket with vapor barrier lagging adhesive.
   4. Ductwork insulation to have a completely sealed vapor barrier, except segmental insulation on medium/high velocity trunk ducts and warm air ducts in concealed spaces, where approved.

## 3.6 DUCT SOUND INSULATION REQUIREMENTS

A. Refer to Section 23 3100 - Ducts and Accessories.

B. Install where shown.

C. Install in accordance with manufacturers installation instructions. Completed installation shall be fastened tightly to ductwork and free of sags.

## 3.7 TECHNIQUE FOR APPLICATION TO DUCTWORK

A. Rigid and Semi-rigid Insulation:
   1. Impaling Over Pins: Install insulation with edges tightly butted using adhesive and metal pins. Impale insulation on pins welded to the duct and secure with speed clips. Trim off pins close to speed clip. Space pins as required to hold insulation firmly against duct surface but not less than one pin per square foot.
   2. Other Method of Securement: If the welded pin method is not feasible, secure the insulation to the duct with adhesive. Cover the entire surface of the metal with adhesive when applying to the underside of horizontal ducts. Application to top and sides may be in strips with a minimum of 50 percent coverage. Additionally, secure insulation with No. 16 galvanized wire on not more than 12 inches on center. Provide metal angle at corners to protect edges of insulation.

3. Vapor Barrier: Seal joints and speed clips with adhesive tape of similar construction to insulation jacket. Thoroughly clean contact surfaces for adhesive as specified under pipe insulation technique. Glass cloth tape set in adhesive may be used. Provide metal or plastic corner angles within eight feet of floor, walkway, or stairs.
4. Provide fiberglass or canvas jacket where specified. Completely cover with minimum 1/8" lagging adhesive. Cover canvas with two heavy coats of same adhesive and completely fill the weave. Inspect when dry for complete vapor barrier throughout and refinish as required.

B. Blanket Insulation:
1. Position insulation so that longitudinal seam will be underneath and not supporting weight of sheet. Remove a uniform strip of insulation from backing to provide a lap strip. Butt insulation and secure lap strip with outwardly clinching staples.
2. Use pins to secure blanket on large flat areas as specified for rigid insulation. Reinforce jacket at pin penetration where required.
3. Seal laps, staples and butt joints with adhesive tape of similar construction to insulation jack. Seal speed clips if used. Thoroughly clean contact surfaces for adhesive as specified under pipe insulation technique.
4. When system is under pressure, inspect insulation for inflation caused by improperly sealed ducts. Repair duct seal and reinsulate as necessary.
5. The Contracting Agency may inspect completed insulation and test taped joints for adhesion. Seal laps and butt tapes that can be removed with reasonable force shall require that entire branch or trunk duct be reinsulated.

END OF SECTION 20 0700

# SECTION 20 4100
# MECHANICAL DEMOLITION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes: Demolition and removal of selected mechanical systems, equipment and selected components.

B. See Division 1 for general demolition requirements and disposal of demolished materials.
   1. Coordinate the demolition and disposal of materials and equipment with Contracting Agency.
   2. Provide Contracting Agency with the first right of refusal for the salvage of demolished equipment and materials.

### 1.2 DEFINITIONS

A. Demolish: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

### 1.3 QUALITY ASSURANCE

A. See section 20 0000 - Mechanical General Requirements.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Standards: Comply with ANSI A10.6 - Safety and Health Program Requirements for Demolition Operations, and NFPA 241 - Standard For Safeguarding Construction, Alteration, And Demolition Operations.

D. Pre-demolition Meetings: Conduct coordination meetings prior to demolition as required by Division 1.

### 1.4 PROJECT CONDITIONS

A. Adjacent portions of the building will remain partially occupied during selective demolition. Conduct demolition such that Owner's operations will not be disrupted.

B. Drawings and specifications involving existing conditions are based on building record drawings and limited field observation. Provide field verification. Addition building record drawings are available from the Owner with a written request.

C. Notify Contracting Agency of discrepancies between existing conditions and the Contract Documents before proceeding with demolition.

D. Hazardous Materials: The existing roof construction, to include the existing mechanical penetrations through the roof is likely to include materials which contain asbestos. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Contracting Agency and coordinate the demolition of such hazardous materials in accordance with the hazardous materials abatement procedures specified in Division 1.

E. Maintain existing utilities to the maximum extent possible. Coordinate outages, if necessary, in accordance with Division 1.

F. Maintain fire-protection systems in service during mechanical demolition operations.

G. Storage or sale of removed items or materials on-site is not permitted.

1.5 WARRANTY

A. See section 20 0000 - Mechanical General Requirements.

B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

A. Drawings and specifications involving existing conditions are based on building record drawings and limited field observation.

B. Conduct a site inspection prior to submission of Bid to become thoroughly familiarized with the Scope of Work. Review actual site conditions and compare with the Contract Documents mechanical demolition drawings. Obtain direction from Contracting Agency for identified conflicts.

C. Inventory and record the condition of items to be removed, removed and reinstalled or removed and salvaged. Provide Contracting Agency with first right of refusal for the salvage of demolished equipment and materials.

D. Verify field measurements, locations, sizes, and routing arrangements and site conditions.

E. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Contracting Agency for direction.

F. Commencement of demolition implies Contractor accepts existing conditions.

## 3.2 PREPARATION

A. Maintain existing utilities in operation to the maximum extent possible during the selective demolition of mechanical systems. When utility outages are necessary, coordinate outages and their duration with Contracting Agency in accordance with Division 1. Arrange to shut off indicated utilities with utility companies.

B. "Tag" equipment and systems to be demolished. Identify the extent to which each system will be demolished.

C. Locate, identify, isolate, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

D. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

E. Coordinate with the Contracting Agency to provide a central staging area for the temporary storage of demolished equipment and systems.

F. Identify hazardous materials which will be demolished (i.e. mercury thermostats, etc.). Provide and designate a segregated temporary storage area for demolished hazardous materials organized by hazard type.

## 3.3 DEMOLITION - GENERAL

A. General:
   1. Demolish and remove existing mechanical equipment and systems only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   2. Terminate ductwork and piping back to branch connections and replace tees and fittings with straight couplings. Terminate electrical circuits back to panel (See Divisions 26, 27 and 28). Remove unused ductwork, piping, conduit and associated hangers and other support devices.
   3. Abandonment in place of unused equipment and systems affected by the remodel is not allowed.
   4. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
   5. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
   6. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents

of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
7. Promptly transport and dispose of demolished equipment, systems and material at the closest, approved dump site.
8. Heating System: Drain, flush and clean the existing hydronic heating systems throughout the entire building. Dispose of existing circulation solutions in an approved manner.

B. Controls:
1. Sequence limited demolition of the controls system.
2. Limited schedules outages are acceptable for system cross-over.
3. Coordinate outages with Contracting Authority 24 hours in advance of the scheduled outage.

C. Indoor Air Quality:
1. Maintain cleanliness and indoor air quality in areas adjacent to construction areas.
2. Submit a demolition and construction plan for review by the Contracting Agency prior to beginning work.
3. Reference SMACNA IAQ Guidelines for Occupied Buildings Under Construction - Second Edition - 2007.

D. Fire Protection: Notify the Contracting Agency and the Fire Department Agencies at least 24 hours before partially or completely disabling Fire Protection Systems.

E. Removed and Salvaged Items:
1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Contracting Agency.
4. Transport items to Contracting Agency designated on-site storage area.
5. Protect items from damage during transport and storage.

F. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

G. Existing items to Remain:
1. Protect construction indicated to remain against damage and soiling during selective demolition.
2. When permitted by Contracting Agency, items may be removed to a suitable, protected storage location during demolition and cleaned and reinstalled in their original locations after demolition operations are complete.

## 3.4 CLEANING AND REPAIRS

A. Plug, patch and repair surfaces, adjacent construction, and finishes damaged during demolition and new work. Restore to original condition or better. Retexture surfaces

to match surrounding surfaces. Repaint affected surfaces, with extent of paint to include adjacent surfaces to next wall or other clean break to avoid mismatched finish. Repair fire proofing.

B. Clean construction areas after completion of the project. Wipe down new and existing surfaces including but not limited to walls, floors, ductwork, piping and equipment. Clean adjacent equipment and systems to remain and building surfaces of dust, dirt, and debris caused by demolition operations.

C. Return adjacent areas to the condition existing before demolition operations began.

END OF SECTION 20 4100

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# SECTION 21 1000

# WATER BASED FIRE SUPPRESSION SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes performance requirements, products, and methods of execution relating to fire suppression for the project. The contract documents have performance, materials, and installation requirements which exceed code and standard minimums. This Section is substantially a “performance” specification.

### 1.2 REFERENCES

A. Provide fire suppression in accordance with the provisions of the following codes and standards:
   1. See section 20 0000 - Mechanical General Requirements.
   2. NFPA 13 – 2016, Installation of Sprinkler Systems.

### 1.3 SYSTEM DESCRIPTION

A. The facility is fully protected by a wet automatic fire sprinkler system. Modify the existing system to provide full coverage. Add, remove or relocate sprinklers to support the work of this contract. Provide new sprinkler heads where relocated sprinklers are required. Match existing sprinklers.

### 1.4 SUBMITTALS

A. Submittals shall be complete for review. Drawings, calculations, and product cutsheets shall be complete and submitted together in one package. See Section 20 0000 - General Mechanical Requirements for additional requirements not covered below.

B. Submittal review is for general design and arrangement only and does not relieve the Contractor from any of the requirements of the Contract Documents.
   1. Submittals will not be checked for quantity, dimension, fit, or for proper technical design of manufactured equipment.
   2. Providing a complete and satisfactory working installation is the responsibility of the Contractor.
   3. Product data, shop drawings, and calculations shall be submitted together for review. Partial submittals will not be reviewed.

C. Shop Drawings:
   1. Submit Authority Having Jurisdiction approved sets of shop drawings and calculations. Drawings and calculations shall include the NICET certification and State of Alaska Permit IIC or IIC-DO number and signature, or signed seal of a licensed professional engineer, and the fire suppression Contractor’s Alaska specialty license number.

D. Design Data:

1. Submit Authority Having Jurisdiction approved sets of calculations. Drawings and calculations shall include the NICET certification and State of Alaska Permit IIC or IIC-DO number and signature or stamp of a licensed professional engineer and the fire suppression Contractor's Alaska specialty license number. Submit complete hydraulic calculations which were used to prepare the final design drawings. One set will be retained by the Engineer.

E. Quality Assurance/Control Submittals:
1. Fire suppression system shall be installed, tested, as-builts completed and installation approved by the Authority Having Jurisdiction, AHJ, before substantial completion request or notification is made.
2. Significant changes in piping due to on site coordination with other trades and existing conditions shall require hydraulic recalculation to confirm adequate pipe sizing and be resubmitted to AHJ and Contracting Agency's Insurance agency.

F. Review, Approvals, and Permits Required
1. Obtain written review and/or approval of the entire fire suppression system design and arrangement from the following authorities:
   a. Contracting Agency - (Approval).
   b. Authority Having Jurisdiction, AHJ - (Approval).
   c. Mechanical Engineer - (Review).
2. Comply with the above review comments, revising the system design as required, and resubmitting in a timely manner, so as not to hinder the construction schedule.
3. Obtain and pay for required permits, inspections, tests, and approvals as required by Authority Having Jurisdiction.

G. Closeout Submittals:
1. Refer to Division 1 for general procedures for submittals.
2. Project Record Documents: Record actual locations of components and locations of access doors required for access or valving.
3. Warranty: Submit manufacturer warranty and ensure forms have been completed in Contracting Agency's name and registered with the manufacturer.

H. Record Drawings:
1. Maintain current and up-to-date As-Built prints of the fire suppression system at the job site.
2. Approved full size As-Built drawings and electronic copy of as-built drawing files in PDF and DWG formats shall be submitted with IO&M manuals.

## 1.5 QUALITY ASSURANCE

A. Furnish the services of a qualified and approved fire suppression subcontractor to provide the work of this specification section. Unless otherwise noted, this is substantially a "performance" specification.

B. Minimum qualifications of the Contractor/subcontractor shall include the following:
1. Specialist Firm: Company specializing in automatic fire suppression/sprinkler systems, possessing a minimum of three years of experience with systems similar in nature to the type specified herein. Demonstrate satisfactory

completion of five projects of similar size and scope in the State of Alaska; provide references.

2. Design Certification: Drawings and calculations shall be prepared by a Level III or IV Fire Sprinkler Designer, certified by the National Institute for Certification in Engineering Technologies (NICET), in Fire Protection Engineering Technology Automatic Fire Sprinkler System Layout who also have their State of Alaska Permit IIC or IIC-DO license, or an Alaskan Licensed Professional Engineer.
3. Maintain a complete stock of replacement parts.
4. Remain on 24 hour call for emergency service.
5. Maintain an office and telephone, with authorized representatives of the fire suppression contractor's firm, including the Designated Project Administrator, with a physical presence and address in Alaska.

C. Material:
   1. Equipment and components: Bear the “UL” label or the “FM” approval marking.

## 1.6 PROJECT/SITE CONDITIONS

A. Temporary occupancy permits, or partial occupancy require alarm and life safety systems to be fully operational. Expedite installation and complete life safety requirements for temporary and phased occupancy. Existing portions of the building will be occupied and fully functional.

B. Coordinate work with that of other trades to make sure that adequate space is provided, including requirements for accessibility and serviceability. Locate sprinkler heads a minimum 6 inches distance from ceiling T-Bar, structural elements, devices, and other installed equipment. Adjust final location of piping and heads in field to accomplish these requirements for coordination.

# PART 2 - PRODUCTS

## 2.1 GENERAL

A. Provide only products that are a standard product of a manufacturer regularly engaged in the manufacture of fire suppression equipment.

B. Products and materials shall have a minimum working pressure of 175 PSIG and capable of withstanding a hydrostatic test pressure of 200 PSIG at 2 hours test pressure without damage, unless noted otherwise for higher pressure ratings or basis of design includes higher pressure ratings.
   1. Exception for approved ancillary devices that are normally isolated from the fire water and sprinkler lines shall have a minimum rated 150 PSIG working pressure.

C. Submittals are required for all equipment, materials, and products.

D. Exterior items shall be chrome finish or stainless steel.

## 2.2 MANUFACTURERS

A. Sprinkler System and Components:
   1. AGF.
   2. Central.
   3. Croker.
   4. Gem Sprinkler.
   5. Grinnell.
   6. Kennedy.
   7. Metraflex.
   8. Milwaukee.
   9. Notifier Company.
   10. Potter-Roemer.
   11. Potter Electric.
   12. Reliable.
   13. Star.
   14. System-Sensor.
   15. Tyco.
   16. Tolco.
   17. Victaulic.
   18. Viking.

## 2.3 PIPE

A. Plastic pipe is not allowed.

B. The use of pipe nipples less than 1-inch in diameter and less than schedule 40 wall thickness is not allowed.

C. Pipe shall be identified including manufacturer's name, model designation or schedule.

D. Wet Pipe Sprinkler Systems:
   1. Metallic pipes shall be listed for the intended service by UL or FM.
   2. Whenever pipes other than steel schedule 40 is utilized, submit a statement that the pipe complies with NFPA 13 standards, the pipe strength is adequate for the application, and the pipe corrosion resistance ratio (CRR) shall be equal or greater than 1.0, equivalent to schedule 40 pipe for the installed system. Include this CRR data in product submittal.

## 2.4 FITTINGS, ABOVE GROUND

A. Grooved Fittings, Couplings, and Mechanical Tees:
   1. Grooved Fittings: ductile iron fittings with flow equal to standard pattern. Fabricated or segmented fittings are not acceptable. Couplings and mechanical tees shall be standard painted, unless indicated otherwise.
   2. Grooved joint couplings shall consist of two ductile iron housing segments with pressure responsive gaskets and zinc plated, hot dipped galvanized or stainless steel hardware as required for application.
      a. Rigid type: Couplings shall provide joint rigidity, support and hanging in accordance with NFPA 13.

b. Flexible type: For use in locations where vibration attenuation and stress relief or flexible connectors are required.

B. Threaded fittings shall be compatible with piping system and include cast iron Class 125 and 250 , and malleable iron Class 150 and 300 steel..

C. Pipe Flanges shall be compatible with piping system and include: Cast iron Class 125 and 250, and malleable iron Class 150 and 300 steel.

D. Welded Pipe Fittings for Wet Pipe Sprinkler Only: Limited to Weld-o-lets, Thread-o-lets, Gruv-o-lets, Tees, and Welded Flanges. Welding limited to shop fabrication work with approved quality control process, welding procedures, and welders for specific application.

E. Welded pipe joints and fittings shall not be used on galvanized pipe or on pipes with wall thickness less than schedule 10.

F. Other means of joining pipe are not permitted.

2.5 SPRINKLER HEADS

A. Provide sprinklers as required by NFPA 13 standards and in compliance with the IBC Chapter 9. Sprinkler heads using O-ring water seals are not allowed.

B. Match existing type of sprinklers in any space requiring new or relocated sprinklers.

2.6 PIPE AND EQUIPMENT ANCHORS, BRACING, HANGERS, AND SUPPORTS

A. Provide seismic anchoring, bracing, supports, and clearance for equipment, piping and sprinkler heads per NFPA 13, International Building Code, and ASCE 7. Most conservative criteria shall govern.

B. Provide flexible couplings, bracing, and other components required and compatible with the piping materials and fittings.

PART 3 - EXECUTION

3.1 GENERAL

A. The contract documents have performance, materials, and installation requirements which exceed code minimums.

3.2 COORDINATION

A. The fire suppression contractor shall coordinate their work with the work of other trades to assure timely installation and efficient use of mechanical areas including, but not limited to, boiler rooms, fan rooms, and ceiling spaces.

B. Promptly remove any work installed without proper coordination and reinstall in a manor to allow for a good practical arrangement of items which need to be installed by other trades involved.

C. Costs associated with coordination, arranging or rearranging of the fire suppression system shall be borne by the affected contractor, without causing any additional expense or delay to the Contracting Agency.

D. Installation, testing, O&M manuals, record drawings, and AHJ approvals shall be completed, submitted, and approved by the Contracting Agency before beneficial occupancy.

E. Work shall be scheduled to minimize disruption of existing fire service. Coordinate with Contracting Agency for shut down and maintain a fire watch when system is inoperable.

## 3.3 PIPING INSTALLATION

A. Install pipes, fittings, and appurtenances in accordance with codes and recommended practices. Follow manufacturers' installation instructions.

B. Installed system to have a corrosion resistance ratio (CRR) equal or greater than 1.0.

C. Provide clearance around pipes extending through walls, floors, ceilings, platforms, and foundations, including drains, fire department connections, and other auxiliary pipes. Holes shall be sized 2" larger than the pipe for pipe 1" to 3-1/2" and 4" larger for pipe 4" and larger, unless flexible couplings are located within 1 foot of each side of item penetrated, and excluding frangible construction that is not required to have a fire resistance rating.

D. Install pipes to conserve building space and route pipes around roof hatches, electrical panels, access panels, and maintenance accesses.

E. Minimum 3 inches clearance from structure not used to support pipes.

F. Sprinkler pipes shall be substantially supported from the building structure, which shall support the water loaded pipe plus a minimum 250 pounds temporary point load applied at the point of hanging. Pipe hangers shall include 250 pounds and weight of 5 time pipe filled with water.

G. Pipes in exposed ceiling areas shall be limited to branches serving heads in the area. Pipe routing shall be coordinated to minimize visual impact and approved prior to installation.

H. Install “beam clamp” type fasteners with retainer straps and locking nuts. Retainer strap shall be tight to beam.

I. Welded pipe shall be shop fabricated by certified welders and procedures.

## 3.4 GROOVED AND ROLLED FITTINGS

A. Follow the manufacturer's suggested methods to prepare gaskets, pipes, and fittings to prevent leakage, system breakdown, and designed pipe and fitting movement.

B. Cut grooved pipe shall be limited to schedule 40 pipe.

C. Welding fittings shall not be used on galvanized pipe.

D. Installers to have been trained by the coupling manufacturer in the use of grooving tools and installation of product. The manufacturer's representative shall periodically visit the job site to ensure best practices are being followed.

## 3.5 SPRINKLER HEAD INSTALLATION

A. Sprinkler heads to be centered per approved shop drawings. Changes due to field conditions shall be pre-approved.

B. Sprinkler heads to be centered on acoustical lay-in panels and symmetrically 4-way on architectural drawings laid out in each separate room or space with GWB type ceiling regardless of finishes and minimum Code requirements.

C. Escutcheons and cover plates shall be metallic and listed for the assembly.

D. Provide guards where sprinklers may be subject to mechanical damage.

E. Do not install sprinklers that have been dropped, damaged, show a visible loss of fluid, or a cracked bulb.

F. The sprinkler bulb protector shall be removable by hand, without tools or devices that may damage the bulb.

G. Sprinkler head temperature ratings shall be selected based upon installed distance from heat source.

H. Provide clearance for removal of sprinkler heads and minimum 1-inch clearance from structure. Exclude concealed, recessed, and flush types, which have clearances above the ceiling.

## 3.6 SPRINKLER PIPES AT ELECTRICAL, TRANSFORMER, TELECOM/DATA, AND COMPUTER ROOMS

A. Provide complete interface with electrical/transformer rooms in compliance with the National Electrical Code and AHJ.

B. Route no pipes through rooms except branch piping supplying sprinklers protecting the room. Branch pipes shall not exit electrical room to supply additional sprinklers outside the room.

C. No pipes shall be routed above electrical panels or telecommunication racks.

D. Noncombustible hoods or shields, as described in NFPA 13, shall be provided to deflect direct sprinkler discharge away from electrical panels and equipment.

E. Maintain a minimum of 42 inches clear in front of electrical panels, coordinate with electrical requirements.

END OF SECTION 21 1000

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# SECTION 22 1100

# DOMESTIC WATER PIPING AND SPECIALTIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Pipe, fittings, and connections for domestic potable water system.
2. Piping accessories.
3. Valves.
4. Electric Water Heaters.
5. Hot Water Circulating pumps.
6. Domestic hot water thermal expansion tank.
7. Water hammer arresters.
8. Trap primer valves.
9. Tempering valve.
10. Access doors.

### 1.2 REFERENCES

A. Codes and Standards:
1. See section 20 0000 - Mechanical General Requirements.
2. Foundation for Cross-Connection Control and Hydraulic Research, 9th edition, University of Southern California.
3. NFPA 24, Installation of Private Fire Service Mains and Their Appurtenances.
4. 2011 Reduction of Lead in Drinking Water Act.
5. NSF/ANSI 61 - Drinking Water System Components - Health Effects.

### 1.3 SYSTEM DESCRIPTION

A. Design Requirements:
1. This section describes specific requirements, products and methods of execution for interrelated systems necessary for the various plumbing systems and equipment.
2. Wetted surfaces of pipes, fittings, valves, and equipment in potable water systems shall be lead free as defined by the 2011 Reduction of Lead in Drinking Water Act.

B. Performance Requirements:
1. Potable water systems shall perform quietly, with no objectionable vibration transmitted to the surrounding construction.
2. Replace piping and equipment that does not perform as intended with properly operating equipment.

### 1.4 SUBMITTALS

A. Refer to Section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed:

B. Product Data:
   1. Submit product literature for items specified in Part 2 and those products required by the performance standards of this section. Literature clearly annotated to indicate specified salient features and performance criteria.
   2. Indicate valve data and ratings.
   3. Provide plumbing specialty component sizes, rough-in requirements, service sizes, and finishes.

C. Manufacturer's Installation, Operation, and Maintenance (IO&M) Manuals.

D. Test and Evaluation Reports:
   1. Submit hydrostatic pressure test report.
   2. Submit sterilization of system report.

## 1.5 WARRANTY

A. Manufacturer Warranty: See section 20 0000 - Mechanical General Requirements for general mechanical warranty requirements.

# PART 2 - PRODUCTS

## 2.1 WATER SERVICE PIPING (ABOVE GRADE INSIDE BUILDING)

A. Copper (Hard drawn):
   1. Tubing: Type L (ASTM B88).
   2. Fittings:
      a. Cast copper alloy (ASME B16.18).
      b. Wrought copper and bronze (ASME B16.22).
   3. Joints: Solder, Grade 95TA (ASTM B32).

B. Copper Press Fitting System:
   1. Limited to tubing sizes 4 inch and smaller.
   2. Cast or wrought copper fittings, ASME B16.18 or ASME B16.22. Pre-formed grooves with pre-lubricated EPDM O-rings designed to seal fitting to copper tubing water tight with the use of manufacturer's crimping tool. Fittings shall be rated for 250 degrees F and 200 PSI.
   3. IAPMO UPC listing.
   4. Manufacturer: Viega ProPress, NIBCO Press System, no substitutions.

## 2.2 UNIONS (STANDARD)

A. Steel Piping (Threaded):
   1. Class 150 malleable iron, ground joint, copper or copper alloy seat. AnvilStar Figure 463. (150 PSIG steam, 300 WOG).
   2. Where indicated: Class 250 malleable iron ground joint, copper or copper alloy seat. AnvilStar Figure 554.

B. Copper Piping (Sweat and Threaded): Cast bronze, ground joint, copper to copper, or copper to threaded joint. Nibco 733-LF series.

## 2.3 DIELECTRIC ISOLATORS (ELECTRICALLY INSULATING)

A. Provide dielectric unions for 2 inch pipe and smaller.

B. Provide dielectric flanges for 2-1/2 inch pipe and larger.

C. Insulating gaskets, all types, shall be suitable for fluid type, temperature and pressure.

D. Galvanized pipe to copper: Brass threaded end and sweat copper end.

E. Black steel to copper: Zinc plated steel threaded end and sweat copper end.

F. Manufacturers: Capitol, Epco, Control Plastics, Watts, or approved equal.

## 2.4 VALVES

A. General:
   1. Select valves of the best quality and type suited for the specific service and piping system used. Minimum working pressure rating 125 PSIG saturated steam or 200 PSIG WOG. Packing material or seals shall not contain asbestos.

B. Ball Valves:
   1. Two (2) inch and smaller: Two piece type, full port, bronze body and silicone bronze ball or chrome plated brass ball, TFE seats, blowout proof stem, 150 PSIG pressure/temperature rating (steam).
   2. Two and one half (2-1/2) inches through four (4) inch: Two piece type, full port, bronze body and silicone bronze ball or chrome plated brass ball, TFE seats, 150 PSIG pressure/temperature rating (steam). May be substituted for gate valves except where otherwise indicated.

C. Gate Valves:
   1. Two (2) inch and smaller: Bronze body and trim, rising stem, solid wedge. Use only where shown on drawings.
   2. Two and one half (2-1/2) inch through four (4) inch: Iron-body, bronze trim, flanged threaded or sweat fitting. Non-rising stem: Inside screw. Rising stem: OS&Y. Bronze valves optional for 2-1/2 inch and three-inch.

D. Globe Valves:
   1. Two (2) inch and smaller: Bronze body, renewable disc suitable for service.
   2. Two and one half (2-1/2) inch and larger: Iron body, bronze trim, flanged, bronze disc. Bronze valves optional for 2-1/2 inch and three-inch.

E. Swing Check Valves:
   1. Two (2) inch and smaller: Bronze body, horizontal swing, Y-pattern, Buna-N-disc for water, oil and gas. TFE disc for steam.
   2. Two and one half (2-1/2) inch and larger: Iron body, horizontal swing, bolted bonnet, renewable bronze seat and disc, flanged.
      a. Bronze valves optional for 2-1/2 inch and 3 inch.

F. Butterfly Valves:

1. Two (2) inch and smaller: 150 PSIG bubble tight shutoff, suitable for 220 degrees F operation, viton seal, lever handle, full flow low Cv type, bronze body and stainless steel trim, recommended by manufacturer for system intended. Manufacturer: Milwaukee "Butterball".
2. Four (4) inch and smaller: Lug type ductile iron body, EPT O-ring and seat, disc for 150 PSIG shutoff, valve rated for 220 degrees F on heating systems and other 200 degrees F systems. All others, lever handle. Manufacturers: Dezurik, Nibco, Demco, Keystone, Milwaukee, Norris, Victaulic.
3. Six (6) inch and larger: Lug type ductile iron body, EPT O-ring and seat, disc for 150 PSIG shutoff, valve rated for 220 degrees F on heating systems and other 200 degrees F systems. All others, manual gear operator with memory stop. Manufacturers: Dezurik, Homestead, Nibco, Demco, Keystone, Milwaukee, Norris, Victaulic.

G. Drain Valves:
   1. Full port ball valve with threaded hose adapter with bronze end cap.
   2. Do not use sillcocks or butterfly valves as drain valves.

## 2.5 BALANCING VALVES

A. Provide a balancing valve at each point shown on the domestic hot water recirculation branches. Except as indicated, balancing valves shall be full line size. Wide open pressure drop selected at one PSI (2.3 feet) (nominal).

B. Provide calibrated plug or ball valve type balancing valves with self-sealing quick connect pressure taps, scale and locking device. Include schedule with submittal.

C. Manufacturer: Bell & Gossett, or equal.

D. Provide test kit with gauge and hoses to match balancing valves.

## 2.6 ELECTRIC WATER HEATERS

A. Electric Tank type (WH-1)
   1. Performance as scheduled.
   2. UL listed.
   3. Tank:
      a. High temperature porcelain enamel coating with magnesium anode rod.
      b. Maximum working pressure of 150 PSI.
      c. Accessories: ASME rated temperature and pressure relief valve.
   4. Controls. Integral controls with setpoint, manual reset and high limit controls.
   5. Manufacturer: Rheem ELD series or approved equal.

B. Point of Use (WH-2):
   1. Performance as scheduled.
   2. UL 499 and UL 834 listed.
   3. Five year warranty.
   4. Manufacturer: AO Smith Model C2VA series or approved equal.

## 2.7 DOMESTIC HOT WATER CIRCULATING PUMP (PMP-6)

A. Direct drive, field replaceable stainless steel cartridge, self-lubricating.

B. Aluminum stator, non-metallic impeller, ceramic shaft, carbon bearings.

C. O-ring and Gaskets: EPDM

D. Flange mount, stainless steel construction.

E. Manufacturers:
   1. Taco (Basis of Design).
   2. B&G.
   3. Approved equal.

## 2.8 DOMESTIC HOT WATER THERMAL EXPANSION TANKS

A. Tank:
   1. ASME stamped.
   2. Steel tank shell steel support stand.
   3. Enamel or urethane coating.
   4. NSF approved polypropylene liner.
   5. FDA approved replaceable butyl rubber bladder.
   6. Brass threaded system connection.

B. Operating Characteristics:
   1. Maximum Working Temperature: 200 degrees F.
   2. Maximum Working Pressure: 150 PSIG.
   3. Tank Precharge: 40 PSIG.

C. Manufacturer: Amtrol Therm-X-Trol (Basis of Design), Taco, or equal.

## 2.9 WATER HAMMER ARRESTERS

A. Manufacturers:
   1. Sioux Chief.
   2. Precision Plumbing Products.
   3. Mifab.
   4. Zurn.
   5. Any other manufacturer meeting the requirements of the contract documents. Substitution request not required.

B. Pressurized Piston Type:
   1. Description: ASSE 1010 certified water hammer arrester.
   2. Performance:
      a. Maximum working temperature of 250 degrees F.
      b. Maximum working pressure of 350 PSIG.
   3. Materials:
      a. Seamless copper body.
      b. EPDM o-rings lubricated with FDA approved compound.

C. Expansion Bellows Type:
   1. Description:
   2. Performance:
      a. Maximum working temperature of 250 degrees F.
      b. Maximum working pressure of 350 PSIG.
   3. Materials:
      a. Stainless steel body and bellows.

## 2.10 TRAP PRIMER VALVES

A. Manufacturers:
   1. Precision Plumbing Products.
   2. MIFAB.
   3. ProFlo.

B. Electronic Type:
   1. Description: ETL listed, trap primer assembly designed to discharge a metered amount of water to floor drain traps on a timed schedule, subminiature solenoid valve, air gap, 6-feet long electrical cord.
   2. Performance:
   3. Materials: Copper, lead-free brass.
   4. Manufacturer: Precision Plumbing Products Solo-Prime SP-500-24V.

C. Electronic Type:
   1. Description: UL listed, trap primer assembly designed to discharge a metered amount of water to floor drain traps on a timed schedule. Assembly includes electronic solenoid valve, timer box with test button, circuit breaker, 1-inch air gap, and NEMA 1 surface mounted wall box with cover.
   2. Performance:
      a. Pre-set timer opens once for 10 seconds every 24 hours.
      b. 20-150 PSI pressure range. Minimum 2 ounces of water at 20 PSI per drain served.
      c. 32-125 degrees F temperature range.
      d. 120-volt, single phase electrical connection with 0.11 amps hold current and 0.23 amps inrush current.
   3. Materials:
      a. Copper with lead-free solder.
      b. 16 gauge steel wall box and cover.
      c. Stainless steel mesh screen.
   4. Manufacturer: Precision Plumbing Products Mini-Prime.

D. Accessories: Distribution unit to serve multiple floor drains from a single trap primer.

## 2.11 PRESSURE GAUGES

A. Provide where shown on drawings, specified in Part 3, or as required.

B. Bourdon tube type with minimum 4-1/2-inch dial, accuracy plus or minus 1 percent (ANSI/ASME Grade 1A). Normal operating pressure near midpoint of range. Industrial quality.

C. Type 304 stainless steel case and ring, acrylic lens.

D. NSF-61 certified lead free brass.

E. Gauge cock on gauges and pulsation damper (snubber).

F. Manufacturers: Winters PCT-LF, or approved equal.

2.12 THERMOMETERS

A. Provide where shown on drawings, specified in Part 3, or as required.

B. Digital, self-powered type. or equal.

C. Provide separable wells of suitable material for plumbing piping. Set probe in heat transfer paste recommended by thermometer manufacturer.

D. Manufacturers: Weiss DVU, or approved equal.

2.13 TEMPERING VALVE (TV-1)

A. Digital recirculation and tempering valve.

B. Maintains tempered water temperature +/-2 degree F of setpoint.

C. Programmable disinfection function.

D. Lead free construction. Stainless steel components.

E. ASSE 1017 compliant.

F. Manufacturer: Armstrong Model DRV25 or approved equal.

2.14 ACCESS DOORS

A. Provide access doors for mechanical systems in accordance with Section 08 3100 - Access Doors and Panels.

B. Provide UL labeled access doors and panels when required for fire resistance of surrounding construction.

C. Provide key locks on access doors located in public areas below eight feet above finished floor.

D. Prime coat steel.

E. Coordinate location and size of access doors in walls, partitions, floors, and ceilings to correspond with valves, trap primers, cleanouts, and other devices requiring service or adjustment. Maintain any fire rating of the surrounding construction.

F. Manufacturers: Elmdor, KARP, Milcor, MIFAB.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Protection of In-Place Conditions: Cover equipment and plug piping connections to protect components from construction dirt and debris.

### 3.2 INSTALLATION

A. Interface with Other Work:
   1. Review architectural drawings. Coordinate locations of access panels prior to piping installation.
   2. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
   3. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related work shall be completed at no additional expense to the Owner.
   4. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Division 9 for instructions on painting and coordination.

B. Water Service Piping:
   1. Install piping and plumbing products in accordance with UPC and manufacturer's instructions. Provide seismic anchoring, bracing, supports, and clearance for equipment, piping and sprinkler heads per UPC, IBC, and ASCE-07; most conservative criteria shall govern.
   2. Install piping to maintain headroom, conserve space, and not interfere with use of space.
   3. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
   4. At fixtures, install and connect hot water on left and cold water on right, as viewed when facing the fixture.
   5. Use of bullhead tee with opposed flow, double inlet configuration not allowed.

C. Valves:
   1. Provide accessible ball type isolation valves at major piping branches, and on main lines as shown, and at terminal devices.
   2. Install balancing valves for hot water recirculation system to be accessible and adjustable.

D. Domestic Hot Water Thermal Expansion Tanks: Field charge domestic hot water thermal expansion tank to match water service entry pressure.

E. Cross Connection Protection Devices: Conform to applicable Code for installation of backflow prevention devices.

F. Provide finished products with protective covers during balance of construction.

G. Access Doors: Provide appropriate size and install such that plumbing features are readily accessible and maintainable.

H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

## 3.3 REPAIR/RESTORATION

A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

## 3.4 SITE QUALITY CONTROL

A. Site Tests:
   1. Test water piping hydrostatically at 100 PSIG or 150 percent of working pressure, whichever is greater, for a period of four hours. Observe piping during this period and repair leaks and retest.
   2. Test results shall be certified in writing as required by General Conditions. Include dates and sections tested, test pressure, test duration, printed names and signatures of person performing the test and Contracting Agency witnessing the test.

B. Inspection:
   1. Arrange for inspections and provide notice to the Contracting Agency when the entire work or logical portions thereof, is ready for inspection.

## 3.5 SYSTEM STARTUP

A. Start-up and operate plumbing systems and equipment in accordance with the manufacturer's written installation and operation manual checklist.

B. Document start-up and operational checks using the checklist and submit in accordance with submittal requirements.

C. Operationally test control and safety devices and record settings.

D. Submit a copy of start-up report that includes final settings and that indicates that the start-up of each piece of equipment has been completed.

## 3.6 CLEANING

A. Sterilization of Domestic Water Systems:
   1. Sterilize each unit of completed supply line and distribution system with chlorine before acceptance for domestic operation.
   2. Sterilization as described below or by the system prescribed by the American Water Works Association Standard C-651. Apply the amount of chlorine to provide a dosage of not less than 50 PPM (parts per million). Provide chlorine manufactured in conformance to the following standards:
      a. Liquid Chlorine: Federal Specification BB-C-120.
      b. Hypochlorite: General Specification O-C-114a, type 11, Grade B or Federal Specification O-X-602.

3. Introduce the chlorinating material to the water lines and distribution system after piping system has been thoroughly flushed. Maintain a contact period of not less than 24 hours. Flush the system with clean water until the residual chlorine content is not greater than 1.0 part per million.
4. Open and close valves in the lines being sterilized several times during above chlorination.
5. Certify in writing that sterilization has been completed in accordance with these requirements.

B. After construction is completed, clean and wipe down exposed surfaces of pumps, piping and appurtenances.

END OF SECTION 22 1100

# SECTION 22 1300

# SANITARY WASTE AND VENT PIPING AND SPECIALTIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Sanitary waste and vent pipe and fittings.
   2. Cleanouts.
   3. Seismic pipe loop.
   4. Floor drains.

### 1.2 REFERENCES

A. Codes and Standards: See section 20 0000 - Mechanical General Requirements.

B. Abbreviations, Acronyms and Definitions:
   1. ASA - American Supply Association.
   2. ASTM - American Society for Testing and Materials
   3. CISPI - Cast Iron Soil Pipe Institute.

### 1.3 SYSTEM DESCRIPTION

A. Design Requirements: This section describes specific requirements, products and methods of execution for sanitary waste systems and equipment.

B. Performance Requirements:
   1. Sanitary waste systems shall perform quietly, with no objectionable vibration transmitted to the surrounding construction.
   2. Replace piping that does not perform as intended with properly operating equipment.
   3. Provide products with performance, output or salient features indicated or scheduled on the drawings.

### 1.4 PRE-INSTALLATION MEETINGS

A. See section 20 0000 - Mechanical General Requirements.

### 1.5 SUBMITTALS

A. See section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed:

B. Product Data:
   1. Submit product literature for items specified in Part 2 and those products required by the performance standards of this section. Clearly annotate literature to indicate specified salient features and performance criteria.

2. Provide plumbing specialty component sizes, rough-in requirements, service sizes, and finishes.

PART 2 - PRODUCTS

1. Manufacturer: JM Eagle Solvent Weld SDR35 Sewer Pipe.

2.2 DRAINAGE PIPING, ABOVE GRADE

A. Hub-less Cast Iron Pipe and Fittings:
   1. Manufacturers:
      a. Charlotte Pipe and Foundry.
      b. Tyler Pipe and Coupling.
      c. AB&I Foundry.
      d. Equal.
   2. Pipe: CISPI 301, ASA group 022.
   3. Fittings: Cast iron.
   4. Couplings:
      a. Manufacturers:
         1). Husky Series 2000
         2). MG Coupling
         3). Any other manufacturer meeting the requirements of the contract documents. Substitution request not required.
      b. Description: No-hub cast iron pipe couplings conforming to standard CISPI 310.
      c. Materials:
         1). Gaskets conforming to ASTM C564.
         2). Stainless steel clamp-and-shield assemblies.

2.3 CLEANOUTS

A. Manufacturers:
   1. Zurn.
   2. Mifab.
   3. J.R. Smith.
   4. Any other manufacturer meeting the requirements of the contract documents. Substitution request not required.

B. Floor Cleanouts:
   1. Cast iron body, bronze plug with neoprene gasket.
   2. Adjustable head to match finished floor elevation.
   3. Round, scoriated bronze top.
   4. Where indicated, provide cleanout tops with tile-terrazzo insert or carpet insert to match surrounding floor finish.

C. Wall Cleanouts:
   1. Cast iron body, recessed bronze plug.
   2. Wall access panel or access cover with center screw.

D. Yard Cleanouts:
   1. Cast iron body, bronze plug with neoprene gasket.

2. Heavy-duty access frame with anchor flanges and secured cover, fully surrounding and independent of cleanout.

2.4 SEISMIC PIPE LOOP.

A. Stainless steel piping. Stainless steel hose and braid.

B. Differential movement: 2 inches minimum.

C. Maximum working pressure 150 psig. Maximum working temperature 200 degrees F.

D. IAPMO approved.

E. Manufacturer: Metraflex DWV Metraloop or equal.

2.5 FLOOR DRAINS

A. As scheduled.

PART 3 - EXECUTION

3.1 PREPARATION

A. Interface with Other Work:
1. Review architectural and millwork shop drawings. Confirm location of cleanouts and access panels prior to installation.
2. Coordinate and sequence installation of roof drains and piping with trades responsible for portions of this and other related sections of the Project Manual.

B. Protection: Cover equipment and plug piping connections to protect components from construction dirt and debris.

C. Surface Preparation:
1. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 INSTALLATION

A. Install plumbing systems in accordance with manufacturer's instructions and listing.

B. Provide finished products with protective covers during balance of construction.

C. Access Doors: Provide appropriate size and install such that plumbing features are readily accessible and maintainable.

D. Piping:
1. Grading: Minimum 1/4 inch per foot unless indicated otherwise on drawings and approved by AHJ for shallower slopes.
2. Install piping to maintain headroom, conserve space, and not interfere with use of space.
3. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

4. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
5. Where pipe support members are welded to structural building framing; scrape, brush clean, and apply one coat of zinc rich primer to welding.

E. Vents:
1. Install vents as indicated and as required by plumbing code. Add vents when field conditions increase the length of a trap arm or cause other changes in venting requirements.
2. Unless otherwise indicated, the portion of the vent extending through roof shall be increased in size from one foot below roof assembly to termination as defined below. Increase as follows:
   a. Vent size two-inch and under; vent thru roof three-inch.
   b. Vent size three-inch; vent thru roof four-inch.
   c. Vent size four-inch; vent thru roof six-inch.
   d. Vent size six inch & larger; vent thru roof same size.
3. Termination of Vent: As required by the Uniform Plumbing Code.

F. Cleanouts:
1. Provide as indicated on drawings.
2. If field conditions create additional offsets or increase length of piping shown, provide additional cleanouts as required by the Uniform Plumbing Code and AHJ.
3. Where practical or as indicated provide cleanouts on vertical rainwater piping immediately above grade.

## 3.3 REPAIR/RESTORATION

A. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

B. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

C. Substitute replacement parts from other manufacturers are not acceptable.

## 3.4 FIELD QUALITY CONTROL

A. Inspections: Arrange for inspections and provide notice to the Contracting Agency when the entire Work, or logical portions thereof, is ready for inspection.

B. Maintain current as-built drawings on-site recording including invert elevations, connections to fixtures, cleanouts, slopes, pipe sizes, and routing of pipes. Annotate sections of lines with dates when pressure tests have been approved by AHJ.

C. Pressure Tests:
1. Water Test: Test waste and vent system with water in accordance with the Uniform Plumbing Code.

D. Verify penetrations are installed to maintain assembly integrity.

E. Coordinate with Divisions 26, 27 and 28 for power, disconnects, and related electrical items.

## 3.5 ADJUSTING

A. Adjust functional components for proper operation in accordance with manufacturer's recommendations, or as otherwise directed.

## 3.6 CLEANING

A. Clean and flush drain piping to remove dirt and foreign debris from systems.

B. Clean exposed pipes, fittings, and materials.

C. Provide written certification which documents that the complete sanitary sewer system has been flushed of foreign debris. Include date and printed names and signatures of person(s) performing the flush and Contracting Agency witnessing the flush.

## 3.7 CLOSEOUT ACTIVITIES

A. Start-up and operate plumbing systems and equipment in accordance with the manufacturer’s written installation and operation manual checklist.

B. Document start-up and operational checks using the checklist and submit in accordance with submittal requirements.

END OF SECTION 22 1300

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# SECTION 23 0131
# DUCT CLEANING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes: Ductwork and ventilation system equipment cleaning, servicing and adjustment.

B. Related Sections:
1. 20 0000 - Mechanical General Requirements
2. 20 0700 - Mechanical Insulation
3. 20 4100 - Mechanical Demolition
4. 23 3100 - Ducts and Accessories
5. 23 3400 - HVAC Fans
6. 23 3600 - Air Terminal Units
7. 23 3700 - Air Outlets and Inlets
8. 23 7323 - Central Air Handling Units
9. 23 8200 - Terminal Heating and Cooling Units

### 1.2 REFERENCES

A. Codes and Standards:
1. See section 20 0000 - Mechanical General Requirements.
2. ACR the National Air Duct Cleaners Association (NADCA) Standard for Assessment, Cleaning and Restoration of HVAC Systems, 2021.

### 1.3 SYSTEM DESCRIPTION

A. Design Requirements: This section describes specific requirements and methods for cleaning existing ventilation ductwork and equipment.

B. Performance Requirements:
1. Install new and replace existing duct access doors as required.
2. Clean and inspect supply air diffusers and return air grilles.
3. Remove and replace existing flexible ductwork.
4. Clean terminal air units to include fans and reheat coils.
5. Clean supply, return and exhaust ductwork from fan connection points to each air discharge point.
6. Clean central air handling unit internal surfaces and components.
7. Clean outside air louvers, plenums and dampers.
8. Clean fan room and surfaces of equipment located within fan room.

### 1.4 PRE-INSTALLATION MEETINGS

A. See section 20 0000 - Mechanical General Requirements.

## 1.5 SUBMITTALS

A. See Section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data: Submit material safety data sheets (MSDS) for chemical products proposed to be used in cleaning process

C. Shop Drawings:
   1. Select and document new duct access point/door locations and sizes on a clean set of Contract Drawings during cleaning preparation, using the access door symbol provided in the Legend.
   2. Submit for approval by the Contracting Agency prior to installing duct access points/doors.

D. Test and Evaluation Reports:
   1. Preliminary Report:
      a. Prior to any cleaning or duct repair work, provide a formal written preliminary report which:
         1). Defines the physical limits/boundaries of the existing central air distribution system ductwork and equipment to be cleaned.
         2). Provides a general assessment of the condition of the existing ductwork and equipment to be cleaned.
         3). Includes “before” digital photographs for each section of ductwork and equipment to be cleaned which clearly documents the existing condition of the ductwork. Include a key map (floor plan(s)) which clearly shows the location and direction of each photograph taken.
         4). Includes official laboratory analysis report of representative duct contamination samples. Indicate where samples were taken on key map (floor plans).
         5). Provides recommendations regarding the most appropriate cleaning method(s) for each portion of the duct system and equipment to be cleaned. Use cleaning methods selected from the National Air Duct Cleaners Association (NADCA) Industry Standard for Mechanical Cleaning of Non-Porous Air Conveyance System Components.
         6). Includes a copy of the specific recommended cleaning procedures to be implemented.
   2. Final Condition Report:
      a. Within 15 days of completed duct and equipment cleaning, provide a formal written final condition report which:
         1). Demonstrates that there is no visible dirt, contamination, or bacterial growth, at any point within the systems which were cleaned.
         2). Includes “after” digital photographs next to each “before” digital photograph for each section of ductwork and each piece of equipment which clearly documents the cleaning process. Take the “after” photograph from the same orientation as the previously submitted “before” photograph.

E. Quality Control Submittals: Submit references for a minimum of five recently successfully duct cleaning projects.

1.6 CLOSEOUT SUBMITTALS

A. See Section 20 0000 - Mechanical General Requirements.

1.7 QUALITY ASSURANCE

A. See Section 20 0000 - Mechanical General Requirements.

B. Qualifications: Duct cleaning work shall be performed by a firm with three years of continuous, documented experience with similar work.

C. Certifications: The HVAC system cleaning contractor shall have a minimum of one Air System Cleaning Specialist (ASCS) certified by NADCA on a full time basis, or shall have staff certified by a nationally recognized certification program and organization dedicated to the cleaning of HVAC systems.

PART 2 - PRODUCTS

2.1 CLEANING EQUIPMENT AND CLEANING PERSONNEL

A. Provide equipment and materials for cleaning, inspection and repair work including scaffolding, wire brushes, rotary brushes, filters, air lances, mechanical agitators, fiber-optic bore scopes, vacuums, and other equipment and materials necessary for workmen to perform the specified work.

B. Cleaning personnel shall be properly supervised by a qualified, experienced foreman. Foreman shall be prepared to discuss work in progress, at anytime with the Contracting Agency.

C. Provide HEPA systems which are self-contained units with appropriate components and appurtenances, to adequately prevent dirt and debris loosed from duct mains and branches during cleaning operations from entering sensitive locations. Utilize industrial grade HEPA filter elements labeled and certified for 99.9 percent efficiency (0.3 micron particles at rated air flow). Wherever practicable, do not discharge air from HEPA systems to clean spaces. Size volumetric capacity of HEPA filter system to match CFM rating of diffuser, mixing box, ductwork section or device to which unit is being connected.

2.2 ACCESS DOORS

A. Refer to Section 23 3100 - Ducts and Accessories.

2.3 FLEXIBLE DUCT

A. Refer to Section 23 3100 - Ducts and Accessories.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Verification of Conditions:
   1. Study the Contract Documents and facility record drawings provided by the Contracting Agency to become familiar with the general layout of the existing systems to be cleaned.
   2. Conduct site visit(s) to verify the scope of work, accessibility to ductwork and equipment and existing conditions.

B. Obtain written Notice to Proceed from the Contracting Agency prior to beginning duct and equipment cleaning procedures.

### 3.2 PREPARATION

A. Protection of In-Place Conditions:
   1. Prior to cleaning, provide temporary 30 percent filters fitted and sealed at supply grilles and diffusers.
   2. Protect openings to avoid particulate contamination and debris from falling into conditioned air spaces.

### 3.3 INSTALLATION

A. Install access points/doors at approved locations throughout supply, return and exhaust air ductwork. Install access points/doors as follows:
   1. Install access points/doors at not greater than 20-foot intervals to allow cleaning and inspection of each segment of ductwork.
   2. Do not cut into existing ductwork other than to install new access doors.
   3. Record location of each access door on project record drawings. Use access door symbol as indicated in Legend.
   4. When access doors are installed in insulated ductwork, provide access doors which meet the “R” rating of the duct insulation.

B. Where existing access doors are missing or poorly fitted, report condition to the Contracting Agency.

### 3.4 PRE-CLEANING INSPECTION

A. Perform an inspection of the duct interior through the installed access points/doors as follows:
   1. Utilizing a fiber-optic bore scope with dedicated light source to inspect interior ductwork surfaces and ductwork accessories including terminal units, mixing boxes, ductwork liners, duct-mounted coils, filters, dampers, humidifiers, and other appurtenances within ductwork systems.
   2. Visually inspect air handlers and air handler components. Visual inspection shall include, but not be limited to filters, coils, holding frames, fans, flooring, ceilings, wall paneling, air plenums, dampers, and outside air intakes.

B. Submit representative samples of duct contamination to a third party laboratory for analysis. Submit written laboratory report to Contracting Agency for review.

C. Prepare and submit Preliminary Report as outlined in Submittals. Promptly notify the Contracting Agency in writing of any existing conditions/major damage that may prevent the complete cleaning of the air distribution systems as shown.

## 3.5 DUCT CLEANING

A. Control access for cleaning personnel and equipment through installed access points, existing ceiling tiles, access doors, diffusers or grilles. Replace items removed for access to their original state upon completion of work.

B. Upon satisfactory laboratory analyses of duct contamination samples and with temporary filters installed, remove loose contaminants from the interior ductwork surfaces. Perform visual inspections throughout the entire process to ensure that no area(s) are left untreated.

C. By inserting special air lances, mechanical agitators and rotary brushes through the installed access points, gently loosen and remove contaminants from the interior surfaces of the ductwork. Utilize temporary filters and blanking pieces to protect areas that are not currently being treated.

D. Utilize specialized fan-powered, HEPA filtered dust and particulate collection systems in areas designated as being sensitive and as directed by the Contracting Agency. Take precautions to prevent dirt and debris greater or equal to 0.5 microns from entering these sensitive areas.

E. Hand wash duct mounted coils (using air or water) on both coil faces carefully to avoid damage to tubes and fins. Hand brush and vacuum clean coil frames to remove corrosion from around coil frames. Paint exposed metal frame surfaces to match existing coatings. Comb coil fins to restore them to original alignment.

F. Mark duct mounted dampers at their current setting. Then inspect and clean dampers by manually hand scraping, sanding or wire brushing. Lubricate external moving parts with an approved dry lubricant material (Aerolox Dry Moly or equal). After cleaning, repair damaged dampers to provide proper operation and return and lock dampers at original setting positions.

G. Repair/replace existing damaged duct insulation. If existing insulation is exposed without neoprene, foil or approved facing, coat surface with sealer. See Section 20 0700 - Mechanical Insulation, for sealer requirements.

H. Whenever supply/diffusers and return/exhaust grilles are removable, mark existing damper settings (as applicable) and remove them prior to cleaning. Vacuum clean, wash, dry and reinstall diffusers and grilles. Clean welded grilles in place. Return dampers to original setting positions after reinstallation.

## 3.6 AIR HANDLING UNITS

A. Shutdown/restart central air handling systems based upon a pre-arranged schedule approved in advance by the Contracting Agency. Once cleaning is complete, restore central air handling equipment to their normal operating mode.

B. Clean and repair central air handing units located in mechanical rooms or equipment areas as follows:
   1. Remove existing filter bank elements.
   2. Hand wire brush interior sides, ceiling and floor areas to loosen surface contaminates and vacuum clean.
   3. Hand scrape/wire brush, vacuum clean, prime and paint filter holding frames with a chromate based primer and a gray epoxy paint top coat. Replace holding frame rubber seals.
   4. Utilizing a high pressure water cleaning system with a suitable cleaning agent to thoroughly clean heating/cooling coil faces.
   5. Hand scrape/wire brush, vacuum clean, prime and paint coil frames and drain pans with a chromate based primer and a gray epoxy paint top coat. Replace holding frame rubber seals.
   6. Vacuum clean and hand wash control dampers. Replace damaged rubber seals.
   7. Vacuum clean and hand wash fan casing and motors to remove grease debris.
   8. Hand scrape/wire brush, vacuum clean, fan impellors and casings.
   9. Repair/replace existing damaged duct insulation. If existing insulation is exposed without neoprene, foil or approved facing, coat surface with sealer. See Section 20 0700 - Mechanical Insulation, for sealer requirements.
   10. After interior surfaces and equipment are cleaned and refurbished, sanitize the air handling unit interiors with an approved broad spectrum biocide.
   11. Grease and repack fan bearings. Provide new belts. Align drive belts and adjust tension.
   12. Provide new filter bank elements.
   13. Hand wash and rinse exterior air handler surfaces.

C. Prior to reactivating of air handler system:
   1. Verify that painted surfaces are properly dried and cured.
   2. Verify that air handler surfaces are thoroughly cleaned and dried.
   3. Filter elements are installed.
   4. Fan belt guards are installed.
   5. Notify the Contracting Agency prior to restart of air handler and coordinate system restart with facility operation.

## 3.7 REPAIR/RESTORATION

A. Upon completion of the ductwork and equipment cleaning, carefully remove filters from the ceiling diffusers to avoid spilling loose contamination onto room surfaces. Dispose of filters in sealed containers.

B. Shut and latch access doors. Adjust as necessary for a tight air seal.

## 3.8 CLEANING

A. Sanitize ductwork based upon the preliminary report laboratory analysis recommendations of duct contamination samples. Using a special extension lance and atomizing nozzle, coat the interior surfaces of the ductwork with a fine mist of an approved sanitizing fluid through the installed access points. Sanitizing fluid shall be registered with Environmental Protection Agency LD-50 toxicity tests.

B. Upon completion of work, and at the end of each shift, clean work area of trash, rubble, rags, containers, materials and equipment resulting from the work and remove from site. Broom clean Contracting Agency designated work/storage areas.

C. When cleaning procedures are completed, return electrical switches, detection devices and system components to an operable state by qualified personnel.

D. Plug access ports with plugs specifically designed for the intended purpose.

## 3.9 SITE TESTS AND INSPECTIONS

A. Provide Contracting Agency with 48 hours advanced notice prior to site inspection.

B. Visually inspect cleaned duct interior surfaces, ductwork accessories and air handlers as identified in the project's scope of work.

C. Inspect ductwork interior surfaces and non-accessible ductwork components within the air stream via the installed access points/doors, utilizing the fiber optic bore scope with dedicated light source.

D. Photo document post cleaning conditions and submit with Final Condition Report. See Submittals - Test and Evaluation Reports for specific report requirements.

END OF SECTION 23 0131

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# SECTION 23 0593

# TESTING, ADJUSTING AND BALANCING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes: General requirements and methods of execution relating to the testing and balancing of the mechanical systems provided on this project.

### 1.2 REFERENCES

A. Codes and Standards:
   1. See section 20 0000 - Mechanical General Requirements.
   2. National Environmental Balancing Bureau - Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
   3. National Environmental Balancing Bureau - Testing, Adjusting, Balancing Manual for Technicians.
   4. SMACNA - HVAC SYSTEMS Testing, Adjusting, and Balancing.

B. Abbreviations and Acronyms:
   1. TAB: Testing, Adjusting, and Balancing.
   2. NEBB: National Environmental Balancing Bureau

C. Definitions:
   1. Refer to Section 20 0000 - Mechanical General Requirements for general mechanical related definitions.
   2. Accuracy: Capability of an instrument to indicate the true value of a measured quantity.
   3. Adjusting: Varying of system flows by partially closing balancing devices, such as dampers, and valves, and varying fan speeds to achieve optimum system operating conditions within design and installation limitations.
   4. Balancing: Methodical proportioning of air and hydronic flows through the system main, branches, and terminal devices using acceptable procedures to achieve the specified air or hydronic flow with testing and design limitations.
   5. Calibrate: The act of comparing an instrument of unknown accuracy with a standard of known accuracy to detect, correlate, report, or eliminate by adjustment any variation in the accuracy of the tested instrument.
   6. NEBB Certified TAB Firm: A Firm that has met and maintains all the requirements of the NEBB for Firm certification in TAB and is currently certified by NEBB. A NEBB Certified Firm shall employ at least on NEBB Qualified TAB Supervisor in the full time management position.
   7. NEBB Certified TAB Report: Data presented in a NEBB Certified TAB Report accurately represents system measurements obtained in accordance with the current edition of the *NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems*. Variances from design quantities that exceed NEBB or contract document tolerances are to be noted in the TAB report project summary.
   8. NEBB Qualified TAB Supervisor: Full time employee of the TAB Firm in a management position who has successfully passed the supervisor level written

and practical qualification examinations and maintains the Supervisor re-qualification requirements of NEBB.

9. NEBB Qualified Technician: Full time employee of the TAB Firm who has met the technician level experience requirements of NEBB and has successfully passed the technician level written and practical qualification examinations. A NEBB Qualified TAB Technician shall be supervised by a NEBB Qualified TAB Supervisor. Supervision does not infer constant oversight; a NEBB Qualified Technician is capable of performing assigned tasks with periodic supervision.
10. Precision: Ability of an instrument to produce repeatable readings of the same quantity, or a tightly grouped set of values, under the same conditions.
11. Range: Upper and lower limits on an instrument's ability to measure the value of a quantity for which the instrument is calibrated.
12. Resolution: Smallest change in a measured variable that an instrument can detect.
13. Testing: Use of specialized and calibrated instruments to measure temperatures, pressures, rotational speeds, electrical characteristics, velocities, and air and hydronic quantities for an evaluation of flow conditions.
14. Testing and Balancing: As used in these specifications, testing and balancing refers to testing, adjusting, and balancing (TAB) as described in the above references.
15. TAB: A systematic process or service applied to heating, ventilating and air-conditioning (HVAC) systems and other environmental systems to achieve and document air and hydronic flow rates. The standards and procedures for providing these services are referred to as "Testing, Adjusting, and Balancing" and are described in this document.

## 1.3 SYSTEM DESCRIPTION

A. Design Requirements: This section describes specific requirements, products and methods of execution for the testing, adjusting and balancing of the project.

B. Performance Requirements: Furnish the services of a qualified and approved TAB Firm to perform the work of this specification section.

C. The work of this section includes but is not necessarily limited to:
   1. Test and balance fans and supply, exhaust and relief ventilating systems.
   2. Test and balance hydronic heating systems.
   3. Test and balance domestic hot water recirculation flow rate.
   4. Work directly with the control subcontractor to obtain proper system adjustments. This includes, but is not limited to:
      a. VAV box controller airflow coefficient adjustments.
      b. Airflow measuring device calibration adjustments.
      c. Fluid flow measuring device calibration adjustments.
   5. Measure sound power levels if so directed.
   6. Provide a final report.

D. The work of this section does not include:
   1. Adjusting burners for proper combustion operation.
   2. Liquid waste transfer system adjustment.
   3. Refrigeration work.

## 1.4 PRE-BALANCING MEETING

A. Coordinate TAB work with other trades and requirements of other related sections of the Project Manual prior to commencing work.

B. Schedule a pre-balancing meeting one week prior to commencing work of this Section. Refer to Section 20 0000 - Mechanical General Requirements.

## 1.5 SUBMITTALS

A. See Section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data: Sample report forms and outlines indicating adjusting, balancing, and equipment data required prior to commencing work.

C. Certificates:
1. Submit the name and qualifications of TAB Firm for approval with general product submittals. Submit copy of TAB Firm's NEBB certification.
2. Submit the names and certifications of the Firm's NEBB Qualified TAB Supervisor and NEBB Certified Technician.

D. Balancing Report:
1. Submit a complete report of the testing and balancing of all devices in a format equivalent to that shown in the SMACNA HVAC Systems Testing, Adjusting and Balancing manual. Compile the test data and submit eight copies of the complete test data for acceptance and/or analysis and recommendations.
2. Provide report in soft cover, letter size, comb bound binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include drawings within report.
3. Report Cover Sheet. Include the following data:
    a. Project Name.
    b. Project Address.
    c. Names of Architect and Engineer.
    d. Names of General Contractor and HVAC Contractor.
    e. Report date.
    f. Names of TAB technicians responsible for the measurements and report.
4. System Review Sheet:
    a. List air and hydronic systems balanced, with systems highlighted that were found to be performing outside design tolerances.
    b. Include a summary of problems encountered, deviations from design, deficiencies in performance, remaining problems, recommendations, and comments.
5. Instrument Calibration Report:
    a. Include a complete list of test equipment used, including apparatus manufacturer's name, model number, serial number, and date last calibrated.
    b. List the instruments used on the project during the balancing work, on an NEBB "Instrument Calibration Report" form, or equivalent form. This includes flow measuring hoods and other related devices.

6. Air Systems Report: Prepare a report for each air system balanced. Tabulate data separately for each system. Describe balancing method used for each system. At minimum, include the following:
   a. System Diagram: Include locations of air terminal units and pitot tube traverses. Include appropriate notes, static pressure reading locations, etc., taken during testing and balancing.
   b. Air Apparatus or Fan Test Report: Include pertinent data on the test report forms. If test data could not be measured, or is not applicable, indicate such on report forms. List how each actual cfm measurement was obtained (duct traverse, total of outlet airflows, or a combination).
   c. Duct Pitot Tube Traverse Reports: Include actual temperature and pressure readings recorded at the time of testing and balancing.
   d. Air Outlet Test Reports: Include applicable $A_k$ factors and terminal device sizes. If flow measuring hoods are used, indicate their use in the remarks column.
   e. Include complete identification of elements. Identify by box number, room name and number, air outlet symbol, orientation in room, etc., as necessary to clearly and positively identify the location of each element.
7. Hydronic Heating System Reports. Prepare a report for each hydronic system balanced. Tabulate data separately for each system. Describe balancing method used for each system. At minimum, include the following:
   a. Schematic Diagram: Include heat exchange equipment and locations of flow measuring devices.
   b. Pump Test Report: Confirm test data was recorded and properly entered on form. Attach manufacturer's pump capacity curves, with the actual pump operating point plotted, to the test report form. List how the actual pump flow rate was determined (flow meter, pump curve, etc.).
   c. Primary Heat Exchange Equipment: Confirm that appropriate test data has been recorded for the boilers, heat exchangers, chillers, and other primary heat exchange equipment. List how the actual flow rate(s) of each item was determined.
   d. Terminal Heat Exchange Equipment: Confirm that heating coil and terminal unit temperatures and pressures were recorded and properly entered on form. List how each terminal unit flow rate was determined.
   e. Include complete identification of elements. Identify by equipment tag number, room name and number, baseboard symbol, orientation in room, etc., as necessary to clearly and positively identify the location of each element.

## 1.6 QUALITY ASSURANCE

A. Qualifications:
   1. The work described in this section shall be performed by a Firm certified by the National Environmental Balancing Bureau for air and hydronic balancing.
   2. The Firm shall have a record of operation within Alaska for at least three years prior to bid date of this project and shall have demonstrated satisfactory completion of five projects of similar size and scope in the State of Alaska. Provide references if requested.
   3. The Firm's Technician and Supervisor for this project shall be NEBB certified for their respective positions.

4. Bids by suppliers, contractors or any Firm whose principal business is not that of testing, adjusting, and balancing HVAC systems are not acceptable.

B. Balancing Standards:
1. Perform total system balance in accordance with NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
2. Maintain one copy of balancing procedural document on site.
3. Use standard NEBB forms.

C. Timing of Work:
1. Sequence work to commence after completion of systems. Do not begin balancing and testing until the systems are complete and in full working order.
2. Schedule the testing and balancing work in cooperation with other trades.
3. Schedule completion of testing and balancing before Substantial Completion of Project.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify systems are complete and operable before commencing work.

B. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

C. Report defects and deficiencies that may preclude proper TAB of systems and equipment.

3.2 PREPARATION

A. Schedule work under the provisions of Section 20 0000 - Mechanical General Conditions.

B. Provide calibrated instruments required for testing, adjusting, and balancing operations.

C. Prior to starting work, review drawings and actual field conditions for additional balancing devices or components required for correct balance. Coordinate provision of additional balancing devices as required elsewhere in these specifications. Refer to Related Sections above.

D. Preliminarily adjust grille, register, and diffuser blades or pattern controllers per drawings. If airflow blow patterns are not shown on drawings, adjust for uniform diffusion pattern(s) or diffusion into long dimension of room.

3.3 SPECIAL TECHNIQUES:

A. Use instrumentation in accordance with NEBB requirements, calibrated to the accuracy standards specified by this organization.

B. Flow measuring hoods are acceptable for measurement of ceiling diffuser performance if used in a manner as recommended by the manufacturer and calibration and accuracy data is provided with the balancing report.

C. Upon request, make available to the Contracting Agency copies of current calibration certificates.

## 3.4 ACCEPTABLE CRITERIA

A. Systems will be considered balanced in accordance with NEBB *Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems* when the following conditions are satisfied:
   1. Air Handling Systems:
      a. Measured airflow quantities are within plus or minus 10 percent of design quantities. Deficiencies shall be noted in the TAB report.
      b. There is at least one direct path with fully open dampers from the fan or terminal unit device to an air inlet or outlet. Additionally, if a system contains branch dampers, there will be at least one wide open path downstream of every adjusted branch damper.
   2. Air Outlets and Inlets:
      a. Measured airflow quantities total to within plus or minus 10 percent of design to space and individual outlets and inlets in space to within plus or minus 10 percent of design.
      b. Grilles, registers, and diffusers blades or pattern controllers are adjusted for uniform diffusion in the space. Re-adjust airflow patterns that result in airflow velocities greater than 50 FPM (feet per minute) at 5 feet above finish floor (AFF).
   3. Hydronic Systems:
      a. Manually balanced systems:
         1). Measured fluid flow quantities are within plus or minus 10 percent of design.
         2). There is at least on direct path with fully open balancing valves from the pump discharge balancing valve (if present) to a terminal device. Additionally, if a system contains branch balancing valves, there will be at least one wide open path downstream of every adjusted branch balancing valve.
      b. Automatically balanced systems: Pressure drops across a sample of system's automatic balance valves are within the manufacturer's recommended operating range for the device.

B. If systems or components cannot be adjusted to within specified tolerances:
   1. Coordinate the replacement of sheaves, belts, or other components or devices needed for correct balance as required elsewhere in these specifications.
   2. Note deficiencies in the TAB report.

## 3.5 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on equipment sheaves, belts, dampers, valves, air outlets and inlets and each system according to the procedures contained in the current edition of the NEBB *Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems* and this section.

B. Adjustments shall be made with air handler filters blanked off to create a filter pressure drop of 60 percent of the manufacturer's recommended filter final pressure. Where multiple filters are encountered each set shall be individually blanked off, for a cumulated pressure drop of 60 percent of each filters final pressure.

C. Ensure recorded data represents actual measured or observed conditions.

D. Permanently mark final settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Contracting Agency.

H. Schedule and provide assistance in final adjustment and test of fire alarm system with Authority Having Jurisdiction.

## 3.6 SITE QUALITY CONTROL

A. Make calibrated test instruments available to Contracting Agency to facilitate spot checks during testing and commissioning as appropriate.

B. Re-balance components or systems found to be out of tolerance at no additional expense to the Owner.

END OF SECTION 23 0593

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# SECTION 23 1123

# FUEL GAS PIPING AND SPECIALTIES AND SPECIALTIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes: Specific requirements, products, and methods of execution relating to the provision of fuel gas systems for the project.

### 1.2 REFERENCES

A. Codes and Standards:
   1. NFPA 54 - National Fuel Gas Code.

### 1.3 SYSTEM DESCRIPTION

A. Design Requirements:
   1. This section describes specific requirements, products and methods of execution for interrelated systems necessary for the distribution of natural gas within the building.

### 1.4 SUBMITTALS

A. See section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data: Provide manufacturers' product literature for items specified in Part 2 and those products required by the performance standards of this section, clearly annotated to indicate specified salient features and performance criteria.

C. Shop Drawings: Submit dimensioned shop drawings of gas piping size and routing as part of the shop drawings.

## PART 2 - PRODUCTS

### 2.1 PIPING

A. Above ground, pressure less than 14 inches water column:
   1. Schedule 40 black steel pipe.
   2. Welded or threaded black malleable iron fittings.

B. Above ground, pressure greater than or equal to 14 inches water column:
   1. Welded schedule 40 black steel pipe.
   2. Welded schedule 40 steel fittings.

### 2.2 PRESSURE REGULATORS

A. Cast iron or steel body, maximum 125 PSIG. Steel spring and seat, stainless valve stem, zinc plated steel diaphragm.

B. Adjustable pressures setting, capacity as indicated.

C. Double ported body, soft seat valve plug disc. Trim can be removed for inspection and maintenance without disassembling the actuator or removing the regulator from the pipeline.

D. Manufacturer: Sprague, Fisher.

2.3 SCREENED VENT

A. Combined vent termination assembly where indicated on the Drawings.

B. Individual regulator vents where indicated on the Drawings.

C. Downward venting Mushroom or Tee-type vent to prevent water or contaminates from entering vent line:
1. Clay and Bailey No. 300.
2. EMCO Wheaton 785.
3. OPW 113.

PART 3 - EXECUTION

3.1 INSTALLERS

A. Installer: Perform work by experienced personnel under the supervision of a qualified installation supervisor.

3.2 PREPARATION

A. Protection of In-Place Conditions: Plug piping connections for protection from construction dirt and debris.

B. Surface Preparation: Prior to installation of pipes, verify that shop drawings are approved, and pipe locations and routing have been coordinated with other trades.

3.3 INSTALLATION

A. Special Techniques:
1. Install equipment in accordance with manufacturer's instructions and requirements of the codes specified herein.
2. Arrange products to be readily accessible for inspection, testing, and shutting off gas supply.
3. Install pipe and fittings clean and free from cuttings, burrs, and defects in structure of threading, and thoroughly brushed and scale blown.
4. Do not install any piping in concrete, in masonry, or below grade inside the building.
5. Provide connection to gas consuming appliances. Connect gas appliances and fixtures with flexible connectors in accordance with the requirements of the appliance listing and manufacturer's instructions.
6. Provide independent gas pressure relief pipes to outside the building from each fuel gas train. Size and install reliefs in accordance with the written UL listing installation instructions. Gang piping to penetrate exterior building skin at a

common location. Terminate relief vents not less than 10 feet from openings to the building and not less than 25 feet from building outside air intakes.

B. Interface with Other Work: Coordinate and sequence installation of gas piping and equipment with trades responsible for portions of this and other related sections of the Project Manual.

## 3.4 RE-INSTALLATION

A. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

## 3.5 SITE QUALITY CONTROL

A. Site Test and Inspections:
   1. Test gas piping before connection to the gas source. Do not enclose or conceal any untested portion of the gas system.
   2. Test piping in accordance with IFGC requirements.

B. Non-Conforming Work: Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

## 3.6 CLEANING

A. Clean gas piping, fittings, valves, etc., of grease, rust, dust and dirt.

B. Paint interior piping with one coat of a suitable rust-inhibiting primer and one final coat of heat-resistant enamel paint to provide a uniform appearance. Color: black.

END OF SECTION 23 1123

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# SECTION 23 2113

# HYDRONIC PIPING AND SPECIALTIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Pipe and fittings for:
      a. Hydronic heating piping.
      b. Equipment drains and overflows.
   2. Piping accessories.
   3. Flexible pipe connectors.
   4. Seismic pipe loop.
   5. Pipe loops, offsets, alignment guides and swivel joints.
   6. Hydronic Specialties:
      a. Expansion tanks.
      b. Air vents.
      c. Air separators.
      d. Strainers.
      e. Brazed plate heat exchangers.
      f. Flushing agents.
      g. Water treatment chemicals.
      h. Glycol specialties.

### 1.2 REFERENCES

A. Codes and Standards:
   1. See section 20 0000 - Mechanical General Requirements.
   2. ANSI/ASHRAE/IENA Standard 90.1-2001 Energy Standard for Buildings Except Low-Rise Residential Buildings.
   3. ASME Boilers and Pressure Vessel Code (1998), Sections IV & VI.

### 1.3 SYSTEM DESCRIPTION

A. Design Requirements:
   1. This section describes specific requirements, products, and methods of execution for the system of liquid heat transfer throughout the project. The system of heat generation is specified elsewhere.
   2. Design expansion compensation system to adequately protect piping and structure from thermal expansion and contraction forces.

B. Performance Requirements:
   1. Provide performance and output shown or scheduled on drawings.
   2. Provide loops, pipe offsets, and swing joints, or expansion joints where required or indicated.
   3. Pipes shall be capable of thermal expansion movement without disengagement of supports or forces on equipment connections.

4. Provide structural work and equipment required to control expansion and contraction of piping. Verify that anchors, guides, and expansion joints provided, adequately protect system.
5. Expansion Calculations:
   a. Installation Temperature: 40 degrees F.
   b. Hot Water Heating: 210 degrees F.
   c. Domestic Hot Water: 140 degrees F.
   d. Safety Factor: 30 percent.

## 1.4 PRE-INSTALLATION MEETINGS

A. See section 20 0000 - Mechanical General Requirements.

## 1.5 SUBMITTALS

A. See Section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:
1. Submit product literature for items specified in Part 2 and those products required by the performance standards of this section. Literature clearly annotated to indicate specified salient features and performance criteria.
2. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot (meter) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
3. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
4. Submit selection calculations for expansion joints and compensators.
5. Design Data: Submit calculations for performance specified products and systems.

C. Shop Drawings:
1. Submit shop drawings for piping systems to demonstrate proper layout and coordination.
2. Provide shop drawings to show system layout with location and detail of flexible pipe connectors and expansion joints.
3. Drawings of boiler room, fan rooms, and other areas with high-density piping, shall be shown at 1/4-inch scale or larger.
4. Indicate elevation of piping above finish floor.
5. Indicate dimensions and weights of equipment, and placement of openings and holes.
6. Include reference to ductwork and other equipment where space coordination is necessary to avoid conflicts.
7. Indicate mechanical and electrical service locations and requirements.

## 1.6 CLOSEOUT SUBMITTALS

A. See section 20 0000 - Mechanical General Requirements.

B. Operation and Maintenance (IO&M) Manuals:
   1. Refer to Section 20 0000 - Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.
   2. Include the following:
      a. Copies of approved submittal information.
      b. Manufacturer's installation, operating and maintenance/repair instructions, parts listings, and spare parts list for each product. Annotate the manual to indicate applicable information for the specific equipment model(s) installed.
      c. Computer software manuals and applicable licenses.
      d. Completed start-up and operational test report as required to validate equipment warranty.
      e. Start-up and operational test reports for each piece of equipment. Report shall include printed names and signatures of the installers and documentation that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.

C. Record Documentation: Record actual locations of equipment, valves, strainers, air vents, flexible pipe connectors, expansion joints, other components, and locations of access doors required for maintenance access in accordance with Section 20 0000 - Mechanical General Requirements.

## PART 2 - PRODUCTS

### 2.1 PIPE AND FITTINGS

A. Water Systems:
   1. Copper pipe three inches and smaller:
      a. Type L copper, wrought copper fittings.
      b. Fit joints using 430 silver solder, 95-5 tin-antimony or other approved lead-free solder. Solder type must be compatible with pipe and fittings. Solder containing lead shall not be allowed on the job site.
      c. Soldering flux: Water flushable, low corrosivity type meeting the requirements of ASTM B813. Flux shall have label indicating it meets these requirements.
      d. Extracted branch joints (T-Drill) may be approved when Contractor can demonstrate satisfactory experience with this method. Joints shall be brazed in accordance with the Copper Development Association Copper Tube Handbook using B-Cup series filler metal.
   2. Steel pipe four inches and larger: Welded pipe and fittings.
      a. Grade B, seamless, ASTM A53 or A106.
      b. Schedule 40 black with ANSI B16 butt weld fittings of type and wall thickness to suit pipe.
   3. Galvanized piping is not permitted.

B. Glycol Systems (Copper or Steel Option):
   1. Copper pipe three inches and smaller:
      a. Type L copper, wrought copper fittings.
      b. Fit joints using 430 silver solder, 95-5 tin-antimony or other approved lead-free solder. Solder type must be compatible with pipe and fittings. Solder containing lead shall not be allowed on the job site.

c. Soldering flux: Water flushable, low corrosivity type meeting the requirements of ASTM B813. Flux shall have label indicating it meets these requirements.
d. Extracted branch joints (T-Drill) may be approved when Contractor can demonstrate satisfactory experience with this method. All joints shall be brazed in accordance with the Copper Development Association Copper Tube Handbook using B-Cup series filler metal.

2. Steel pipe four inches and larger: Welded pipe and fittings. No threaded pipe allowed.
   a. Grade B, seamless, ASTM A53 or A106.
   b. Schedule 40 black with ANSI B16 butt weld fittings of type and wall thickness to suit pipe.
3. Viega ProPress copper press-fit joint-type pipe systems are not permitted.
4. Victaulic mechanical joint-type pipe systems are not permitted.
5. Galvanized piping is not permitted.

C. Copper Press Fitting System:
   1. Limited to tubing sizes 4 inch and smaller.
   2. Cast or wrought copper fittings, ASME B16.18 or ASME B16.22. Pre-formed grooves with pre-lubricated EPDM O-rings designed to seal fitting to copper tubing water tight with the use of manufacturer's crimping tool. Fittings shall be rated for 250 Degrees F., and 200 psi.
   3. IAPMO UPC listing.
   4. Manufacturer: Viega ProPress, NIBCO Press System, no substitutions.

D. Equipment drains and overflows: Type L copper pipe, wrought copper fittings.

## 2.2 VALVES

A. Select valves of the best quality and type suited for the specific service and piping system used. Minimum working pressure rating 125 PSIG saturated steam or 200 PSIG WOG. Packing material or seals shall not contain asbestos.

B. Manufacturers: Crane, Nibco, Hammond, Jenkins, Grinnell, Milwaukee, Stockham or equal.

C. Ball Valves 2 inch and smaller: Two piece type, full port, bronze body and silicone bronze ball or chrome plated brass ball, TFE seats, blowout proof stem, 150 PSIG pressure/temperature rating (steam).

A. Ball Valves 2-1/2 inches through 4 inch: Two piece type, full port, bronze body and silicone bronze ball or chrome plated brass ball, TFE seats, 150 PSIG pressure/temperature rating (steam). May be substituted for gate valves except where otherwise indicated.

B. Ball Valves, 2-1/2 inch through 12 inch: Two piece type, full port, carbon steel or stainless steel body and ball, TFE seats, 150 PSIG pressure/temperature rating (steam). May be substituted for gate valves except where otherwise indicated.

C. Gate Valves, two inch and smaller: Bronze body and trim, rising stem, solid wedge. Use only where shown on drawings.

D. Gate Valves, 2-1/2 inch through four inch: Iron-body, bronze trim, flanged, threaded, or sweat fitting. Non-rising stem: Inside screw. Rising stem: OS&Y. Bronze valves optional for 2-1/2 inch and three-inch.

E. Gate valves, six inch and larger: Iron body bronze trim, flanged. Rising stem: OS&Y, or non-rising stem with solid wedge.

F. Swing Check Valves two inch and smaller: Bronze body, horizontal swing, Y-pattern, Buna-N-disc for water, oil and gas. TFE disc for steam.

G. Swing Check Valves 2-1/2 inch and larger: Iron body, horizontal swing, bolted bonnet, renewable bronze seat and disc, flanged or grooved. Bronze valves optional for 2-1/2 inch and three-inch.

H. Drain Valves: Full port ball valve with threaded hose adapter with bronze end cap. Do not use sillcocks or butterfly valves as drain valves.

I. Valves Specified Elsewhere: Provide special valves such as motor-operated valves, relief valves, temperature regulating valves, etc., as specified under the individual system or as indicated on the drawings.

## 2.3 UNIONS (STANDARD)

A. Steel Piping (Threaded):
   1. Class 150 (150 PSIG steam, 300 PSIG WOG) malleable iron, ground joint, ASME B1.20.1, ASME B16.39. McMaster-Carr.
   2. Where indicated: Class 250 malleable iron ground joint, copper or copper alloy seat. McMaster-Carr.

B. Copper Piping (Sweat): Cast bronze, ASTM B584 Alloy C84400, copper to copper. Nibco No. 733.

## 2.4 DIELECTRIC ISOLATORS (ELECTRICALLY INSULATING)

A. Provide dielectric unions for two inch pipe and smaller.

B. Provide dielectric flanges for 2-1/2 inch pipe and larger.

C. Insulating gaskets shall be suitable for fluid type, temperature and pressure.

D. Galvanized pipe to copper: Brass threaded end and sweat copper end.

E. Black steel to copper: Zinc plated steel threaded end and sweat copper end.

F. Manufacturers: Capitol, Epco, Control Plastics, Watts, or approved equal.

## 2.5 PRESSURE GAUGES

A. Provide where shown on drawings, specified in Part 3, or as required.

B. Bourdon tube type with 4-1/2-inch dial (minimum) accuracy plus or minus one-percent span, recalibratable. Normal operating pressure near midpoint of range. Industrial quality.

C. Gauge cock on gauges and pulsation damper (snubber). Steam gauges shall have siphon to isolate gauge from steam, except where remotely mounted and connected by looped tubing.

D. Differential pressure gauges shall be piston or diaphragm type with range suitable for application and static pressure capability suitable for system pressure. Orange Research.

## 2.6 THERMOMETERS

A. Provide where shown on drawings, specified in Part 3, or as required.

B. Digital, self-powered type: Weiss DVU or equal.

C. Normal operating temperature at scale midpoint and sufficient range to cover operating conditions.

D. Provide separable wells of suitable material for piping and mounting hardware for ducts. Set probe in heat transfer paste recommended by thermometer manufacturer.

## 2.7 PRESSURE AND TEMPERATURE TEST PLUGS

A. Provide where shown on drawings, specified in Part 3 or as required.

B. Standard type for 1/8-inch diameter pressure or temperature probes. Self seal when probe removed and complete with threaded cap. Minimum continuous rating 125 PSIG and 220 degrees F coincident. Sealing element suitable for fluid in pipe.

C. Provide one thermometer and one pressure gauge for each range required by system parameters.

D. Manufacturers: Sisco, Peterson Equipment, or approved equal.

## 2.8 FLEXIBLE PIPE CONNECTORS

A. General:
   1. System Application: Hot water heating or 50 percent propylene glycol solution (heating) or 30 percent propylene glycol solution (cooling).
   2. System Maximum Operating Temperature: 210 degrees F.
   3. Pressure: Internal.
   4. Installation: Straight or Offset as shown.
   5. Movement: Constant or Intermittent.
   6. Maximum offset: Not to exceed 25 percent of the centerline bend radius.
   7. Determine appropriate minimum “live hose length” (flexible portion of assembly) based on the centerline bend radius for each application in accordance with manufacturer’s sizing tables.

B. Copper Pipe Flexible Connectors - Small Diameter (Sweat):
   1. Size: 3/4 inch through 2-1/2 inch nominal pipe size (NPS).
   2. Pipe Ends: Copper tube sweat.
   3. Corrugated Hose: Bronze.
   4. Outer Braid: Single braided bronze.
   5. Minimum Working Pressure Rating: 120 PSIG at 250 degrees F.
   6. Maximum Temperature Rating: 250 degrees F.

C. Copper Pipe Flexible Connectors - Small Diameter (Removable):
   1. Size: 3/4 inch through 2-1/2 inch nominal pipe size (NPS).
   2. Pipe Ends: Female pipe coupling, Female union, Male Hex Nipple, Male Pipe with Hex Nut.
   3. Corrugated Hose: Bronze.
   4. Outer Braid: Single braided bronze.
   5. Minimum Working Pressure Rating: 120 PSIG at 250 degrees F.
   6. Maximum Temperature Rating: 250 degrees F.

D. Steel Pipe Flexible Connectors - Small Diameter (welded):
   1. Size: 3/4 inch through 2-1/2 inch nominal pipe size (NPS).
   2. Pipe Ends: Weld nipple.
   3. Corrugated Hose: Bronze.
   4. Outer Braid: Single braided bronze.
   5. Minimum Working Pressure Rating: 300 PSIG at 250 degrees F.
   6. Maximum Temperature Rating: 250 degrees F.

E. Steel Pipe Flexible Connectors - Small Diameter (Removable):
   1. Size: 3/4 inch through 2-1/2 inch nominal pipe size (NPS).
   2. Pipe Ends: Schedule 40 steel with male pipe thread (MPT).
   3. Corrugated Hose: Bronze.
   4. Outer Braid: Single braided bronze.
   5. Minimum Working Pressure Rating: 300 PSIG at 250 degrees F.
   6. Maximum Temperature Rating: 250 degrees F.

F. Steel Pipe Flexible Connectors - Large Diameter:
   1. Size: 3 inch through 10 inch nominal pipe size (NPS).
   2. Pipe Ends: 150 LB plate steel flat faced flange.
   3. Corrugated Hose: Type 304 stainless steel.
   4. Outer Braid: Single braided Type 304 stainless steel.
   5. Minimum Working Pressure Rating: 150 PSIG at 250 degrees F.
   6. Maximum Temperature Rating: 250 degrees F.

G. Manufacturers: Metraflex, Keflex, or equal.

## 2.9 SEISMIC PIPE LOOP

A. Provide seismic pipe loop of size and type noted on drawings.

B. Flexible loops shall consist of two flexible sections of hose and braid, two 90 degree elbows, and a 180 degree return assembled in such a way that the piping does not change direction, but maintains its course along a single axis. Loops shall have a factory supplied, center support nut located at the bottom of the 180 degree return, and

a drain/air release plug. They shall impart no thrust loads to system support anchors or building structure.

C. Materials of construction and end fitting type shall be consistent with pipe material and equipment/ pipe connection fittings.

D. Differential movement: 2 inches minimum.

E. Manufacturer: Metraflex Metraloop or equal.

## 2.10 EXPANSION TANKS

A. General:
1. Performance as scheduled.
2. Full acceptance flexible heavy duty butyl removable bladder or flexible heavy duty butyl diaphragm sealed into tank, as scheduled.

B. Construction:
1. Designed, tested and stamped in accordance with ASME SEC 8-D standards; supplied with National Board Form U-1.
2. Welded steel shell and base.
3. Forged steel system connections.
4. Steel support stand.

C. Ratings:
1. Working pressure: 125 PSIG.
2. Working Temperature: 240 degrees F.
3. Precharge: As Scheduled.

D. Accessories:
1. Pressure gage.
2. Air charging fitting.
3. Tank drain isolation valve.
4. System connection isolation valve.

E. Model and size: As scheduled.

F. Manufacturers: Amtrol, Armstrong, Bell & Gossett, Taco, or equal.

## 2.11 AIR VENTS

A. Coin operated vent: Manual low profile vent for use in baseboard and other enclosures where automatic vent will not fit. 150 PSIG working pressure, 212 degrees F. operating temperature. Bell & Gossett No. 4V or approved equal.

B. Float Type:
1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
2. Iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

3. Operating pressure 75 PSIG, hydrostatic pressure 200 PSI maximum, intended for use in hot or cold lines. Provide ball type isolation valves for air vents that do not have integral shut off valves.
4. Manufacturers: Spirotherm Spirotop, Honeywell EA791004, or equal.

## 2.12 AIR SEPARATORS

A. Combination dirt/air hydraulic separator (AS-1):
   1. Flanged connections.
   2. Steel body, brass vent head, copper coalescing medium.
   3. Integral air vent.
   4. Maximum working pressure 150 psig. Maximum working temperature 270 degrees F.
   5. Capable of removing 100 percent of free air, 100 percent of entrained air, and 99.6 percent of dissolved air in the system fluid.
   6. Dirt separation of at least 80 percent of all particles larger than 30 micron and larger within 100 passes.
   7. Flowrate and pressure drop as scheduled.
   8. Manufacturer: Spirotherm Model VDX.

B. Combination dirt/air separator (AS-2):
   1. Flanged connections.
   2. Steel body, brass vent head, copper coalescing medium.
   3. Maximum working pressure 150 psig. Maximum working temperature 270 degrees F.
   4. Capable of removing 100 percent of free air, 100 percent of entrained air, and 99.6 percent of dissolved air in the system fluid.
   5. Dirt separation of at least 80 percent of all particles larger than 30 micron and larger within 100 passes.
   6. Flowrate and pressure drop as scheduled.
   7. Manufacturer: Spirotherm Model VDT.

## 2.13 STRAINERS

A. Size two inch and under:
   1. Screwed brass or iron body for 175 PSIG working pressure.
   2. Y pattern with 1/32-inch stainless steel perforated screen.

B. Size 2-1/2 inches to four inches:
   1. Flanged or grooved iron body for 175 PSIG working pressure.
   2. Y pattern with 3/64-inch stainless steel perforated screen.

C. Size five inches and larger:
   1. Flanged or grooved iron body for 175 PSIG working pressure.
   2. Basket pattern with 1/8-inch stainless steel perforated screen.

D. Manufacturers: Metraflex, Armstrong, Crane, Hayward, Watts Regulator, Hoffman, Sarco.

## 2.14 AUTOMATIC FLOW LIMITING AND ISOLATION VALVES

A. Supply pipe side: Brass alloy body with stainless steel flow cartridge assembly, integral ball valve, 20 mesh strainer element, two pressure/temperature test valves and drain valve with hose bibb adapter and end cap. Body design allows removal of flow cartridge without disturbing piping connections. Threaded sweat adapter inlet. Union with sweat adapter outlet.

B. Return pipe side: Forged brass body with integral ball valve, pressure/temperature test valve and manual air vent. Union with sweat adapter inlet. Threaded sweat adapter outlet.

C. Calibration: Control flow within five percent of selected rating, over operating pressure range of at least 10 times minimum pressure required for control. Provide three operating pressure ranges with a minimum range requiring less than 3.5 PSID to actuate flow control cartridge.

D. Flow Control Cartridge: Stainless steel one piece cartridge with segmented port design and full travel linear coil spring.

E. Provide supply and return components packaged as a system and labeled in accordance with the equipment schedule tag to match terminal heating unit served.

F. Manufacturer: Griswold Controls, Bell & Gossett, or approved equal.

## 2.15 BALANCING VALVES

A. Provide calibrated plug or ball valve type balancing valves with self-sealing quick connect pressure taps, scale and locking device. Include schedule with submittal.

B. Manufacturers: Bell & Gossett, Taco

## 2.16 BRAZED PLATE HEAT EXCHANGERS

A. Provide brazed plate type heat exchanger(s) with the heat transfer and hydraulic performance characteristics as scheduled.

B. Heat exchangers to include the following:
   1. Cover plates: Stainless steel ASTM 316L.
   2. Channel Plates: Corrugated stainless steel ASTM 316L, vacuum brazed together.
   3. Brazing material: Copper.
   4. Connections: Stainless steel ASTM 316L.
   5. Design pressure: 435 PSIG.
   6. Design temperature: -310 degrees F (minimum) and 450 degrees F (maximum).

C. Manufacturers: Bell & Gossett, Trantor, or equal.

## 2.17 FLUSHING AGENT

A. Synthetic organic dispersant manufacturer: CH2O, Product 6149 or approved equal.

## 2.18 WATER TREATMENT

A. Hydronic loop treatment manufacturer: CH2O, Product 6439 or approved equal.

## 2.19 GLYCOL SYSTEMS

A. Provide equipment and products specifically designed and approved for continuous operation with the glycol solution specified.

B. Glycol Solution:
   1. Inhibited propylene glycol solution premixed to 50 percent by volume for use with hydronic heating systems.
   2. Fluid analysis test kit.
   3. Manufacturer: Dow Chemical Company Dowfrost. No substitutes.

# PART 3 - EXECUTION

## 3.1 INSTALLERS

A. Installer: Perform work by experienced personnel previously engaged in hydronic system construction and under the supervision of a qualified installation supervisor.

## 3.2 PREPARATION

A. Protection of In-Place Conditions: Cover equipment and plug piping connections to protect components from construction dirt and debris.

B. Surface Preparation:
   1. Prior to installation of equipment, verify concrete housekeeping pads are complete and properly sized for equipment mounting.
   2. Prior to installation of piping and equipment, verify that shop drawings are approved, and locations and routing have been coordinated with the work of other trades.

## 3.3 INSTALLATION

A. Special Techniques:
   1. Install equipment in accordance with manufacturer's instructions and requirements of the codes specified herein.
   2. Provide finished products with protective covers during balance of construction.
   3. Provide accessible ball type isolation valves at major piping branches, and on main lines as shown, and at terminal devices.
   4. Provide drains and manual vents at main line and branch line valves to facilitate draining and filling piping sections. Provide caps on drain outlets.
   5. Access Doors: Provide appropriate size and install such that hydronic system features are readily accessible and maintainable.
   6. Install balancing valves and automatic flow limiting valves to be accessible and adjustable.
   7. Install piping to maintain headroom, conserve space, and not interfere with use of space.
   8. Use of bullhead tee with opposed flow, double inlet configuration not allowed.

9. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
10. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
11. Thermal Expansion:
    a. Install piping to allow for normal thermal expansion and contraction without stressing pipe, joints, or connected equipment.
    b. Provide anchors where necessary and as shown.
    c. Provide support and expansion loops, expansion compensators, and alignment guides to suit conditions and as shown on drawings.
    d. Piping shall be guided and restrained as recommended by the manufacturer.
12. Provide test plugs on both inlet and outlet sides of heat transfer elements to allow measurement of both fluid pressure drop and differential temperature.
13. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.
14. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor the other end. Install in horizontal plane unless indicated otherwise.
15. Provide pipe anchors, offsets, loops and expansion compensators as required to control the expansion of pipelines.
16. Flushing:
    a. Where hydronic piping installed under this project is connected to an existing hydronic system, provide branch isolation valves and provision for cleaning and flushing consisting of tees with valve, hose fittings and caps immediately adjacent to the branch isolation valves.
    b. Clean internal surfaces of the completed heating system as follows:
        1). Flush hydronic piping to remove black magnetic iron oxide and mill scale from the system.
        2). Flush system piping with synthetic organic dispersant to remove grease. Circulate solution through system at 150 degrees F or greater for 12 to 24 hours.
        3). Repeat process until the system is clean to the satisfaction of the Contracting Agency.
        4). Flush system with fresh water as necessary to remove residual cleaning agent.
        5). Exercise proper care during flushing and cleaning of systems to make sure no damage is done to equipment, valves, fittings, or Work of other trades. Restore damaged system components or Work of other trades to new or original condition at no additional cost to Owner.

B. Interface with Other Work: Coordinate and sequence installation of hydronic products with trades responsible for portions of this and other related sections of the Project Manual.

## 3.4 SITE QUALITY CONTROL

A. Non-Conforming Work: Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

B. Manufacturer Services:

1. Verify units are installed and operational in accordance with the manufacturer's written installation instructions.
2. Both the Contractor and Manufacturer's Representative(s) shall sign start-up and operational checklist to confirm proper unit installation and operation.
3. Provide samples of the inhibited propylene glycol solution to the manufacturer for testing using the fluid analysis test kit provided.
4. The manufacturer of the inhibited propylene glycol solution shall provide free testing of the solution 24 hours after system startup and again 90 days later to verify proper fluid performance for both tests.
5. Provide one copy of manufacturer's test reports to the Owner. Adjust fluid concentration and/or correct deficiencies as addressed in the report.

C. Hydronic System Cleaning and Treatment Coordination Meeting:
   1. Conduct a meeting prior to flush cleaning and treatment of the hydronic heating system to discuss cleaning agents, treatment chemicals and procedures to be used. Discuss system fill procedures with inhibited propylene glycol solution.
   2. Participants shall include the Contractor and Subcontractor directly performing the work and the Owner's Maintenance Staff personnel.
   3. Provide one week notice prior to the meeting.
   4. Cleaning, filling and treatment of any hydronic system is not permitted until this coordination meeting has been conducted and the Contracting Agency's concerns have been adequately addressed.

D. System fill:
   1. After flush cleaning the hydronic heating system, fill the primary system with water and add treatment chemicals to the concentration recommended by the manufacturer. Fill the secondary loop system with inhibited propylene glycol solution as specified.
   2. Thoroughly vent the systems to include piping high points and equipment vents (pump casings, air separators, etc.).

E. Site Tests:
   1. Hydrostatic Pressure Test:
      a. Make sure hydronic heating system is filled with clean operating fluid. Hydrostatically test system to 100 PSIG. System must hold test pressure for a two hour period with no pressure drop to pass test.
      b. Inspect system during test and repair leaks.
      c. Provide written report indicating that the pressure test has been satisfactorily completed.
   2. Operational Test:
      a. Inspect system for proper fluid circulation, sufficient clearance for expansion and contraction of piping and proper system pressure control.
      b. Note and correct discrepancies and deficiencies.
      c. Provide written report indicating that the operational test has been satisfactorily completed.
   3. Test results shall be certified in writing as required by General Conditions. Include dates and sections tested, test pressure, test duration, printed names and signatures of person performing the test and Contracting Agency witnessing the test.

F. Verify penetrations are installed to maintain assembly integrity.

## 3.5 SYSTEM STARTUP

A. Start-up and operate hydronic heating systems and equipment in accordance with the manufacturer's written installation and operation manual checklist.

B. Document start-up and operational checks using the checklist and submit in accordance with submittal requirements.

## 3.6 ADJUSTING

A. Adjust functional components for proper operation in accordance with manufacturer's recommendations, or as otherwise directed.

B. Coordinate and work directly with the Balancing and Testing Agency and the requirements of Section 23 0593 - Testing, Adjusting and Balancing, to provide systems in proper operating order.

C. Make corrections and adjustments as required by the Testing, Adjusting and Balancing (TAB) Agency in a timely manner.

## 3.7 CLEANING

A. Waste Management: After construction is completed, clean and wipe down exposed surfaces of pumps, piping and appurtenances.

## 3.8 CLOSEOUT ACTIVITIES

A. Demonstration: Provide 2 hours of demonstration conducted by authorized factory start-up personnel to the Contracting Agencies authorized maintenance personnel.

B. Training: Provide 4 hours of operational instruction conducted by authorized factory start-up personnel to the Contracting Agencies authorized maintenance personnel.

END OF SECTION 23 2113

# SECTION 23 2123
# HYDRONIC PUMPS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. System lubricated circulators.
   2. In-line circulators.
   3. Vertical in-line pumps.

### 1.2 SYSTEM DESCRIPTION

A. Design Requirements:
   1. This section describes specific requirements, products and methods of execution for interrelated systems necessary for the pumping of heating fluid, which will be distributed to the locations shown.
   2. The method of generation of, and distribution of, this heat is specified elsewhere.

B. Performance Requirements:
   1. Select pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
   2. Provide performance and output shown or scheduled on drawings.

### 1.3 SUBMITTALS

A. See section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:
   1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria.
   2. Include the following:
      a. Catalog data sheets for each pump scheduled. Indicate which model is being submitted.
      b. Certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
      c. Dimensional data.
      d. Features and appurtenances being provided.
      e. Electrical characteristics and connection requirements.

C. Shop Drawings:
   1. Submit fully dimensioned shop drawings of boiler room showing major equipment and housekeeping pads, with clear callouts indicating deviations from layout shown.
   2. Indicate mechanical and electrical service locations and requirements.

D. Quality Assurance/Control Submittals:
   1. Design Data and Test Reports: Provide design data and test reports for each pump.
   2. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:
      a. Provide a complete manufacturer's written installation, operation and maintenance manual for each installed pump. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.
      b. Test pump operation and sequencing in accordance with the manufacturer's written installation and testing instructions and Section 25 9000 - Sequence of Operations.
      c. Submit a letter of certification indicating that the pump installation and start-up has been completed, that the pumps are properly adjusted and operating within the tolerances as specified by the manufacturer, and that the sequence of operation is fulfilled.
      d. Included with the manual one copy of the completed start-up and operation checklist. The checklist shall include:
         1). Printed names and signatures of the installers.
         2). Documentation from Manufacturer's representative and Contracting Agency that the pumps have been properly installed and each is fully operational, thus validating the equipment warranty.

1.4 CLOSEOUT SUBMITTALS

A. See section 20 0000 - Mechanical General Requirements.

B. Closeout Submittals:

C. Project Record Documents: Record actual locations of pumps and associated valves, and areas required for maintenance access.

D. Operation and Maintenance (IO&M) Manuals:

1.5 WARRANTY

A. Manufacturer Warranty: See section 20 0000 - Mechanical General Requirements, for general mechanical warranty requirements.

PART 2 - PRODUCTS

2.1 IN-LINE CENTRIFUGAL PUMPS (PMP-1, PMP-2)

A. Type: Single stage, single suction, close coupled, in-line pump with inverter duty motor for VSD operation.

B. Materials:
   1. Pump Body: Cast iron, with 125 psig ANSI flanged connections.
   2. Impeller: Stainless Steel.
   3. Bearings: Sealed.
   4. Shafts: Stainless steel.
   5. Mechanical Seal Assembly.

a. Stationary face: Carbon.
b. Rotating face: Tungsten Carbide.

C. Performance:
1. As scheduled.
2. Maximum working temperature: 230 degrees F.
3. Maximum working pressure: 175 psig.

D. Electrical Characteristics:
1. As scheduled.
2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

E. Manufacturers: Taco 1900 Series (Basis of Design), Armstrong, Bell and Gossett, Grundfos.

2.2 IN-LINE CIRCULATOR PUMPS (PMP-3, PMP-4, PMP-5)

A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting.

B. Materials:
1. Pump Volute: Cast iron, with 125 pound ANSI flanged pump connections.
2. Impeller: Polymer.
3. Shaft: ANSI 420 stainless steel..
4. Bearings: Carbon sleeve type.

C. Performance:
1. As scheduled.
2. Maximum working temperature: 230 degrees F.
3. Maximum working pressure: 175 PSIG.

D. Electrical Characteristics:
1. As scheduled.
2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

E. Manufacturers: Taco VR Series (Basis of Design), Armstrong, Bell and Gossett.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection: Cover pumps and plug piping connections to protect pumps from construction dirt and debris.

B. Preparation: Prior to installation of pumps, verify that electrical power is available and of the same voltage and phase characteristics as the pump being installed.

## 3.2 INSTALLATION

A. Install pumps, pump supports, suction guides, mechanical seal piping, pressure gauges and other pump appurtenances in accordance with the manufacturer's written installation instructions.

B. Provide access space around pumps for service. Provide no less than the minimum as recommended by manufacturer.

C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings.

D. Provide line sized shut-off valve on pump suction, and line sized soft seat check valve.

E. Provide gauges with connections to suction and discharge.

## 3.3 CONSTRUCTION

A. Interface with Other Work:
   1. Coordinate and sequence installation of pumps and appurtenances with trades responsible for portions of this and other related sections of the Project Manual.
   2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

## 3.4 REPAIR/RESTORATION

A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

## 3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:
   1. After completion of the installation, a qualified representative of the pump manufacturer shall conduct pump start-up and written certification.
   2. Start-up and adjust the system to within the tolerances as specified by the equipment manufacturer. Verify pump impellers rotate in the correct direction.
   3. Provide two hours operating instruction to authorized Owner's Representative.
   4. Test pump operation and sequencing in accordance with submittal requirements.
   5. Submit a letter of certification indicating that the pump installation and start-up has been completed.

## 3.6 ADJUSTING

A. Coordinate and work directly with the Testing, Adjusting and Balancing Agency to provide systems in proper operating order. Make corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.

## 3.7 CLEANING

A. After construction is completed, clean and wipe down exposed surfaces of pumps, piping and appurtenances.

B. Touch up marred or scratched factory finished surfaces using finish materials furnished by manufacturer.

## 3.8 DEMONSTRATION & START-UP

A. Start-up and operate hydronic pumps in accordance with the manufacturer's written installation and operation manual checklist.

B. Document start-up and operational checks using the checklist and submit in accordance with submittal requirements.

END OF SECTION 23 2123

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# SECTION 23 3100

# DUCTS AND ACCESSORIES

## PART 1 - GENERAL

### 1.1 SUMMARY

*A.* Section Includes:Metal Ductwork and Fittings.
2. Flexible Ductwork.
3. Acoustical Linings.
4. Casings and Plenums.
5. Volume Dampers.
6. Control Dampers.
7. Fire Dampers.
8. Flexible Duct Connectors.
9. Access Panels and Doors.

B. Related Section
1. 20 0000 - Mechanical General Requirements
2. 20 0529 - Mechanical Hangers and Supports
3. 20 0553 - Mechanical Identification
4. 20 0700 - Mechanical Insulation
5. 20 4100 - Mechanical Demolition
6. 23 0131 - Duct Cleaning
7. 23 0593 - Testing, Adjusting and Balancing
8. 23 3400 - HVAC Fans
9. 23 3600 - Air Terminal Units
10. 23 3700 - Air Outlets and Inlets
11. 23 7323 - Central Air Handling Units
12. 23 8200 - Terminal Heating and Cooling Units

### 1.2 REFERENCES

A. Codes and Standards:
1. ASHRAE Standard 90.1-2010 Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. SMACNA HVAC Duct Construction Standards - Metal and Flexible, Third Edition 2005.
3. SMACNA HVAC Air Duct Leakage Test Manual, Second Edition 2012.
4. SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, Fifth Edition 2002.
5. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.
6. ACR the National Air Duct Cleaners Association (NADCA) Standard for Assessment, Cleaning and Restoration of HVAC Systems, 2021.

### 1.3 SUBMITTALS

A. See Section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data: Include manufacturer's detailed fire, smoke, and combination fire/smoke damper installation instructions for each specific wall, ceiling, and floor construction type(s) for the project.

C. Shop Drawings:
   1. Include the following information in the scaled ventilation system shop drawings:
      a. Label duct sizes using the same labeling method as the Contract Documents.
      b. Show terminal equipment ductwork connections.
      c. Volume, control, backdraft, fire, smoke, and combination fire/smoke damper locations as applicable.
      d. Flexible connection locations.
      e. Access panels and doors with sizes and swing directions shown.
   2. Casings and plenums: Submit detailed shop drawings showing the proposed plenum and casing materials to be used and the construction method.

## 1.4 CLOSEOUT SUBMITTALS

A. See Section 20 0000 - Mechanical General Requirements.

B. Record Documentation: Record actual locations of ductwork and areas required for maintenance access in accordance with Section 20 0000 - Mechanical General Requirements.

# PART 2 - PRODUCTS

## 2.1 METAL DUCTWORK AND FITTINGS

A. General: Provide metal ductwork and fittings fabricated in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, G90 zinc coated unless otherwise noted.

B. Medium Pressure/Velocity Ductwork:
   1. Duct Pressure Class: 4inches WC.
   2. Seal Class: A.
   3. Maximum Velocity: 2,200 FPM.

C. Low Pressure/Velocity Ductwork:
   1. Duct Pressure Class: 2 inches WC.
   2. Seal Class: A.
   3. Maximum Velocity: 1,500 FPM.

## 2.2 FLEXIBLE DUCTWORK

A. Manufacturers:
   1. Thermaflex, Model M-KE.
   2. Hart & Cooley.
   3. JPL.
   4. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Description: UL listed, Class 1 flexible ductwork in compliance with NFPA 90A and 90B.

C. Performance/Design Criteria:
1. Positive Pressure Rating:

| | |
|---|---|
| Ten inches WC | (4”-12” ID). |
| Six inches WC | (14”-16” ID). |
| Four inches WC | (18”-20” ID). |

2. Negative Pressure Rating:

| | |
|---|---|
| One inch WC | (4”-12” ID). |
| One half inch WC | (14”-20” ID). |

3. Maximum Velocity: 5000 FPM.
4. Operating Temperature Range:
   a. 0 degrees F to 140 degrees F (continuous).
   b. Minus 20 degrees F to 250 degrees F (intermittent).
5. Insulating Value: R-4.2.
6. Acoustical Net Insertion Loss (Based on 8 inch duct, 10 feet long, 2,500 fpm airflow):

| band | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|
| dB | 13 | 35 | 34 | 39 | 29 | 17 | 14 |

D. Materials:
1. Acoustically rated black polyester core permanently bonded to coated spring steel wire helix.
2. Fiberglass insulation.
3. Tear resistant, reinforced metalized vapor barrier.

## 2.3 ACOUSTICAL LININGS

A. Manufacturers:
1. Knauf.
2. Johns Manville.
3. Owens-Corning.
4. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Description:
1. UL listed.
2. NFPA 90A and 90B compliant.
3. One inch thick, 1.5 PCF, flexible, edge-coated, mat-faced glass fiber insulation bonded with thermosetting resin.
4. Does not promote growth of fungi or bacteria.

C. Performance/Design Criteria:
1. Maximum Velocity: 6000 FPM.
2. Operating Temperature Range: Up to 250 degrees F.
3. Maximum Water Vapor Sorption: Three percent by weight.

## 2.4 CASINGS AND PLENUMS

A. General:
1. Consider ductwork with any dimension exceeding 72 inches to be a plenum.
2. Provide packaged air handling unit casings and plenums fabricated by the air handling unit manufacturer.
3. Provide factory pre-fabricated or field fabricated plenums and casings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Specific Double-Walled Casing and Plenum Requirements:
1. Outer duct: Galvanized steel (minimum 20 gauge).
2. Supply Air Plenum Liner: Perforated, galvanized steel (minimum 22 gauge).
3. Outside Air Plenum Liner: Galvanized steel (minimum 22 gauge).
4. Insulation:
   a. Standard 2-inch fiberglass insulation with Mylar or similar cover material to prevent dust accumulation and to prevent insulation from entering the air stream.
5. Access Doors: Provide access doors in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
6. Acoustical Performance Sound Transmission Losses (dB):

| BAND, HZ | 125 | 250 | 500 | 1000 | 2000 | 4000 |
|---|---|---|---|---|---|---|
| 2” Wall Thickness | 18 | 21 | 29 | 38 | 49 | 55 |
| 4” Wall Thickness | 16 | 24 | 35 | 45 | 53 | 58 |

## 2.5 VOLUME / BALANCING DAMPERS

A. Manufacturers:
1. Ruskin.
2. Greenheck.
3. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Materials:
1. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for fabricated volume damper construction requirements.
2. Round ducts to 12 inches diameter and rectangular to 18 inches width:
   a. Flat sheet, galvanized steel, single blade damper.
   b. Damper blade two gauges thicker than the duct gauge at the location installed (24 gauge minimum for round, 22 gauge minimum for rectangular).
   c. Manual hand quadrant.
3. Round ducts over 12 inches diameter:
   a. Flat sheet, galvanized steel, single blade damper.
   b. Damper blade two gauges thicker than the duct gauge at the location installed (22 gauge minimum).
   c. Manual hand quadrant with continuous steel rod.

4. Rectangular ducts over 18 inches width:
   a. Flat sheet, galvanized steel, single blade damper.
   b. Damper blade 18 gauge minimum.
   c. Manual hand quadrant with continuous steel rod.
5. Accessible and lockable damper operators.

C. Extractors: Not Permitted.

D. Splitter Dampers: Not Permitted.

## 2.6 REMOTE VOLUME DAMPER OPERATORS

A. Manufacturers:
   1. Duro-dyne.
   2. Young Regulator.
   3. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Provide flush mounted chrome plated remote operators with tamperproof cover, extension rod, and not more than one 90 degree angle gear drive.

C. Regulator: Duro-dyne Series SRC-380 or Young Regulator 301.

D. Angle Drive: Duro-dyne Model AD-38 or Young Regulator 927.

## 2.7 CONTROL DAMPERS

A. Manufacturers:
   1. Ruskin, Model CD50 (rectangular) or CDR25 (round).
   2. Greenheck, Model VCD-43 (rectangular).
   3. Air Balance.
   4. Pottorff.
   5. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Rectangular:
   1. Performance/Design Criteria:
      a. Temperature Limits: -72 degrees F to 275 degrees F.
      b. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
         1). Closed Position: Maximum pressure of 13 inches WC at a 12-inch blade length.
         2). Open Position: Maximum air velocity of 6,000 feet per minute.
      c. Leakage: Maximum 3.0 cubic feet per minute per square foot at 1.0 inch WC for sizes 24 inches wide and above.
      d. Pressure Drop: Maximum 0.05 inches WC at 1,500 feet per minute across 24 inch by 24 inch damper.
   2. Material:
      a. Frame: Five inches by one inch by minimum 0.125 inch 6063T5 extruded aluminum hat channel, mounting flanges on both sides of frame, reinforced at corners.

b. Blades: Airfoil-shaped, single-piece blades made of heavy-duty 6063T5 extruded aluminum. Maximum 6 inches blade depth.
c. Bearings: Non-corrosive, molded synthetic sleeve, turning in hole in frame.
d. Seals:
1). Blade: Extruded vinyl type for ultra-low leakage. Mechanically attached to blade edge.
2). Jamb: Flexible metal compressible.
e. Linkage: Concealed in frame.
f. Axles: Minimum 1/2-inch diameter plated steel hex, mechanically attached to blade.

3. Finishes: Mill aluminum.

C. Round:
1. Performance/Design Criteria:
a. Temperature Rating: Maximum 250 degrees F.
b. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
c. Closed Position: Maximum pressure of 10 inches WC.
d. Maximum system velocity: 4,000 feet per minute.
e. Maximum Leakage: Maximum 6 cubic feet per minute per square foot at 1 inch WC.
f. Pressure Drop: Maximum 0.05 inch WC at air volume of 7,000 cubic feet per minute through 24 inch diameter damper.
2. Material:
a. Frame:
1). Under 6 inches Diameter: Two inches by minimum 12 gauge galvanized steel tube.
2). 6 through 12 inches Diameter: Two inches by 1/2-inch by minimum 14 gauge galvanized steel channel.
3). Above 12 through 24 inches Diameter: Two inches by 1/2-inch by minimum 1/8-inch galvanized steel channel.
b. Blade: Provide single-piece construction made of the following material:
1). 18 inches diameter and less: Minimum 12 gage galvanized steel.
2). Over 18 inches diameter: Minimum 10 gage galvanized steel, stiffeners as required.
c. Blade Seals: Closed cell polyethylene foam rubber or neoprene, fully encompassing and mechanically attached to blade edge.
d. Bearings: Self-lubricating stainless steel sleeve.
e. Axles: Minimum 1/2-inch diameter plated steel, full length of and extending 6 inches beyond damper frame, mechanically attached to blade.
3. Finishes: Mill galvanized.

## 2.8 FIRE DAMPERS

A. Manufacturers:
1. Ruskin (Basis of Design).
2. Greenheck.
3. Pottorff.
4. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Regulatory Requirements: UL listed and labeled in accordance with UL Standard 555.

C. Performance/Design Criteria:
   1. Fire rating suitable for the applicable wall construction rating in accordance with IBC.
   2. Rated for use in dynamic system with maximum velocity of 2,000 FPM and maximum 4 inches WC static pressure.
   3. Provide with 165 Deg F fuse link.

## 2.9 FLEXIBLE DUCT CONNECTORS

A. Manufacturers:
   1. Duro-dyne Corporation.
   2. Vent Fabrics.
   3. Ductmate.
   4. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Performance/Design Criteria: Provide fan connectors with static pressure ratings suitable for each specific application. Minimum pressure ratings must be greater than, or equal to, the fan's shut-off static pressure, as indicated by the submitted fan curve, with a 50 percent safety factor.

C. Materials:
   1. Metal edging: 24 gauge galvanized steel.
   2. Fabric: UL Listed, polyester blend with vinyl coating. Double folded seams. Four inches width.

## 2.10 ACCESS PANELS AND DOORS FOR DUCTS AND PLENUMS

A. Manufacturers:
   1. Air Balance Inc. model FSA-100 (Basis of Design).
   2. Ruskin.
   3. Ductmate.
   4. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Material:
   1. Frame and Door: Minimum 24 gauge galvanized steel.
   2. Reinforced doors with cross-bracing and/or otherwise stiffened to prevent rattling and vibration.
   3. Seals: Rubber gaskets, secured to door or frame.
   4. Where ductwork is insulated or lined, provide double-walled access door panels with one inch of internal insulation to match duct or plenum insulating and/or sound attenuating characteristics.
   5. Walk Through Doors:
      a. Construct in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
      b. Provide insulation and inner liner to match plenum or casing.

C. Hinges and Latches:

1. Low velocity system access panels:
   a. Sizes 12 inches by 12 inches through 24 inches by 24 inches.
   b. Continuous steel hinge mechanically fastened to frame and quarter turn cam latches.
2. Medium velocity system access panels:
   a. Sizes 12 inches by 12 inches through 24 inches by 24 inches.
   b. Continuous steel hinge mechanically fastened to frame.
   c. Provide a minimum of two latches for rolled plate doors.
   d. Cement sheet rubber gasket to door.
3. Walk through doors (any dimension over 24 inches):
   a. Provide three hinges.
   b. Provide two latches with inside and outside handles.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Verify location, size and type (i.e. fire resistive construction) of wall, floor and ceiling/roof penetrations.

### 3.2 PREPARATION

A. Protection on In-Place Conditions: During construction, install temporary closures of sheet metal, cardboard or polyethylene taped over ductwork openings to prevent construction dust and debris from entering duct systems.

### 3.3 INSTALLATION

A. Metal Ductwork and Fittings:
   1. Install, seal and support ductwork and fittings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible for the duct pressure class and seal class specified. The use of “duct tape” as a duct seal method is prohibited.
   2. Provide medium pressure/velocity ductwork at the following locations: VAV ventilation systems from air handler cabinet discharge plenum connection to VAV terminal unit inlet neck connections.
   3. Provide low pressure/velocity ductwork at the following locations:
      a. VAV terminal unit discharge connections to air outlet connections.
      b. Outside air intake ductwork.
      c. Exhaust and relief air ductwork.
      d. Constant volume ventilating systems.
   4. Proprietary or other joint systems may be substituted for SMACNA details when submitted and approved in writing before starting work.
   5. Where ducts penetrate through walls exposed in occupied spaces, provide sheet metal escutcheons at each penetration to provide a clean, finished appearance.
   6. Duct penetrations: See Section 20 0529 - Mechanical Hangers and Supports.
   7. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoffs, use 90-degree conical tee or low-loss tee connections.
   8. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream of equipment.

9. Provide orifice plates or balance dampers at branch connections as required for proper ventilation system balancing. Select balancing device and installation method to limit noise from mechanical vibration or air bypass.
10. Do not use turning vanes in medium velocity duct systems.
11. Support duct mounted equipment equal to or greater than 40 pounds, such as heating coils, independently from ductwork.
12. Support duct mounted equipment less than 40 pounds using standard duct supports and sway bracing located within 12 inches of equipment.
13. Where offsetting ductwork is not possible, ducts may be reduced a maximum of 20 percent to clear obstacles with Contracting Agency's permission.
14. Where steel ductwork is visible through air outlets or inlets, paint visible interior ductwork flat black.

B. Flexible Ductwork:
1. Install, connect and support flexible ductwork in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
2. Connection to air outlets in suspended grid ceiling systems: Provide a flexible duct length of 6 to 8 feet with one 90-degree bend or large radius 180-degree curve in addition to outlet connection. Support flexible duct at connections to air outlets to maintain minimum recommended bend radius.
3. Seal flexible duct connections to rigid ductwork with draw bands to the pressure class of the rigid duct system.
4. Flexible duct connections between medium pressure ductwork and air terminal units are prohibited.
5. Flexible ductwork is prohibited in inaccessible locations, such as above "hard" ceilings.
6. Flexible ductwork is prohibited at penetrations through walls.

C. Acoustical Lined Ductwork:
1. Provide standard one inch thick acoustically lined ductwork as indicated using the acoustical liner material specified. Attach the lining material to the ductwork in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. Provide thicker acoustical lining where specifically noted.
2. Duct dimensions indicated are net free-area duct dimensions. Add twice the liner thickness to obtain outside duct dimensions.
3. Sleeve acoustical duct penetrations through full height walls perpendicular to wall surface. Provide 1/2-inch minimum gap between sleeve and duct. Fill gap with mineral wool backer and seal each side of penetration with acoustical sealant.

D. Casings and Plenums:
1. Install casings and plenums in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
2. Set plenum doors 6 to 12 inches above floor. Arrange door swing so fan static pressure holds door in closed position.
3. Casings: Unless indicated otherwise, install floor mounted casings on 4 inch high concrete curbs.
4. At floor, rivet panels on 8 inch centers to steel angles. Where floors are acoustically insulated, furnish 18 gauge galvanized expanded metal mesh liner supported at 12-inch centers, turned up 12 inches at sides with sheet metal shields.

E. Volume Dampers:

1. Provide air volume dampers at each low-pressure duct main and branch take-off for proper air balancing.
2. Locate dampers a minimum of 10 feet from diffusers except where shown otherwise.
3. Volume dampers are not to be installed in medium pressure, variable air volume systems.

F. Control Dampers:
   1. Provide opposed blade type dampers for the following applications:
      a. Exhaust fan discharge dampers.
      b. Outside air intake dampers.
      c. Isolation dampers.
   2. Provide parallel dampers for the following application: Air handling unit mixing box.

G. Fire Dampers:
   1. Before starting work, verify the location and types of fire resistive construction as indicated by the Contract Drawings. Typical fire rated separations include:
      a. Area separation walls, vertical only.
      b. Occupancy separation walls, or partitions and floors. Vertical or horizontal.
      c. Fire resistive egress corridors, halls and vestibules.
      d. Fire resistive enclosures of hazardous spaces within an occupancy, including rooms for fuel-fired or electric heating equipment.
      e. Fire resistive floor/ceiling assemblies associated with any of the above.
   2. Verify locations and types of dampers indicated on drawings. If dampers appear to be incorrectly located or missing, obtain clarification from Contracting Agency.
   3. Install dampers at locations indicated on the Drawings and in accordance with manufacturer's UL approved installation instructions.
   4. Install rectangular dampers square and free from racking.
   5. Do not compress or stretch damper sleeve into duct or opening.
   6. Handle damper using frame/sleeve. Do not lift damper using blade, actuator, or jackshaft.

H. Flexible Duct Connectors:
   1. Install duct connectors in accordance with the manufacturers written installation instructions.
   2. Provide a flexible airtight joint between fans and other vibrating equipment and the air distribution ductwork systems.
   3. Externally isolated air handling units and fans: Provide flexible connections where ducts attach to unit inlet and outlet(s) of unit.

I. Penetrations:
   1. Coordinate mechanical penetrations with architectural and structural construction details prior to installation. Set sleeves in position in concrete formwork. Provide reinforcement around sleeves as required.
   2. Provide compatible materials, fasteners, adhesives, sealants, and other products required for proper installation.
   3. Penetrations through roof, exterior walls and floors to be weather and water tight.
   4. Penetrations through fire rated assemblies to be UL listed.
   5. Penetrations through smoke partitions and barriers to resist passage of smoke.

6. Other penetrations to have acoustical seals.

J. Access Panels and Doors:
   1. Locate access doors to enable in-duct equipment to be easily inspected, cleaned, maintained and tested and/or reset.
   2. Provide access doors at the following locations:
      a. Fire, smoke and combination fire/smoke dampers.
      b. Motor operated dampers.
      c. Each side of duct mounted coils.
      d. Each side of duct mounted humidification dispersion panels.
      e. As necessary for duct cleaning in accordance with NADCA Industry Standard for Mechanical Cleaning of Non-Porous Air Conveyance System Components.
      f. As necessary for maintenance access to serviceable instrumentation and control equipment.
   3. Coordinate location and size of access doors in walls, partitions and ceilings to correspond with duct access doors, dampers and automatic control devices and instruments.
   4. Coordinate with supplier of component air handlers, package units and similar equipment to ensure that access doors and panels will not be obstructed when the equipment is installed.

K. Interface with Other Work:
   1. Assist electrical and controls trades in mounting instrumentation devices and safety controls in ductwork and air handling units.
   2. Make penetrations through exterior building walls watertight. Detail ductwork connections to prevent condensation or leakage from entering into surrounding building construction. Provide sleeves, special connections and sealant as required to accomplish this performance requirement.

## 3.4 ADJUSTING

A. Adjust and balance dampers in accordance with Section 23 0593 - Testing. Adjusting and Balancing.

END OF SECTION 23 3100

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# SECTION 23 3400

# HVAC FANS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes:
   1. In-line centrifugal fans.
   2. Small cabinet fans.

### 1.2 REFERENCES

A. Codes and Standards:
   1. See section 20 0000 - Mechanical General Requirements.
   2. Air Movement and Control Association (AMCA) 99 - Standards Handbook.
   3. ANSI/AMCA 210 (ANSI/ASHRAE Standard 51) - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
   4. AMCA Publication 261 Directory of Products Licensed to Bear the AMCA Certified Rating Seal.
   5. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
   6. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

### 1.3 SYSTEM DESCRIPTION

A. Performance Requirements: Provide product performance characteristics and output as specified or scheduled on drawings.

### 1.4 PRE-INSTALLATION MEETINGS

A. See section 20 0000 - Mechanical General Requirements.

### 1.5 SUBMITTALS

A. See section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:
   1. Provide fan curves with scheduled operating point clearly plotted.
   2. Provide sound power levels (in decibels) for each octave band for inlet, discharge, and radiated sound power for the assembled fan unit. Obtain sound level data by one of the following methods:
      a. Actual measurements from tests performed in accordance with AMCA Standards in an AMCA registered test chamber.
      b. Documented calculations that start with AMCA tested fan sound data and are modified in accordance with ASHRAE procedures identified in Chapter 48 of the 2011 ASHRAE HVAC Applications Handbook to accurately predict the sound power levels for the configuration shown.

3. Provide electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

C. Shop Drawings. Include the following information in the scaled ventilation system shop drawings:
   1. Location, orientation, and size of fans.
   2. Maintenance access and clearance requirements.
   3. Fan support methods (i.e., housekeeping pads, roof curbs, etc.).
   4. Ductwork connections and sizes.

D. Operation and Maintenance (IO&M) Manuals.

## 1.6 WARRANTY

A. Manufacturer Warranty: See section 20 0000 - Mechanical General Requirements, for general mechanical warranty requirements.

# PART 2 - PRODUCTS

## 2.1 GENERAL

A. Manufacturers:
   1. Greenheck.
   2. Cook.
   3. PennBarry.
   4. Acme.
   5. Substitution request required.

B. Description:
   1. Regulatory Requirements:
      a. AMCA Certified Ratings seal for sound and air performance.
      b. Products Requiring Electrical Connection - Listed and classified by Underwriters Laboratories Inc., or by a testing firm acceptable to the Authority Having Jurisdiction as suitable for the purpose specified and indicated.

C. Performance/Design Criteria: As scheduled.

D. Materials:

E. Manufacturer's Nameplate: Permanently affixed, embossed metal containing model number and individual serial number for future identification, located on a permanent part of the fan.

## 2.2 IN-LINE CENTRIFUGAL FANS

A. Duct mounted, directdrive, in-line centrifugal type fans. Rectangular fan housing design constructed of heavy gauge galvanized steel with rectangular duct mounting collars.

B. Removable panel in fan cabinet of sufficient size to permit access for service to internal components without dismantling the cabinet.

C. Centrifugal backward inclined fan wheel, constructed of aluminum and matched wheel and inlet cones for precise running tolerances. Dynamically and statically balanced at the factory.

D. Heavy duty ball bearing type fan motors, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. Motors and drives readily accessible for maintenance.

E. AMCA Certified Ratings. Seal for both sound and air performance.

2.3 MODULAR SMALL CABINET FAN

A. Cabinet:
   1. Materials: Formed double wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections gasketed.
   2. Outside Casing: 18 gauge, galvanized steel (G90).
   3. Inside Casing: 18 gauge, galvanized steel (G90).
   4. Floor Plate: 18 gauge, galvanized steel (G90).
   5. Utility Lugs: For lifting unit and fastening to permanent structure, 8 gauge, galvanized steel (G90).

B. Cabinet Insulation. Comply with NFPA 90A or NFPA 90B:
   1. Materials: Fiber glass insulation.
   2. Thickness: 1 inch.
   3. Density: 1-1/2 pounds per cubic foot.
   4. Thermal Conductivity (k-Value): 0.26 at 75 degrees F (0.037 at 24 degrees C) mean temperature.
   5. Fire-Hazard Classification: Maximum flame spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.

C. Tool less hinged gasketed access doors with latch.

D. Fan Section:
   1. Fan Section Construction: Belt driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor drive assembly, and support structure and equipped with formed steel channel base for integral mounting of fan, motor, and casing panels. Mount fan with interior spring vibration isolation.
   2. Fan statically and dynamically balanced. Forward Curved Fan Wheels: Galvanized steel and/or aluminum/painted steel construction with inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.
   3. AMCA Certified Ratings Seal for air performance.
   4. Shafts: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   5. Turned, ground, and polished (hot rolled) (stainless) steel with keyway. Ship with a protective coating of lubricating oil.
   6. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
   7. Pre-lubricated and Sealed Shaft Bearings: Self-aligning, pillow block type ball bearings.

8. Ball-Bearing Rating Life: ABMA 9, $L_{10}$ of 100,000 hours.
9. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation and with 1.5 service factor based on fan motor.
10. Pulleys: Mechanical cast iron with split, tapered bushing dynamically balanced at factory.
11. Motor Pulleys: Adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
12. Belts: Oil resistant, static free.
13. Motor Mount: Adjustable for belt tensioning.

E. Mixing box with opposed blade low leakage dampers with vinyl edge seals in configuration shown.
F. Filter section with 2 inch MERV8 filters, maximum face velocity of 350 Feet per minute.
G. Corrosion resistant fasteners.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. General:
1. Install fans in compliance with manufacturer's written installation instructions.
2. Provide flexible connections at fan duct connections as shown or specified. See Section 23 3100 - Ducts and Accessories for flexible duct connectors.
3. Support fans independently from ductwork. Provide fan support in accordance with 20 0529 - Mechanical Hangers and Supports.
4. Ensure that fan access doors and panels are not obstructed when the equipment is installed.
5. Extend lubrication points so each is easily reached for maintenance.

B. Interface with Other Work:
1. Coordinate and sequence installation of fans with trades responsible for portions of this and other related sections of the Project Manual.
2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate the installation with related work shall be completed at no additional expense to the Owner.

### 3.2 SYSTEM STARTUP

A. Start-up and operate fans in accordance with the manufacturer's written installation and operation manual check list.

### 3.3 ADJUSTING

A. Adjust and balance fans in accordance with Section 23 0593 - Testing, Adjusting and Balancing.

### 3.4 CLEANING

A. Upon completion of installation and prior to initial start-up, vacuum clean and wipe down external system components and internal shrouded areas.

END OF SECTION 23 3400

# SECTION 23 3600

# AIR TERMINAL UNITS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes: Single duct variable air volume terminal units.

B. Products Installed But Not Supplied Under This Section: Coordinate installation of damper control actuators and application specific controllers, furnished under Section 25 5000 - Building Automation System. Control enclosure shall be factory mounted by the air terminal unit manufacturer.

### 1.2 REFERENCES

A. Codes and Standards:
   1. See section 20 0000 - Mechanical General Requirements.
   2. SMACNA - HVAC Duct Construction Standards, Metal and Flexible, Fourth Edition 2021.
   3. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
   4. ANSI/AHRI 880-2011 - Performance Rating of Air Terminals.

### 1.3 SYSTEM DESCRIPTION

A. Design Requirements:
   1. This section describes specific requirements, products and methods of execution for the single duct, variable air volume, direct digital control terminal units.
   2. The method of distribution of air is specified elsewhere.

B. Performance Requirements:
   1. Provide product performance characteristics as specified or scheduled on drawings.
   2. Operate ventilation system in accordance with Section 25 9000 - Sequence of Operations.

### 1.4 SUBMITTALS

A. See section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data.

C. Shop drawings:
   1. This Section shop drawings to be submitted under Section 20 0000 - Mechanical General Requirements.
   2. Include the following information on the scaled ventilation system shop drawings:
      a. Air terminal unit locations and sizes, including discharge plenum.
      b. Equipment tags.

c. Control enclosure orientation and access clearance requirements.
d. Ductwork connections and sizes.
e. Reheat coil and hydronic piping connections and valving as applicable.
f. Coil access door locations.

D. Installation, Operation and Maintenance (IO&M) Manuals.

1.5 WARRANTY

A. Manufacturer Warranty: See section 20 0000 - Mechanical General Requirements, for general mechanical warranty requirements.

PART 2 - PRODUCTS

2.1 SINGLE DUCT VARIABLE AIR VOLUME TERMINAL UNITS

A. Manufacturers:
1. Titus, Model: DESV.
2. Price.
3. Nailor Industries.
4. Substitution request required.

B. Performance/Design Criteria:
1. Capacities: Provide terminal units of the sizes and performance capacities as scheduled.
2. Sound Rating:
a. Sound data certified by AHRI.
b. Sound ratings for basic air terminal units with inlet diameters less than or equal to 16 inches shall not exceed NC-20 at maximum rated flow (CFM) with a differential static pressure drop of 1.0 inch water column.
c. Radiated and discharge sound power levels at maximum air flow operating conditions shall be submitted with product information.
3. Casing Leakage: Less than 2 percent of nominal CFM at 1.5 inches WC differential pressure.

C. Control Actuator and Application Specific Controller: NEMA 1 control enclosures/digital control packages furnished by Section 25 5000 - Building Automation System to the air terminal unit manufacturer for factory mounting on side of casing.

D. Materials:
1. Casing:
a. Minimum 22 gauge galvanized steel.
b. Mechanically sealed and gasketed, leak resistant construction.
c. Beaded inlet for low leakage construction, sized to fit standard round duct.
d. Rectangular discharge opening designed for slip and drive cleat connection to low pressure ductwork or reheat coil.
e. Multi-port, center averaging inlet velocity sensor with sensor tubing. Flow measurement taps provided for connection to application specific controller.
f. Internally line casing with sound liner specified below.
2. Control Damper:
a. Heavy gauge galvanized steel, butterfly type damper.

b. One-piece, 1/2-inch diameter damper shaft with self-lubricating Delrin® or bronze oilite bearings or self-lubricating. Notched shaft end, to indicate damper position.
c. Synthetic damper seal to limit close-off leakage to less than 1% of terminal rated airflow at 3.0 inches water column differential pressure.
d. Mechanical stop to prevent damper over-stroking.

3. Duct Transitions:
   a. Provide rectangular reheat coil discharge plenum:
      1). Minimum width to match reheat coil width.
      2). Minimum height to match reheat coil height or maximum downstream branch duct spin-in connection diameter plus 4 inches, whichever is greater.
      3). Minimum length 36 inches or longer to accommodate branch ducts.
   b. Sound line duct transitions and plenums to match terminal unit casing liner.

E. Accessories:
1. Sound Liner:
   a. UL Listed and in conformance with NFPA Standard 90A. Liners shall be fungi and bacterial resistant.
   b. 1" thick fiber-free closed cell foam insulation, minimum 1-1/2 pound per cubic foot density, mechanically fastened to unit casing.
   c. Cut liner edges and seal to prevent erosion with discharge edges secured with metal barrier strips for fiberglass or similar insulation.
2. Hydronic Reheat Coils:
   a. Performance characteristics as scheduled.
   b. Constructed from seamless copper tubing (minimum 0.016-inch wall thickness) with aluminum fins, enclosed in 20 gauge (minimum) galvanized steel casing with slip and drive connections. Provide extended copper sweat connections.
3. Access Doors: Provide access doors upstream and downstream of reheat coils for coil cleaning. Refer to Section 23 3100 - Ducts and Accessories.

## PART 3 - EXECUTION

### 3.1 INSTALLERS

A. Installer: Perform work by experienced personnel previously engaged in ventilation system construction and under the supervision of a qualified installation supervisor.

### 3.2 PREPARATION

A. Protection of In-Place Conditions: Cover air terminal unit inlet and discharge openings to protect components from construction dirt and debris.

### 3.3 INSTALLATION

A. General:
1. Install air terminal units in strict compliance with the manufacturer's written installation instructions.

2. Do not locate any part or the terminal unit assembly, including reheat coil and associated low pressure sound lined plenums, such that it passes over a partition wall or through a full height wall penetration.
3. Locate terminal units such that the bottom of the complete assembly is 6 to 18 inches above the top of the ceiling grid or hard lid ceiling framing as applicable.
4. Locate terminal unit controller, coil hydronic piping/valves, and coil access doors on same side of unit. Locate on side that maximizes accessibility (i.e. above accessible ceiling tiles, away from full height walls and main duct runs).
5. Support air terminal units independent of duct system. Provide sway bracing within 12 inches of support attachment.
6. Connect air terminal unit inlets to ductwork using straight sections of unrestricted rigid duct of the same inlet diameter as terminal unit inlet. Provide a minimum straight duct length of 4 duct diameters at each terminal unit inlet. Medium pressure flexible duct connections to terminal units is not allowed except where specifically shown.
7. Close-coupling of a terminal inlet to the side of a main supply duct is not acceptable without written permission from the Contracting Agency. When this method is approved, provide an inlet flow straightening device.
8. Install low pressure ductwork branches vertically centered along the sides of the low pressure sounded lined plenum. A minimum of two (2) inches of sheet metal is required between the spin-in (or similar connection) and top and bottom external edge of the metal plenum.
9. Provide insulated access doors upstream and downstream of reheat coil for coil cleaning.
10. Secure control enclosure cover in place as intended by the manufacturer.
11. Verify mechanical connections, electrical and control wiring and sensor tubing are properly secured.

B. Interface with Other Work:
1. Coordinate and sequence the installation of air terminal units with trades responsible for portions of this and other related sections of the Project Manual.
2. Coordinate ceiling and/or wall access panel locations to provide convenient maintenance and cleaning access for each air terminal unit.
3. Coordinate air terminal unit locations with ceiling grids, lighting troffers, air outlets and return grilles to maximize accessibility and minimize interference.
4. Rework required as a result of failure to follow the manufacturer's written installation instructions, properly coordinate the installation with related work, or provide adequate access (as determined by the Contracting Agency) shall be completed at no additional cost to the Owner.

## 3.4 REPAIR/RESTORATION

A. Refer to Section 20 0000 - Mechanical General Requirements for general repair/restoration requirements.

## 3.5 SYSTEM START-UP

A. With the applicable central ventilation system air balancing completed and the ventilation system operating under automatic control utilizing the BAS, cycle each air terminal unit control damper between minimum and maximum scheduled air flow settings to demonstrate proper operation and capacity in accordance with 25 9000 - Sequence of Operations for verification by the Contracting Agency.

B. Verify reheat coil and auxiliary heating unit (as applicable) hydronic control valves properly cycle with terminal unit control damper, in accordance with Section 25 9000 - Sequence of Operations.

## 3.6 ADJUSTING

A. Adjust velocity sensor bias adjustment as necessary to provide accurate air flow measurement.

B. For units with reheat coil supply temperature sensors, verify maximum supply temperature is limited to 20 degrees F above zone temperature setpoint.

## 3.7 CLEANING

A. Upon completion of installation and prior to initial operation, vacuum clean and wipe down air terminal units and control enclosures.

B. Remove any debris from control enclosure.

C. Inspect and clean reheat coils. Re-straighten coil fins if necessary.

END OF SECTION 23 3600

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# SECTION 23 3700

# AIR OUTLETS AND INLETS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Air Diffusers and Registers.
   2. Return/Exhaust Grilles.
   3. Stationary Louvers.
   4. Roof Hoods.

### 1.2 REFERENCES

A. Codes and Standards:
   1. See section 20 0000 - Mechanical General Requirements.
   2. SMACNA HVAC Duct Construction Standards - Metal and Flexible Fourth Edition 2021.
   3. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
   4. ARI Standard 890-2001 - Air Diffusers and Air Diffuser Assemblies.

### 1.3 SYSTEM DESCRIPTION

A. Performance Requirements: Provide product performance characteristics as specified or scheduled on drawings.

### 1.4 SUBMITTALS:

A. See section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:
   1. Air outlets and inlets performance data at operating conditions.
   2. Submit color selections for air outlets and inlets from manufacturer’s color selection chart.
   3. Submit color selections for louvers from manufacturer’s color selection chart.

C. Shop Drawings:
   1. This Section shop drawings to be submitted under Section 20 0000 - Mechanical General Requirements.
   2. Include the following information on scaled ventilation system shop drawings:
      a. Air diffuser, register and grille locations, duct connection sizes and throw directions.
      b. Louver locations with plenum dimensions.
      c. Louver penetration detail which clearly shows wall type, louver frame type, duct connection method, sealant and or gasket locations and drainage path.

D. Test and Evaluation Reports:

1. Louver plenum water tightness test: Submit written certification that louver plenums have been satisfactorily tested and have been verified water-tight prior to insulating plenums.
2. Refer to louver test under Part 3 below.

E. Installation, Operation and Maintenance (IO&M) Manuals.

1.5 WARRANTY

A. Manufacturer Warranty: See section 20 0000 - Mechanical General Requirements, for general mechanical warranty requirements.

PART 2 - PRODUCTS

2.1 AIR DIFFUSERS AND REGISTERS

A. Manufacturers:
1. Titus (Basis of Design).
2. Price.
3. Nailor Industries Inc.
4. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Performance/Design Criteria: As scheduled.

C. Finishes: Standard white, baked enamel or powder coated finish suitable for field application of custom finish color as required.

D. Accessories:
1. Equalizing grids.
2. Earthquake tabs.

E. Correlate diffuser style, dimension, and fit with ceiling. Provide diffusers with modules of the proper size to match the suspended ceiling layout or with appropriate factory provided frame for surface mounting.

2.2 RETURN/EXHAUST GRILLES

A. Manufacturers:
1. Titus (Basis of Design).
2. Price.
3. Nailor Industries Inc.
4. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Performance/Design Criteria: As scheduled.

C. Finishes: Standard white, baked enamel or powder coated finish suitable for field application of custom finish color as required.

D. Accessories: Earthquake tabs.

E. Correlate grille style, dimension, and fit with ceiling. Provide grilles with modules of the proper size to match the suspended ceiling layout or with appropriate factory provided frame for surface mounting.

## 2.3 WALL LOUVERS

A. Manufacturers:
   1. Ruskin.
   2. Greenheck.
   3. Pottorff.
   4. Substitution request required.

B. Description:
   1. General:
      a. 6 inches deep, stationary wall louvers.
      b. Horizontal drainable blades (37.5 degree blade angle) with integral downspouts incorporated into frame jamb and mullion design.
      c. Frame style designed for installation into wall penetration construction type indicated. See Architectural penetration details to coordinate style types.
      d. Louver frame with surfaces designed to accept exterior caulking.
   2. Regulatory Requirements:
      a. Louvers shall bear the AMCA Certified Ratings label for Water and Air Performance.
      b. Manufacturer's ratings based on testing in accordance with AMCA Publication 511.

C. Performance/Design Criteria:
   1. Size and performance as scheduled.
   2. Water penetration: 0.01 ounces of water per square foot of free area at 1000 FPM free area velocity.

D. Materials: Heavy gauge extruded aluminum.

E. Finishes:
   1. Standard Finish: Baked enamel (fluoropolymer). Color selected by Architect.

F. Accessories:
   1. Bird Screens: Flattened, expanded aluminum with 1/2 inch mesh pattern. Located on internal side of louver assembly.
   2. Extended Sills: Extruded aluminum.

## 2.4 GRAVITY INTAKE/RELIEF ROOF HOODS

A. Manufacturers:
   1. Greenheck.
   2. Cook.
   3. Metal Form.
   4. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Description:

1. Low profile hoods constructed of roll-formed arched panels with interlocking seams.
2. Coordinate curb cap size with roof curb.
3. Tie down points.

C. Performance/Design Criteria:
1. Size and performance as scheduled.
2. Manufacturer's ratings based on testing in accordance with AMCA Publication 511.

D. Materials:
1. Bolted and welded construction utilizing corrosion resistant fasteners.
2. Minimum 18 gauge aluminum construction.
3. Minimum 8 gauge aluminum support members.

E. Finishes: Galvanized.

F. Accessories:
1. Hinged hood for HD-4.
2. Bird Screens: Aluminum with 1/2-inch mesh pattern.
3. Dampers: Refer to Section 23 3100 - Ducts and Accessories.
4. Roof Curbs: Field fabricated. Refer to Architectural drawings.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Removal: Remove existing air diffusers, registers and grilles designated for relocation and reuse after repair and cleaning.

### 3.2 INSTALLATION

A. General:
1. Install products in compliance with the manufacturer's written installation instructions.
2. Connect air outlets, registers, grilles and louvers to ventilation duct systems in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Air Diffusers, Registers and Grilles:
1. Install air diffusers, registers and return/exhaust grilles at the locations shown.
2. Orient and adjust diffusers to provide the throw directions indicated.
3. Provide appropriate borders for the ceiling, wall or floor construction type.

C. Wall Louvers:
1. Install wall louvers at the locations shown and in accordance with manufacturer's written installation instructions and details for the specific wall type.
2. Coordinate louver locations, borders and mullion spacing with architectural panels.
3. Install louvers plumb, level, in plane of wall, and in alignment with adjacent work.
4. Seal louver penetrations watertight. Install, seal and insulate louver ductwork (intake or exhaust/relief plenums) to interior louver frame to prevent condensation or entrained water that enters ductwork from leaking into building. Provide

sleeves, special connections and sealant as required to accomplish this requirement.

5. Slope plenum ductwork such that any entrained water drains out through base frame of wall louver. If drain holes are not provided by the manufacturer, drill 1/2-inch (minimum diameter) weep holes at 12-inch intervals on center through base of louver as required for drain water to escape. Touch-up holes with factory supplied touch-up paint.

## 3.3 REPAIR/RESTORATION

A. Refer to Section 20 0000 - Mechanical General Requirements for general repair/restoration requirements.

## 3.4 SITE QUALITY CONTROL

A. Site Tests and Inspections: Prior to insulating louver intake and exhaust/relief plenums, with applicable fans shutdown, lightly spray water into louver from building exterior such that water enters plenums. Verify that the water readily drains out of louver drain holes without pooling and that no visible leakage is present. Repair and retest as necessary until performance requirements are met.

## 3.5 CLEANING

A. Clean exposed surfaces of air outlets and inlets, with water and mild soap or detergent not harmful to finish, in order to remove fingerprints and dirt.

END OF SECTION 23 3700

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# SECTION 23 52 16

# CONDENSING BOILERS AND ACCESSORIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes:
   1. Packaged condensing gas fired boilers and appurtenances.

### 1.2 REFERENCES

A. Codes and Standards:
   1. International Mechanical Code (IMC).
   2. International Fuel Gas Code (IFGC).
   3. Uniform Plumbing Code (UPC).
   4. NFPA 54 - National Fuel Gas Code.
   5. ASME Boilers and Pressure Vessel Code (1998), Sections IV & VI.
   6. ASME CSD-1 - Controls and Safety Devices for Automatically Fired Boilers.

B. Abbreviations, Acronyms and Definitions:
   1. Refer to Division 01 for general abbreviations, acronyms, and definitions.
   2. Refer to Section 20 0000 - Mechanical General Requirements for general mechanical related definitions.
   3. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

### 1.3 SYSTEM DESCRIPTION

A. Design Requirements:
   1. This section describes specific requirements, products and methods of execution for the generation of heat, which will be distributed to the locations shown.
   2. The method of distribution of this heat is specified elsewhere.

B. Performance Requirements:
   1. Provide product performance characteristics as specified or scheduled on drawings.
   2. Operate central heating system in accordance with Section 25 90 00 - Sequence of Operations.

### 1.4 PRE-INSTALLATION MEETINGS

A. Coordinate installation of boilers and associated piping and equipment with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.

## 1.5 SUBMITTALS

A. See Section 20 00 00 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:
   1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria to include:
      a. Product model and selected optional equipment, appurtenances and special features.
      b. Boiler physical and performance characteristics as scheduled.
      c. Total equipment weight (filled with water). Boilers weighing 20 percent more than the scheduled equipment will be disapproved unless it is determined by the Owner's Representative that the structure as designed is capable of bearing the additional load with an adequate safety margin.
      d. Dimensional data.
      e. Anchoring method.
   2. Regulatory Requirements: Provide automatic boiler controls listed in the IMC and ASME CSD-1, latest edition, together with most current addenda and interpretations.

C. Shop Drawings:
   1. Submit fully dimensioned shop drawings of boiler room(s) showing the following:
      a. Major equipment and housekeeping pads, with clear callouts indicating deviations from layout shown:
         1). Submitted boiler shall be dimensionally equal to scheduled product within 6 inches in each dimension. Maintain clearances shown on drawings. Submit fully dimensioned shop drawings of boiler room(s) at drawing scale of 1/4-inch equals 1 foot 0 inches or larger, showing entire boiler room, equipment and deviations. Provide boiler room modifications required due to dimensional and technical deviation at no additional cost to the Owner. Submit shop drawings of proposed equipment layout and base or pad for each piece of equipment.
         2). If equipment to be provided exceeds the weight of the specified equipment by more than 20 percent, or if the location is to be altered, submit shop drawings and calculations of proposed revised structural design, noting location of pertinent loads, stamped by a registered professional engineer.
      b. Service area boundaries as required by manufacturer's installation.
      c. Boiler piping and vent stack locations with dimensions. Coordinate stack roof penetrations with roof structure.
      d. Indicate mechanical and electrical service locations and requirements.
      e. Boiler management system location.

D. Manufacturer Reports:
   1. Provide start-up and operational test reports for each boiler.
   2. Provide start-up report for boiler control system with selected presets annotated.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance (IO&M) Manuals:

B. Warranty Documentation: Provide standard manufacturer's warranty and submit documentation in accordance with Section 20 00 00.

## 1.7 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 3 years documented experience.
   2. Installers:
      a. Minimum 3 years' experience in the installation and start-up of boilers.
      b. A factory-authorized technician shall perform boiler startup service.
      c. The manufacturer's authorized technician shall supervise the installation, startup, programming, and adjustment of the Energy Management System.
   3. Testing Agencies: Products requiring electrical connection shall be listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and as indicated.

## 1.8 WARRANTY

A. Manufacturer Warranty:
   1. See Section 20 00 00 - Mechanical General Requirements, for general mechanical warranty requirements.
   2. Provide prorated 10 year warranty on pressure vessel/heat exchanger against failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.
   3. Provide 2 year warranty on control circuit boards.
   4. Submit necessary documentation to the Manufacturer's Representative to validate manufacturer's warranty.
   5. Provide to the Contracting Agency 1 copy of warranty documentation and confirmation receipt from the Manufacturer's Representative.

# PART 2 - PRODUCTS

## 2.1 CONDENSING GAS FIRED BOILERS

A. Manufacturer:
   1. Riello Array series
   2. Approved equal.

B. Description:
   1. Gas fired, condensing fire tube design with modulating power burner and positive pressure discharge.
   2. Multiple module boiler with dedicated boiler circulating pump per module.
   3. UL Listed, CSD-1 approved, ASME coded and stamped.
   4. IRI gas train.

C. Performance/Design Criteria: Manufacturer must publish known partial load efficiencies, and the thermal efficiency must increase as the firing rate decreases.

D. Assembly/Fabrication:
   1. Air/Fuel Supply/Burner:
      a. Turndown capacity: 20:1 without loss of combustion efficiency or staging of gas valves.
   2. Pressure Vessel/Heat Exchanger:
      a. Multiple 316L stainless steel heat exchangers in a single boiler cabinet.
      b. 75 psi relief valve.
   3. Exhaust Flue and Condensate Drain:
      a. Corrosion resistant stainless with 8 inch diameter steel flue connection.
   4. Packaged Boiler Controls:
      a. Graphic touchscreen control.
      b. Cascading up to 8 boilers.
      c. Dedicated service display inside cabinet.
      d. Onboard delta T limiting to minimize cycling of equipment.
      e. Modbus communication.
   5. Accessories:
      a. Condensate neutralizer.
   6. Electrical Power: 230VAC/1 PH/60 Hz.

E. BAS system integration: Coordinate with Division 25 for connection to the BAS system. Refer to Section 25 9000 Sequence of Operations.

## 2.2 BOILER SEALED COMBUSTION AIR SYSTEM

A. Description: Complete, engineered sealed combustion air system for each boiler to include straight duct, fittings, connections, adapters, and support brackets.

B. Performance/Design Criteria: Provide supports and seismic restraints in accordance with the manufacturer's and IBC requirements.

C. Materials:
   1. Sheetmetal: See specification Section 23 31 00 - Ducts.

D. Assembly/Fabrication:
   1. Insulate sealed combustion ducts as required for outside air ducts.

E. Finishes:
   1. Sheetmetal: Galvanized.

## 2.3 BOILER EXHAUST VENTING SYSTEM

A. Manufacturers:
   1. Schebler
   2. AMPCO
   3. Approved equal.

B. Description:

1. Provide complete, engineered venting system for flue gas exhaust for each boiler to include straight duct, fittings, connections, adapters, thimbles, terminations and support brackets.
2. Provide supports and seismic restraints in accordance with the manufacturer's UL listing and Section 20 05 29 - Mechanical Hangers and Supports.

C. Performance/Design Criteria:
1. UL 1738 listed for use with Category IV appliances (operating temperatures up to 600 Degrees F, positive pressure, condensing flue gas service).

D. Materials:
1. Inner wall: AL29-4C stainless steel.
2. Outer wall: Type 304 stainless steel.

E. Assembly/Fabrication:
1. Double walled venting system with 1 inch air space between walls.
2. Vent sections shall be sealed with banded flanges and silicone joint sealant for temperatures up to 600 degrees F with a UL tested pressure rating of 4.0 in WC.
3. Inner liner seams shall be fully welded. Riveted, tack or spot welded seams are not permitted.
4. Supports and seismic restraints in accordance with the manufacturer's UL listing.

## 2.4 EMERGENCY BOILER SHUTOFF

A. Provide an emergency boiler shutoff switch. See Division 26.

# PART 3 - EXECUTION

## 3.1 INSTALLERS

A. Installer: Perform work by experienced personnel previously engaged in boiler plant construction and under the supervision of a qualified installation supervisor.

## 3.2 PREPARATION

A. Protection of In-Place Conditions: Cover products and plug piping connections to protect equipment from construction dirt and debris.

B. Surface Preparation:
1. Prior to installation of boilers, verify concrete housekeeping pads are complete and properly sized for boiler mounting.
2. Prior to installation of stacks, verify that shop drawings are approved and stack locations and routing have been coordinated with required roof penetrations and the work of other trades.

## 3.3 INSTALLATION

A. Special Techniques:
1. Install equipment in accordance with manufacturer's instructions and requirements of the codes specified herein.

2. Install Boiler management system (BMS) in accordance with manufacture's installation instructions. Connect each of the boilers to the BMS. Program BMS to maintain boiler water temperature control as described in Sequence of Operation below.
3. Connect to the building automation system through the open protocol communication port in the BMS.
4. Setting of equipment:
   a. Set equipment on concrete housekeeping pads compatible with the building structural system.
   b. Level equipment to within recommended tolerances.
5. Anchoring:
   a. Anchor boilers to housekeeping pads as recommended by the manufacturer and to allow for normal expansion and contraction.
   b. Coordinate with Section 20 05 48 -Vibration and Seismic Control.
6. Thermal Expansion:
   a. Install hydronic piping to allow for normal thermal expansion and contraction.
   b. Provide anchors where necessary and as indicated.
   c. Provide expansion loops, anchors and alignment guides to suit conditions and as indicated.
7. In systems containing glycol, provide only products specifically designed and approved for continuous operation with the glycol solution specified.
8. Install components that were removed from equipment for shipping purposes.
9. Install components that were furnished loose with equipment for field installation.
10. Provide interconnecting electrical control and power wiring.
11. Provide fuel gas vent and service piping.
12. Provide piping for boiler pipe connections.
13. Program, adjust and operationally test boiler operation and sequencing in accordance with the manufacturer's written installation and testing instructions and Section 25 9000 - Sequence of Operations.
14. Touch up marred or scratched factory finished surfaces using finish materials furnished by manufacturer.
15. Install emergency boiler shutoff switch outside the boiler room at each exit at 48 inches above finished floor.

B. Interface with Other Work: Coordinate and sequence installation of boilers and stacks with trades responsible for portions of this and other related sections of the Project Manual.

C. Systems Integration: Coordinate location and operation of boiler emergency shutoff switch with Divisions 26, 27 and 28.

## 3.4 REPAIR/RESTORATION

A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

## 3.5 SITE QUALITY CONTROL

A. Non-Conforming Work: Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

B. Manufacturer Services:
   1. Provide manufacturer's representative start-up and instruction of each complete boiler system including all components assembled and furnished by the manufacturer whether or not of his own manufacture.
   2. Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the authorized service organization.
   3. Start-up and adjust the system to within the tolerances as specified by the equipment manufacturer.
   4. Operationally test safety devices and record settings. Test and record oxygen, carbon dioxide, stack temperature, and calculate excess air and steady state efficiency. Make final lead/lag setpoint adjustments. List setpoints in report. Submit final data for review.
   5. Test boiler operation and sequencing in accordance with the manufacturer's written installation and testing instructions and Section 25 90 00 - Sequence of Operations.
   6. Provide a start-up report that includes final control settings, and a performance chart of the control system furnished.
   7. Submit a letter of certification with copy of start-up report, indicating that the boiler start-up has been completed, that the boilers are properly adjusted and operating within the tolerances as specified by the manufacturer, and that the sequence of operation is fulfilled.

## 3.6 ADJUSTING

A. Coordinate and work directly with the requirements of Section 23 05 93 - Testing, Adjusting and Balancing, to provide systems in proper operating order.

B. Make corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.

## 3.7 CLEANING

A. Waste Management: After construction is completed, clean and wipe down exposed surfaces of boilers and burners.

## 3.8 CLOSEOUT ACTIVITIES

A. Demonstration: Provide 2 hours of demonstration conducted by authorized factory start-up personnel to the Contracting Agencies authorized maintenance personnel.

B. Training: Provide 2 hours of operational instruction conducted by authorized factory start-up personnel to the Contracting Agencies authorized maintenance personnel.

END OF SECTION 23 52 16

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# SECTION 23 6300

# REFRIGERANT CONDENSERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Design, performance criteria, refrigerants, controls, and installation for packaged air-cooled scroll compressor condensing units.
   2. Refrigerant piping.

B. Related Sections
   1. 20 0000 - Mechanical General Requirements
   2. 20 0513 - Common Motor Requirements
   3. 20 0529 - Mechanical Hangers and Supports
   4. 20 0553 - Mechanical Identification
   5. 20 0700 - Mechanical Insulation
   6. 23 0593 - Testing, Adjusting and Balancing
   7. 23 7323 - Central Air Handling Units
   8. 25 3000 - Building Automation System Field Devices
   9. 25 5000 - Building Automation System
   10. 25 9000 - Sequence of Operations
   11. Division 26 - Electrical

### 1.2 REFERENCES

A. Codes and Standards:
   1. See Section 20 0000 - Mechanical General Requirements.
   2. ASHRAE Standard 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings, for efficiency standards.

### 1.3 SYSTEM DESCRIPTION

A. Design Requirements: Provide complete scroll-compressor condensing units as specified herein and as shown on the Drawings. The unit shall be constructed and operate in accordance with the referenced design standards and with local Codes in effect.

B. Performance Requirements: Refer to the schedule of performance on the Drawings. The unit(s) shall be capable of stable operation to a minimum of 50 percent of full load without hot gas bypass. Performance shall be in accordance with ARI Standard 365-94.

### 1.4 SUBMITTALS

A. See Section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:
   1. Include submittal information specific to the equipment specified by this section as followings:
      a. Provide manufacturer's literature that fully demonstrates compliance with the manufacturing methods, appurtenances and salient features specified.
      b. Provide sound power level data (decibels) for each octave band for the equipment.
      c. Determine sound level data using one of the following methods:
         1). Actual measurements from tests performed in accordance with AMCA Standards in an AMCA registered test chamber.
         2). Documented calculations that start with AMCA tested fan sound data and are modified in accordance with 2019 ASHRAE HVAC Applications, , Chapter 49 Noise and Vibration Control accurately predict the sound power levels for the configuration shown.
      d. Provide electrical connection requirements.
      e. Provide electrical power connection and control logic wiring diagrams. Diagrams must differentiate between factory installed and field-installed wiring.

C. Installation, Operation and Maintenance (IO&M) Manual:

D. Training and Demonstration:
   1. Provide letter of certification showing system operation has been demonstrated and training has been accomplished.
   2. Submit completed manufacturer's installation checklist.

## 1.5 CLOSEOUT SUBMITTALS

A. See Section 20 0000 - Mechanical General Requirements.

B. Submit a certificate from the Manufacturer's Representative indicating that the condenser(s) is/are installed and operational in accordance with the manufacturer's written installation, operation and maintenance manual and the specified sequences of operation.

## 1.6 QUALITY ASSURANCE

A. Regulatory requirements: Products requiring electrical connection shall be listed and classified by Underwriters Laboratories Incorporated, or by a testing firm acceptable to the Authority Having Jurisdiction.

## 1.7 WARRANTY

A. Manufacturer Warranty: See Section 20 0000 - Mechanical General Requirements, for general mechanical warranty requirements.

## PART 2 - PRODUCTS

### 2.1 DESCRIPTION

A. Manufacturers List:
   1. AAON.
   2. Approved equal.

B. Unit Description:
   1. Pre-engineered and packaged air-cooled digital scroll compressor condensing unit(s) to include the following components:
      a. Air-cooled condenser section and isolated control compartment.
      b. Hermetically sealed digital scroll compressors.
      c. Packaged control system with BAS interface.
      d. Suction and liquid connection valves.
      e. Additional components necessary for safe and controlled unit operation when connected to the specified air handling equipment direct expansion cooling coils.

C. Construction:
   1. Factory assembled, piped, and wired and shipped in one section.
   2. Designed for outdoor application.
   3. Paint finish capable of withstanding a minimum of 2500 hours within a salt spray and fog atmosphere (ASTM B 1 17-95 test procedure) with no visible corrosive effects.
   4. Condenser coil physically protected from damage by painted galvanized steel louvers covering the full area of the coil.

D. Unit Features:
   1. Compressor:
      a. Hermetically sealed digital scroll compressors with inherent thermal overload protection.
      b. Each refrigeration provided with variable capacity digital scroll compressor.
      c. Crankcase heater.
   2. Condenser:
      a. Coils constructed of seamless copper tubes mechanically bonded into plate type aluminum fins. Fins to include full drawn collars to completely cover copper tubes.
      b. Sub-cooling section forms an integral part of the main condenser coil.
      c. Propeller type fans with variable speed direct drive fan motors arranged for vertical air discharge.
      d. Fan discharge areas protected with a heavy-gauge fan guards.
      e. Weather protected, single-phase, direct drive, 1100 RPM, open drip-proof type fan motors.
      f. Adjustable condenser head pressure control to allow cooling operation down to 35 degrees F
   3. Refrigerant Circuit:
      a. Refrigerant: R-410A.
      b. Two equally sized circuits.
      c. Liquid line filter driers and service valves for liquid and suction connections.
      d. Field installed refrigerant circuit to include:
         1). Air handling unit DX cooling coils.

2). Refrigerant.
3). Thermal expansion valves.
4). Liquid line
5). Insulated suction line.

4. Control System:
   a. Centrally located weather-proof control panel isolated from condenser coil airflow with field power connection points, control terminal block and control system.
   b. Control circuit 24V transformer and wiring voltage line voltage to unit.
   c. Power and starting components to include:
      1). Fan motor contactors.
      2). Five minutes off time delay relays for the compressors.
      3). Fan motor overload protection.
      4). Unit power terminal blocks for connection to remote disconnect switch.
      5). Manually reset high pressure switch.
      6). Automatic reset low pressure switch.
      7). Barrier panels to protect against accidental contact with line voltage while accessing control system.
5. Wiring Diagrams:
   a. Color-coded and marked wiring diagrams in both “point-to-point” and “ladder” to match the color and markings of the unit wiring.
   b. Diagrams laminated in plastic and permanently fixed to the control compartment door.
6. Electrical Power Options:
   a. Phase and brown-out protection: Shut down motors if phase voltages are more than 10 percent out of balance, voltage is more than 10 percent below design voltage, or on phase reversal.
   b. Factory installed and wired 115 volt, 12 amp ground fault service receptacle powered by a 1.5 kVA transformer.
   c. Short Circuit Current Rating (SCCR): Minimum 65K.

## 2.2 REFRIGERANT PIPING

A. Provide refrigerant piping (liquid and suction) between each roof mounted condensing unit and its central air handling units DX cooling coil in accordance with IMC 2018, Section 1107.

B. Refrigerant: R-410A (classification A1).

C. Piping materials:
   1. Seamless copper tube, type ACR (hard or annealed), ASTM B 280.
   2. Annealed copper tube limited to 2 inch nominal diameter and smaller.

D. Piping joints: Provide brazed joints.

E. Seismic pipe loop:
   a. Pressure rating 700 psig at 300 degree F.
   b. Stainless steel hose and braid. Long radius elbow.
   c. Differential movement: 2 inches minimum.
   d. Manufacturer: Metrraflex MLVR or approved equal

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Protection: Maintain unit(s) covered and pipe connections capped to protect components from construction dirt and debris.

B. Surface Preparation: Verify roof curb to be complete, clean and level and capable of supporting the unit. Verify that proper anchoring points are incorporated into the roof curb design.

### 3.2 INSTALLATION

A. Install condensing unit(s) in compliance with the manufacturer's written installation instructions, approved shop drawings and the Contract Documents.

B. Center and support condensing unit(s) base frame on structural frame. Anchor base frame to frame per structural details.

C. Provide refrigerant lines, valves, sensors, other appurtenances (as applicable) and a full refrigerant/oil charge to provide a complete and fully functional installation.

D. Program condensing unit(s) to operate with associated air handling unit(s) in accordance with the manufacturer's written installation and operating instructions and Section 25 9000 - Sequence of Operation.

E. Coordinate electrical installation with electrical contractor.

F. Coordinate controls with control contractor.

### 3.3 CONSTRUCTION

A. Interface with other Work:
   1. Coordinate and sequence installation air handling units with trades responsible for portions of this and other related sections of the Project Manual.
   2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

### 3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:
   1. Verify that the condensing unit(s) is/are installed and operational in accordance with the manufacturer's written installation instructions.
   2. Both the Contractor and Manufacturer's Representative shall sign start-up and operational checklist to confirm proper system installation and operation.

### 3.5 CLEANING

A. Upon completion of installation and prior to initial start-up, clean internal and external surfaces.

## 3.6 DEMONSTRATION & START-UP

A. Start-up and operate condensing unit(s) along with associated air handling unit(s) in accordance with the manufacturer's written installation and operation and maintenance.

B. Verify each operating sequence in accordance with Section 25 9000 - Sequence of Operation.

C. Document start-up and operational checks using the manufacturer's installation checklist and submit in accordance with submittal requirements.

## 3.7 TRAINING

A. Instruct Owner's Representative for 4 hours with regard to:
   1. System start-up.
   2. Normal system operation.
   3. System shutdown.
   4. Packaged control system programming and interface with BAS.
   5. Preventative maintenance.

END OF SECTION 23 6300

# SECTION 23 7323

# CENTRAL AIR HANDLING UNITS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Central air handling units.
2. Air filter media and support frames.

B. Related Sections:
1. 20 0000 - Mechanical General Requirements
2. 20 0513 - Common Motor Requirements
3. 20 0529 - Hangers and Supports
4. 20 0553 - Mechanical Identification
5. 20 0700 - Mechanical Insulation
6. 23 0593 - Testing, Adjusting and Balancing
7. 23 2113 - Hydronic Piping and Specialties
8. 23 3100 - Ducts and Accessories
9. 23 6300 - Refrigerant Condensers
10. 25 3000 - Building Automation System Field Devices
11. 25 4000 - Variable Speed Drives
12. 25 5000 - Building Automation System
13. 25 9000 - Sequence of Operations
14. Divisions 26, 27 and 28 - Electrical

### 1.2 REFERENCES

A. Codes and Standards:
1. See Section 20 0000 - Mechanical General Requirements.
2. AMCA 99 (Air Movement and Control Association) - Standards Handbook.
3. ASHRAE Standard 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
4. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

B. Abbreviations, Acronyms and Definitions:
1. Refer to Section 20 0000 - Mechanical General Requirements for general mechanical related definitions.
2. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

### 1.3 SYSTEM DESCRIPTION

A. Design Requirements:
1. This section describes specific requirements, products and methods of execution for the central air handling equipment, which will be distributed to the locations shown.
2. The method of air distribution is specified elsewhere.

B. Performance Requirements:
   1. Provide product performance characteristics as specified or scheduled on drawings.
   2. Operate ventilation systems in accordance with Section 25 9000 - Sequence of Operations.

1.4 PRE-INSTALLATION MEETINGS

A. See Section 20 0000 - Mechanical General Requirements.

1.5 SUBMITTALS

A. See Section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:
   1. Sound Power Levels: Provide custom sound power level data (decibels) for each octave band at inlet, discharge and radiated for the assembled air handling unit as shown.
      a. Octave band sound power levels shall not exceed those scheduled.
      b. Determine sound level data using one of the following methods:
         1). Actual measurements from tests performed in accordance with AMCA Standards in an AMCA registered test chamber.
         2). Documented calculations that start with AMCA tested fan sound data and are modified in accordance with ASHRAE Handbook 2011 HVAC Applications, Chapter 48 - Noise and Vibration Control to accurately predict the sound power levels for the configuration shown.
   2. Wiring Diagrams: Provide electrical power connection and control logic wiring diagrams. Diagrams must differentiate between factory installed and field-installed wiring.

C. Shop Drawings:
   1. This Section shop drawings to be submitted under Section 20 0000 - Mechanical General Requirements.
   2. Provide dimensional and orientation information (plan and elevation) for the approved central air handling unit(s), including housekeeping pad perimeter, incorporated into the ventilation system shop drawings.
      a. Label overall air handling unit(s) as scheduled. Label each cabinet section as specified.
      b. Show duct connections, with duct sizes indicated. Locate bottom of supply duct connections off discharge plenum as high as possible to maximize fan room floor space.
      c. Show damper arrangement and sizes.
      d. Show access door locations and access clearances for filter, coil and fan replacement.
      e. Show electrical connection points.
   3. Coordinate supply fan discharge plenum floor penetrations and return fan/exhaust fan roof penetrations with structural. Exhaust fan vertical stack/relief hood alignment is critical as is coil/filter pull space alignment with the buildings support columns.

D. Installation, Operation and Maintenance (IO&M) Manuals.

E. Manufacturer Reports:
   1. Provide a certificate from the Manufacturer's Representative indicating that the central air handling unit(s) is/are installed and operational in accordance with the manufacturer's written installation, operation and maintenance manual.
   2. Provide start-up and operational checks using manufacturer checklists, signed by both the installing Contractor and Manufacturer's Representatives.

1.6 CLOSEOUT SUBMITTALS

A. See Section 20 0000 - Mechanical General Requirements.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. See Section 20 0000 - Mechanical General Requirements.

B. Extra Stock Materials: Spare Filters. Furnish one complete set of replacement filters for each air handling unit upon final completion of project. Filters are to remain sealed in their original boxes and labeled by equipment tag as scheduled. Locate filters in storage area designated by the Contracting Agency.

1.8 QUALITY ASSURANCE

A. See Section 20 0000 - Mechanical General Requirements.

B. Manufacturer qualifications: Company specializing in manufacturing the products specified in this section with a minimum of 10 years' documented experience.

C. Certifications: Air filters certified and tested in accordance with ASHRAE Test Standard 52.2.

D. Regulatory requirements: Products requiring electrical connection shall be listed and classified by Underwriters Laboratories Incorporated, or by a testing firm acceptable to the Authority Having Jurisdiction.

1.9 DELIVERY, STORAGE, AND HANDLING

A. See Section 20 0000 - Mechanical General Requirements.

B. Storage and Handling Requirements: Maintain access doors shut, dampers and supply duct connections covered, and drain connections capped to protect components from construction dirt and debris.

1.10 WARRANTY

A. Manufacturer Warranty: See Section 20 0000 - Mechanical General Requirements, for general mechanical warranty requirements.

## PART 2 - PRODUCTS

### 2.1 CENTRAL AIR HANDLING UNITS

A. Manufacturers:
   1. York Solution
   2. Trane Performance
   3. Daikin Applied Custom
   4. Substitution request required.

B. Description:
   1. Dimensions: Air handler dimensions and base rail heights scheduled are for basis of design manufacturer as indicated. The dimensions for “as equal” manufacturers may differ. Prior to submitting equipment provided by an “as equal” manufacturer, verify that the unit will adequately fit in the space provided with proper access for operation and maintenance to include the removal/replacement of components.
   2. Regulatory Requirements: Products requiring electrical connection - Listed and classified by Underwriters Laboratories Incorporated, or by a testing firm acceptable to the Authority Having Jurisdiction.

C. Unit casing construction:
   1. Welded structural steel channel base frame with lifting and anchoring lugs.
   2. Minimum 16 gauge galvanized steel cabinet, reinforced and braced with steel angle framing for maximum rigidity.
   3. Acoustically lined cabinet interior with 4-inch thick, 3 lb/cu ft, UL listed acoustical liner materials.
   4. Exterior casing, base frame and accessories coated with baked enamel finish.
   5. Internal components and accessories coated with baked enamel finish or galvanized.
   6. Connect parts with plated, galvanized steel fasteners.
   7. Provide interior liner type and drain pan as indicated under each air handler section.
   8. Provide steel stamped nameplate with air handler performance data clearly indicated.
   9. Provide 12 gauge galvanized steel, continuously welded checker plate floor with a maximum deflection of 1/4 inch in a 240 inch span. Units that "oil can" are not acceptable.
   10. Insulate base with a minimum 2-inch fiberglass insulation and sheet it with 22 gauge galvanized steel liner.
   11. Provide water tight wash down floor construction with 1.5-inch water dam around the perimeter of the floor.
   12. The use of metal tape in the unit construction is not acceptable.
   13. Provide insulated access doors with windows and to match casing thickness. Minimum access door width is 24 inches.
   14. Provide maintenance and access plenums for each bank of filters and each coil section. Provide each plenum section with an access door. Do not "gang" together pre- and final filters or heating and cooling coils.
   15. Provide shipping splits such that no individual section is longer than 120 inches.

D. Mixing box Section:
   1. Twenty two gauge solid galvanized steel interior liner.

2. Hinged, insulated, double walled access door.
3. Provide floor drain with capped drain connection that terminates through side of unit.
4. Mixing Box Outside Air and Building Relief Control Dampers
   a. Manufacturer: Tamco, Series 9000. No substitutes.
   b. Low leakage, heavy gauge, internally insulated, extruded aluminum, air foil blades with extruded EDPM blade gaskets and frame seals.
   c. Flanged frame with parallel blade action.
   d. Damper Sizing: Provide damper for the AHU minimum outside air flow rate (CFM) scheduled using a flow velocity of 1,500 FPM not to exceed 0.1 in WC static pressure drop with damper fully open.
   e. Damper mounting: Mount the damper assembly to the mixing box as indicated.
   f. Performance/Design Criteria:
      1). Leakage Class 1A at 1 in WC static pressure differential.
      2). Designed for operation in temperatures ranging between -40 Deg F and 212 Deg F.
      3). Size dampers using a flow velocity range of 1,250 to 1,500 FPM not to exceed 0.1 in WC static pressure drop with damper fully open.
      4). Size dampers for maximum AHU economizer cooling air flow rate (CFM) scheduled minus the minimum outside air flow rate (CFM) scheduled.
5. Mixing Box Return Control Dampers
   a. Manufacturer: Tamco, series 1000 or approved equal.
   b. Performance/Design Criteria:
      1). Leakage Class 1A at 1 in WC static pressure differential.
      2). Designed for operation in temperatures ranging between -40 Deg F to 212 Deg F.
      3). Size dampers using a flow velocity range of 1,250 to 1,500 FPM not to exceed 0.1-inch static pressure drop with damper fully open.
      4). Size return air damper for maximum AHU air flow rate (CFM) scheduled.
   c. Materials:
      1). Heavy gauge, extruded aluminum frame and blades.
      2). Air foil blades with extruded EDPM blade seals
      3). Extruded silicone frame seals.
      4). Flanged frame with parallel blade action.
6. Damper Arrangement:
   a. Provide outside air, return and relief dampers as applicable factory installed and sealed to the cabinet as indicated.
   b. Provide outside air intake damper centered on top of mixing box. Provide mounting flange for attachment of outside air intake ductwork. Arrange parallel dampers to direct outside air stream towards return air damper to promote mixing.
   c. Provide return air damper horizontally centered on the front of mixing box. Locate top of return damper a maximum of one foot from top of mixing box interior ceiling. Arrange parallel dampers to direct return air up towards outside air intake damper to promote mixing.

E. Filter Sections:
   1. Cabinet:
      a. Twenty two gauge solid galvanized steel interior liner.
      b. Hinged, insulated, double walled access door.

c. Provide floor drain with capped drain connection that terminates through side of unit.

2. Manufacturers:
   a. Camfil Farr.
   b. American Air Filter.
   c. Substitution request required.
3. Filter Holding Frame:
   a. Factory installed filter housing and frame designed specifically for the specified filters.
      1). Welded, galvanized steel reinforced with bracing and corner gussets and sealed to prevent leakage.
      2). Gaskets in filter frames of closed cell synthetic rubber and positive spring type clamps to hold filter securely against gaskets.
      3). Access for changing filters from one or both sides of housing. Walk-in plenums shall have access for changing filter from upstream side.
      4). Side access filter units consisting of a separate frame for each filter, sliding on tracks with a gasket system, shall be provided where indicated. Standard manufactured systems shall be used.
   b. Provide detail for filter holding frames, grids and filter housing arrangements as applicable. Indicate filter sizes and number of each filter size necessary to complete each filter bank, using 24 inch x 24 inch filter dimensions whenever possible.
4. Pre-filters:
   a. Provide disposable, pleated dry media filters having a Minimum Efficiency Reporting Value of MERV 8 or greater when tested in accordance with ASHRAE 52.2.
   b. Complete filter shall be UL listed as a Class 2 air filter.
   c. Filter shall be constructed from pleated media supported and bonded to welded wire grid within a rigid beverage board frame. Media shall be non-woven, reinforced cotton and synthetic fabric. Media shall provide not less than 4.5 square feet of media area for each square foot of face area. Media and frame shall be bonded to prevent air leakage.
   d. Design of filter bank shall be based on an airflow rate of not more than 350 CFM per square foot of gross face area unless otherwise indicated. Initial static pressure loss shall not exceed 0.31 inches water column at 500 feet per minute face velocity. Filters shall be capable of operating at up to 1.0 inch water column at 500 fpm face velocity.
   e. Preferred filter sizes are 24 by 24 by 2 inches with maximum of one 24 by 12 by 2 inches per row. Filter banks shall be designed to use the minimum number of readily available standard filter sizes.
5. Final Filters:
   a. Provide high performance, disposable type dry media filters having a Minimum Efficiency Reporting Value of MERV 13 or greater when tested in accordance with ASHRAE 52.2.
   b. Complete filter shall be UL listed as a Class 2 air filter.
   c. Non-woven polypropylene microfiber filter media. Effective media area not less than 41 square feet of filter area for 24 inch by 24 inch by 12 inch filter size.
   d. Welded steel, PVC coated media retainer to prevent oscillation and sagging of media.

e. Size filter bank for medium airflow capacity (300 FPM). Initial static pressure not to exceed 0.24 inches water column at 300 feet per minute face velocity. Filter shall be designed to operate at up to 1.0 inches water column (manufacturer's recommended final resistance).
f. Preferred filter sizes are 24 by 24 by 2 inches with maximum of one 24 by 12 by 2 inches per row. Filter banks shall be designed to use the minimum number of readily available standard filter sizes.

6. Filter Gauges:
   a. Manufacturers: Magna-Helic (Basis of Design) or approved equal.
   b. Provide a dial type gauge with diaphragm magnetically coupled to pointer and with connections to upstream and downstream static pressure probes for each filter bank.
   c. Provide monitoring contacts for connection to the BAS. Coordinate with 25 5000 – Building Automation System and Section 25 9000 – Sequence of Operations to connect filter monitoring pressure switches to same probes as the gauge.
   d. Gauge scale range shall be 0 to 1 inch water column for pre-filters and 0 to 2 inch water column for final filters.

F. Heating Coil Section:
1. Performance/Design Criteria:
   a. Coil performance as scheduled.
   b. Coils designed for counter-flow heat transfer with equal pressure drop through each circuit.
   c. Working Pressure: 250 PSIG.
2. Cabinet:
   a. Twenty two gauge solid galvanized steel interior liner.
   b. Sloped, galvanized steel drain pan with capped drain connection that terminates through side of unit.
   c. Provide split casing panel to facilitate coil removal. Coordinate panel location with coil access and coil piping.
3. Heating Coil:
   a. Primary surface:
      1). Round, seamless, 5/8 inch O.D. x 0.025 inch thick copper tubing.
      2). Tubes mechanically expanded into fins over the entire finned length.
      3). Brazed joints.
   b. Secondary surface: Solid, 0.0095 inch thick aluminum fins (no punched openings to accumulate lint and dirt) with full drawn collars (Bare copper tube not visible between fins).
   c. Coil Casing: Continuous 16 gauge galvanized steel with reinforced flange type side plates.
   d. Coil piping connections:
      1). Male Pipe Thread (MPT) connections for 2-inch and smaller pipe.
      2). Flange connections for 2-1/2 inch and larger pipe.
      3). Cap piping connections prior to shipment.
      4). For staggered coils, extend coil piping connections to outside of casing.
   e. Coil Headers:
      1). Seamless, copper tubing.
      2). Low point coil drain and high point coil vent.

G. Cooling Coil Section:

1. Performance/Design Criteria:
   a. Coil performance as scheduled.
   b. Coils designed for counter-flow heat transfer with equal pressure drop through each circuit.
   c. Working Pressure: 250 PSIG.
2. DX Cooling Coil:
   a. Provide coil compatible with R410A refrigerant.
   b. Provide dual interlaced refrigerant circuits for each coil.
   c. Coils shall be dehydrated and filled with a nitrogen holding charge at the factory.
   d. Primary surface:
      1). Round, seamless, 5/8 inch O.D. x 0.025 inch thick copper tubing.
      2). Tubes mechanically expanded into fins over the entire finned length.
      3). Brazed joints.
   e. Secondary surface: Solid, 0.0095 inch thick aluminum fins (no punched openings to accumulate lint and dirt) with full drawn collars (Bare copper tube not visible between fins).
   f. Coil Casing: Continuous, 16 gauge stainless steel with reinforced flange type side plates.
   g. Coil piping connections:
      1). Male Pipe Thread (MPT) connections for 2-inch and smaller pipe.
      2). Flange connections for 2-1/2 inch and larger pipe.
      3). Cap piping connections prior to shipment.
      4). For staggered coils, extend coil piping connections to outside of casing.
   h. Coil Headers:
      1). Seamless, copper tubing.
      2). Low point coil drain and high point coil vent.

H. Fan Section:
1. Cabinet:
   a. Twenty two gauge perforated, galvanized steel interior liner.
   b. Hinged, insulated, double walled access door.
   c. Provide floor drain with capped drain connection that terminates through side of unit.
2. General Fan Requirements:
   a. Provide factory assembled, balanced and tested fan unit of the size, type and capacity scheduled. AMCA listed and labeled.
   b. Provide factory applied enamel coating system to fan assembly components (except aluminum).
   c. Provide fan arrangement with accessibility for complete cleaning, component replacement and preventative maintenance. Provide grease fitting(s) with extended grease lines (as necessary for direct access).
   d. Provide AMCA approved fan wheel guard.
3. Vibration Isolation:
   a. Isolate fan frame from unit casing using stable spring vibration isolators with a 2-inch minimum static deflection.
      1). Manufacturer: Mason Industries model SSLFH, VMC Group, or equal.
   b. Isolate fan vibration from inlet nozzle with flexible airtight joint:
      1). UL Listed, vinyl coated, woven nylon/polyester blend fabric with double folded seam and galvanized steel edging.
      2). Manufacturer: Duro-dyne Corporation, Vent Fabrics, or equal.

c. Bearings: Greater than 200,000 hours average rated life at rated load and speed specified.

4. Motors: See Section 20 0513 - Common Motor Requirements, for detailed fan motor specifications.
5. Fan Curve(s): Provide fully labeled fan curve(s) with system curve and operating point clearly plotted. For variable speed fans, provide fan curves for both minimum and maximum operating points.
6. Air flow Monitoring Stations:
   a. Manufacturer.
      1). Air Monitor Corporation, model Volu-Probe/FI.
      2). Approved equal.
   b. Multi-port, self-averaging airflow probes with integral airflow direction correcting design.
   c. Provide separate factory mounted airflow monitoring station each fan.
   d. Mount velocity probes directly to fan inlet cone or bell-mouth.
   e. Accuracy: Three percent.

I. Discharge Plenum Section:
1. Provide custom discharge plenums for air handling units. Fabricate custom discharge plenums to the same material, fabrication and quality standards as other cabinet sections.
2. Twenty two gauge perforated galvanized steel interior liner.
3. Hinged, insulated, double walled access door.
4. Provide external bell mouth fitting at each supply air duct connection to discharge plenums. Show dimensioned bell mouth locations on equipment submittals.

J. Electrical Requirements:
1. Power requirements as scheduled.
2. Provide marine lights with a protective metal cage and glass seals, complete with duplex receptacle, on wall opposite each access door.
3. Provide single pilot light-type light switch on exterior of unit to activate lights.
4. Provide separate power circuits for fan motors and 120VAC lighting/receptacle power.

K. Miscellaneous Requirements:
1. Provide a through-the-wall test port assembly for unit air stream testing in each access door of air handling unit cabinet.

## PART 3 - EXECUTION

### 3.1 INSTALLERS

A. Installer: Perform work by experienced personnel previously engaged in ventilation system construction and air handling unit installation, and under the supervision of a qualified installation supervisor.

## 3.2 PREPARATION

A. Protection of In-Place Conditions:
   1. Provide a complete set of pre-filters for use during construction. Final filter bank media is to remain sealed in original boxes until final building housekeeping has been completed.
   2. Protect return air inlet with 30 percent filters during construction.

B. Surface Preparation: Provide clean and level housekeeping pad to support equipment.

## 3.3 INSTALLATION

A. General:
   1. Install air handling units and components in compliance with the manufacturer's written installation instructions. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with Other Work shall be completed at no additional expense to the Contracting Agency.
   2. Locate hydronic piping connections and drip pan drains on same side of unit(s) as floor drain.
   3. Provide field installed condensate traps per manufacturer's recommendations on cooling coil drains. Pipe to indirect drain to floor drain.
   4. Support central air handling unit base frames on concrete housekeeping pads. Center units on housekeeping pads to provide an equal housekeeping pad lip all around unit.

B. Interface with Other Work:
   1. Seismically anchor air handling unit(s) using method approved by the seismic design engineer and in accordance with Section 20 0529 – Hangers and Supports.
   2. Install BAS actuators, sensors, controls and control wiring in accordance with Section 25 5000 - Building Automation System.
   3. Install electrical power and wiring in accordance with Divisions 26, 27 and 28.

## 3.4 REPAIR/RESTORATION

A. Refer to Section 20 0000 - Mechanical General Requirements for general repair/restoration requirements.

## 3.5 SITE QUALITY CONTROL

A. Site Tests and Inspections. With ventilation system operating at maximum air volume flow rate and with clean filter media installed:
   1. Verify each filter bank is properly sealed and filter bank leakage is within manufacturer's performance tolerances.
   2. Verify that filter bank differential pressure gauges are operating properly in accordance with manufacturer's written installation, operation and maintenance instructions.
   3. Verify that clean filter differential pressures are as indicated in manufacturer's submittal data (within 5 percent) for actual filter bank flow velocity.

B. Manufacturer Services: Verify air handling unit(s) is/are installed and operational in accordance with the manufacturer's written installation instructions.

## 3.6 CLEANING

A. Upon completion of installation and prior to initial start-up, vacuum and wipe down internal and external surfaces.

B. Upon completion of final housekeeping and with written approval of the Contracting Agency, replace construction pre-filters with a complete set of new pre-filters and install remaining filter banks for use during testing and balancing.

## 3.7 SYSTEM START-UP

A. Start-up and operate air handling units in accordance with the manufacturer's written installation, operation and maintenance (IO&M) manual.

B. Verify proper operation of sequences in accordance with Section 25 9000 - Sequence of Operations.

## 3.8 ADJUSTING

A. Test, adjust and balance air handling equipment in accordance with Section 23 0593 - Testing, Adjusting and Balancing, the manufacturer's recommendations, and as otherwise directed by the Contracting Agency.

END OF SECTION 23 7323

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# SECTION 23 8123

# DEDICATED AIR-CONDITIONING UNITS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Packaged, direct expansion, air conditioning systems with microprocessor based controls for electrical room cooling.
   2. Refrigerant piping.

B. Related Sections:
   1. 20 0000 - Mechanical General Requirements
   2. 20 0513 - Common Motor Requirements
   3. 20 0529 - Mechanical Hangers and Supports
   4. 20 0553 - Mechanical Identification
   5. 22 1300 - Sanitary Waste and Vent Piping and Specialties
   6. 23 0593 - Testing, Adjusting and Balancing
   7. 25 5000 - Building Automation System
   8. 25 9000 - Sequence of Operations
   9. Division 26 - Electrical

### 1.2 REFERENCES

A. Codes and Standards:
   1. ARI 360 - Commercial and Industrial Unitary Air Conditioning Equipment testing and rating standard.
   2. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
   3. ANSI/ASHRAE 37 - Testing Unitary Air Conditioning and Heat Pump Equipment.
   4. ANSI/UL 465 - Central Cooling Air Conditioners Standard for Safety Requirements.

### 1.3 SYSTEM DESCRIPTION

A. Design Requirements: This section describes specific requirements, products and methods of execution for the dedicated air conditioning units.

B. Performance Requirements:
   1. Provide product performance characteristics as specified or scheduled on drawings.
   2. Operate system in accordance with Section 25 9000 - Sequence of Operations.

### 1.4 PRE-INSTALLATION MEETINGS

A. See section 20 0000 - Mechanical General Requirements.

1.5 SUBMITTALS

A. See Section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data: Submit copies of product data indicating rated capacities, weights, accessories, and electrical requirements.

C. Shop Drawings: Submit drawings indicating components, dimensions, weights and loadings, required clearances, and location, routing and size of refrigerant lines and condenser discharge ductwork.

D. Closeout Submittals: Submit copies of operation and maintenance manuals in accordance with Section 20 0000 - Mechanical General Requirements.

1.6 CLOSEOUT SUBMITTALS

A. See section 20 0000 - Mechanical General Requirements.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. See section 20 0000 - Mechanical General Requirements.

1.8 QUALITY ASSURANCE

A. See section 20 0000 - Mechanical General Requirements.

B. Regulatory Requirements: Units shall be UL listed.

1.9 DELIVERY, STORAGE AND HANDLING

A. See section 20 0000 - Mechanical General Requirements.

1.10 WARRANTY

A. Manufacturer Warranty: See section 20 0000 - Mechanical General Requirements, for general mechanical warranty requirements.

PART 2 - PRODUCTS

2.1 SELF-CONTAINED AIR CONDITIONING UNIT (AC-1A, AC-1B)

A. General:
   1. Provide packaged, direct expansion, self-contained air conditioning system as scheduled. System consists of wall mounted evaporator unit with a variable speed inverter driven compressor and fan motor and a separate, remote, mounted condenser unit. System refrigerant shall be R-410A. The system shall maintain zone setpoint temperatures using a packaged wall mounted controller.
   2. Basis of Design: Mitsubishi.

B. Indoor Unit:

1. The indoor unit shall be factory assembled and tested complete with factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
2. Indoor unit and refrigerant pipes shall be charged with dehydrated air prior to shipment from the factory.
3. Cabinet:
   a. The cabinet shall be fixed to factory supplied wall hanging brackets.
   b. Multi-directional refrigerant and drain piping offering four (4) directions for refrigerant piping and two (2) directions for draining are required.
4. Fans and Motors:
   a. The fan shall be direct-drive fan type with statically and dynamically balanced impeller with high and low fan speeds available.
   b. The fan motor shall operate on voltage as scheduled on the drawings.
   c. The fan motor shall be thermally protected.
5. Filter: Filter return air by means of an easily removable, washable filter.
6. Evaporator Coil:
   a. Coils shall be of nonferrous construction with smooth plate fins on copper tubing. Tubing shall have inner grooves for high efficiency heat transfer. Tube joints shall be brazed with phos-copper or silver alloy.
   b. The coil shall be pressure tested at the factory.
7. Electrical:
   a. The fan motor shall operate on voltage as scheduled on the drawings.
   b. 208-230 volts, 1 phase, 60 hertz. System shall be capable of satisfactory operation within voltage limits of 198 to 253 volts. Power to the unit shall be supplied from the outdoor unit, using the Mitsubishi Electric A-Control system. For A-Control, a three (3) conductor AWG-14/16 wire with ground shall provide power feed and be-directional control transmission between the outdoor and indoor units.

C. Remote Condensing Unit:
1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of a swing compressor, motors, fan, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, service ports and suction accumulator.
2. The system will automatically restart operation after a power failure and will not cause any settings to be lost, eliminating the need for re-programming.
3. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
4. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
5. Fans and Motors:
   a. The condensing unit fan shall consist of one propeller type, direct-drive fan motor that has multiple speed operation via a DC (digitally commutating) inverter.
   b. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.

c. The fan motor shall be provided with a fan guard to prevent contact with moving parts.

6. Condenser Coil:
   a. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
7. Compressor:
   a. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which shall result in significant energy savings.
   b. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater is to be used.
   c. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

D. Quality Assurance:
1. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), and bear the ETL label.
2. Wiring shall be in accordance with the National Electric Code (NEC).
3. System rated in accordance with Air Conditioning Refrigeration Institute's (ARI) Standard 210/240 and bear the ARI label.
4. Provide a holding charge of dry nitrogen in the evaporator.
5. System efficiency meets or exceeds 17.6 SEER.

## 2.2 REFRIGERANT PIPING

A. Provide refrigerant piping (liquid and suction) between the remote condensing unit and evaporator unit. Line sets provided by the manufacturer are acceptable.

B. Refrigerant: R-410A (classification A1).

C. Piping materials:
1. Seamless copper tube, type ACR (hard or annealed), ASTM B 280.
2. Annealed copper tube limited to 2 inch nominal diameter and smaller.

D. Piping joints: Provide brazed or mechanical joints.

E. Seismic pipe loop:
   a. Pressure rating 700 psig at 300 degree F.
   b. Stainless steel hose and braid. Long radius elbow.
   c. Differential movement: 2 inches minimum.
   d. Manufacturer: Metrraflex MLVR or approved equal

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. General:
1. Install units in accordance with manufacturer's written installation instructions.

2. Install units plumb and level, firmly anchored in the locations indicated while maintaining manufacturer's recommended clearances.
3. Adjust evaporator unit location to align with ceiling grid.

B. Electrical Wiring: Furnish one copy of manufacturer's electrical connection diagrams to the electrical subcontractor.

C. Piping Connections: Furnish one copy of manufacturer's condensate pump connection diagram to the plumbing subcontractor.

## 3.2 FIELD QUALITY CONTROL

A. Startup air conditioning unit in accordance with the manufacturer's written start up instructions.

B. Test control features and demonstrate compliance with operational requirements.

END OF SECTION 23 8123

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# SECTION 23 8200

# TERMINAL HEATING AND COOLING UNITS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Duct mounted hydronic reheat coils.
   2. Unit heaters.

### 1.2 SYSTEM DESCRIPTION

A. Design Requirements: Provide terminal heating and cooling units, piping, appurtenances, and controls to automatically maintain interior temperature setpoint for each area of the building.

B. Performance Requirements: Provide performance and output shown or scheduled on drawings.

### 1.3 SUBMITTALS

A. See section 20 0000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:
   1. Submit product literature for items specified in Part 2 and those products required by the performance standards of this section. Literature clearly annotated to indicate specified salient features and performance criteria.
   2. Include the following:
      a. Performance characteristics as scheduled.
      b. Enclosure style, material and grille arrangement.
      c. Dimensional data.

C. Closeout Submittals:
   1. Operation and Maintenance (IO&M) Manuals:
      a. Refer to Section 20 0000 - Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.

### 1.4 WARRANTY

A. Manufacturer Warranty: See section 20 0000 - Mechanical General Requirements, for general mechanical warranty requirements.

B. Provide 5-year manufacturer’s warranty for unit heaters and cabinet unit heaters.

## PART 2 - PRODUCTS

### 2.1 DUCT MOUNTED HYDRONIC REHEAT COILS

A. Performance:
   1. Provide coil with scheduled operational performance characteristics.
   2. Designed for counter-flow heat transfer equal pressure drop through each circuit.
   3. Working Pressure: 250 PSIG.

B. Construction:
   1. Primary surface:
      a. Round seamless 5/8-inch outside diameter by 0.020-inch thick copper tube.
      b. Tubes mechanically expanded into fins over the entire finned length.
      c. Brazed joints.
   2. Secondary surface:
      a. 0.008-inch thick aluminum fins with full drawn collars. Bare copper tube not visible between fins.
      b. Solid fins with no punched openings to accumulate lint and dirt.
   3. Coil Headers:
      a. Seamless copper tubing.
      b. Extended sweat connections.
   4. Casing:
      a. Galvanized steel.
      b. “S and Drive” clip connections.

### 2.2 UNIT HEATERS

A. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.

B. Casing: 0.0478-inch steel with threaded pipe connections for hanger rods.

C. Finish: Factory applied baked enamel finish.

D. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.

E. Air Outlet: Adjustable pattern diffuser on projection models and two way louvers on horizontal throw models.

F. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models. Refer to Section 20 0513 - Common Motor Requirements.

G. Control: Local disconnect switch.

H. Capacity: As scheduled.

I. Electrical Characteristics:
   1. Horsepower, voltage, and phase as scheduled on the Drawings, 60 Hz.

2. Refer to Divisions 26, 27 and 28.

J. Manufacturers: Sterling, Modine, Rittling, Trane, Vulcan, JAGA.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection: Cover equipment and plug piping connections to protect components from construction dirt and debris.

B. Preparation: Prior to installation of terminal units, make sure wall construction is complete enough to correctly locate and mount units.

3.2 INSTALLATION

A. Install terminal equipment in accordance with manufacturer's instructions.

B. Install equipment exposed to finished areas after walls and ceilings are finished and painted.

C. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.

D. Hydronic Units:
1. Provide accessible ball type isolation valves on supply and return lines to each terminal unit to allow for unit drain down and repair.
2. Provide low-point drain valve that allows for complete gravity draining of terminal unit.
3. Provide balancing valve as specified elsewhere.
4. Provide high-point automatic air vent as specified elsewhere.

E. Access Doors: Install such that a drain hose may be easily connected to each drain line hose bibb, allowing the applicable portion of the system to be completely drained.

F. Install balancing valves and serviceable products for heating terminal units to be operable and adjustable without removal of the finish cover.

G. Provide pressure and temperature test plugs on both sides of heat transfer elements to measure the drop across runs of heat transfer elements.

H. In systems containing glycol, provide only products specifically designed and approved for continuous operation with the glycol solution specified.

3.3 CONSTRUCTION

A. Interface with Other Work:
1. Coordinate and sequence installation of terminal heating and cooling units with trades responsible for portions of this and other related sections of the Project Manual.

2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

## 3.4 REPAIR/RESTORATION

A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

## 3.5 ADJUSTING

A. Adjust functional components for proper operation in accordance with manufacturer's recommendations, or as otherwise directed.

B. Coordinate and work directly with the Testing, Adjusting and Balancing Agency to provide systems in proper operating order. Make corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.

## 3.6 CLEANING

A. After construction is completed (including painting), and prior to initial start-up, clean and wipe down exposed surfaces of units. Vacuum clean coils and inside of cabinets and enclosures.

B. Touch up marred or scratched surfaces of factory finished cabinets and enclosures, using finish materials furnished by manufacturer.

C. Clean permanent filters or install new disposable filters.

## 3.7 DEMONSTRATION AND START-UP

A. Start-up and operate terminal heating and cooling units in accordance with the manufacturer's written installation and operation manual check list.

B. Demonstrate proper system operation using the building automation system.

C. Document start-up and operational checks using the checklist and submit in accordance with submittal requirements.

END OF SECTION 23 8200

# SECTION 25 3000

# BUILDING AUTOMATION SYSTEM FIELD DEVICES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Requirements, products, procedures, performance requirements, and methods of execution relating to the Building Automation System (BAS) terminal devices and field hardware.
   2. Refer to related sections for other technical requirements, products, and methods of execution relating to the controls system for monitoring and control of mechanical systems.

B. Related Sections: Refer to Section 25 5000 - Building Automation System

### 1.2 REFERENCES

A. Refer to Section 25 5000 - Building Automation System.

### 1.3 SUBMITTALS

A. Submit in accordance with Section 25 5000 - Building Automation System and in accordance with Division 1.

### 1.4 CLOSEOUT SUBMITTALS

A. Submit in accordance with Section 25 5000 - Building Automation System and in accordance with Division 1.

### 1.5 WARRANTY

A. Refer to Section 25 5000 - Building Automation System.

## PART 2 - PRODUCTS

### 2.1 PRODUCTS AND COMPONENTS FOR CLASSIFIED AREAS

A. Products and components used in environments indicated to be NEC Class I, Division I shall be built and labeled as explosion-proof for the Group.

B. Products and components used in environments indicated to be NEC Class I, Division II shall be listed for Class I Division I environments or Class I Division II environments.

### 2.2 TEMPERATURE SENSOR

A. Digital room sensors:
   1. Temperature monitoring range: 55/95 degrees F.
   2. Network jack.
   3. Output signal: Changing resistance.

4. Accuracy at Calibration point: Plus or minus 0.5 degrees F.
5. Wall Mounted unit with finished cover:
   a. Private offices and rooms:
      1). LCD display, day/night override button, and setpoint slide adjustment override options. The setpoint slide adjustment can be software limited by the automation system to limit the amount of room adjustment.
      2). Set Point and Display Range: 55 degrees to 95 degrees F.
   b. Public Spaces: Blank Cover.

B. Liquid immersion temperature:
   1. Temperature monitoring range: Minus 40/240 degrees F.
   2. Output signal: Changing resistance.
   3. Accuracy at Calibration point: Plus or minus 0.5 degree F.
   4. Provide immersion sensor assembly as specified. Immersion sensors shall include a separate thermowell for sensor installation. Annular space between well and sensor shall be filled with heat conductive compound.

C. Duct (single point) temperature:
   1. Temperature monitoring range: 20/120 degrees F.
   2. Output signal: Changing resistance.
   3. Accuracy at Calibration point: Plus or minus 0.5 degrees F.
   4. Sensing element shall be located a minimum of 25 percent across duct width.

D. Duct Average temperature:
   1. Temperature monitoring range: 20/120 degrees F.
   2. Output signal: 4-20 mA DC.
   3. Accuracy at Calibration point: Plus or minus 0.5 degrees F.
   4. Sensor Probe Length: 25 feet.

E. Outside air temperature:
   1. Temperature monitoring range: Minus 58/122 degrees F.
   2. Output signal: 4-20 mA DC.
   3. Accuracy at Calibration point: Plus or minus 0.5 degrees F.
   4. Provide NEMA3R rated mounting assembly (rain tight).

## 2.3 WALL MOUNTED SENSOR GUARD

A. Heavy-duty wire cage type with mounting plate.

B. Cast Aluminum Guard and mounting bracket.

C. Clear or opaque butyrate plastic guard, key lock, mounting plate.

## 2.4 ELECTRIC THERMOSTAT

A. Electric Room Thermostats: Low voltage, two position devices as indicated on the plans. Furnish standard manufacturing configurations of single or multi-stage as well as heating/cooling arrangements as required to provide an operable system. Thermostats shall be dual setpoint with deadband for heating and cooling.

B. Unit Heater Thermostat: Amperage capacity sufficient to cycle fan without need for contactor.

C. Remote Bulb Electric Thermostats: Precision snap acting, dust tight contacts; external adjustment by screwdriver slot or range adjusting knobs; operating temperature point in mid range of the instrument.

## 2.5 LOW TEMPERATURE DETECTION THERMOSTAT

A. Provide low temperature control thermostat, electric type manual reset, non-averaging 20 feet long sensing elements that switch whenever any 12 inch section or more of any portion senses a temperature as low as the thermostat setpoint as specified in sequences.

B. Provide with automatic reset with control system reset.

C. Provide with two sets of contacts, one for hardwired fan shutdown and one for remote monitoring.

## 2.6 HIGH AND LOW LIMIT THERMOSTATS

A. Provide electric, high or low limit thermostats as required by sequence of operation.

B. Freeze Protection Thermostats: Employ a 20 foot element. If any one foot section of the element is subjected to temperatures below 35 degrees F, the respective electric or pneumatic circuit opens, causing action to fans and dampers as required under the sequence of operations. Provide with automatic reset.

C. High Limit Thermostats (Fire Stats, etc.): Employ rod and tube type elements that extend approximately ten inches into the duct. If instrument is subjected to temperatures above 135 degrees F., action required by sequence of operation occurs.

## 2.7 DIGITAL STATUS POINTS

A. Digital status shall be monitored by sensing normally closed contacts (contact closed in alarm conditions). The addition of the monitoring relay shall not affect the operation of the systems involved.

## 2.8 DIGITAL COMMAND POINTS

A. Command relays shall be momentary, automatic, maintained, or magnetic latch fail/safe as required. Maintained contacts located in occupied spaces or plenum spaces shall be mechanically latched. Relays shall be plug in and field replaceable. Contact ratings shall be in accordance with service.

## 2.9 DIFFERENTIAL AIR STATIC PRESSURE SENSOR

A. Provide integral pressure transducer and transmitter in enclosure suitable for wall or panel mounting. 4-20ma output signal proportional to the input pressure span.

B. Transmitter range shall be selected so that the normal operating setpoint is midway between the upper and lower range of the transmitter. Transmitter range shall be bi-directional.

C. The following sensor locations with static pressure ranges are:
   1. Fan Room static pressure: Plus or minus 0.1 inch W.C.
   2. Supply duct static pressure: Plus or minus 2.0 inch W.C.
   3. Filter bank static pressure drop: Plus or minus 1.5 inches W.C.
   4. Air flow station: Varies based on manufacturer recommendations.

D. Temperature operating range: 32 to 122 degrees F.

E. Each transmitter shall have field adjustable span and zero adjustments for field calibration. Accuracy plus or minus 0.5 percent of full scale. Linearity plus or minus 0.1 percent.

## 2.10 EXTERIOR AIR STATIC PRESSURE REFERENCE HEAD

A. Provide parallel plate reference heads with mounting pipe, brackets, supports, and guys for complete installation. Pipe shall be 2 inch diameter, 10 gauge, type 316 stainless steel with FPT connection.

B. Accuracy: Capable of sensing outside air pressure within 2 percent of actual value when subjected to radial wind velocities up to 40 mph with approach angles up to 30 degrees to the horizontal.

C. Provide a one-liter capacity volume chamber with restrictor between the exterior air static reference head and the pressure sensor.

D. Manufacturer: Air Monitor Corporation Model S.O.A.P. (Static Outside Air Probe), or equal.

E. Manufacturer: TSI Inc.

## 2.11 INTERIOR AIR STATIC PRESSURE PROBE

A. Provide shielded static air pressure probe with appurtenances for complete installation. Integral volume chamber, sensing ports engineered for quiet, steady operation. Type 316 stainless steel.

B. Accuracy: Capable of sensing room air pressure within 1 percent of actual static pressure value.

C. Manufacturer: Air Monitor Corporation Model S.A.P. (Static Air Probe), or equal.

## 2.12 DIFFERENTIAL FLUID PRESSURE SENSOR

A. Provide integral pressure transducer and transmitter with 4-20 mA output signal proportional to the input pressure span.

B. Provide NEMA 1 aluminum enclosure.

C. Transmitter range shall be selected so that the normal operating setpoint is midway between the upper and lower range of the transmitter. Transmitter range shall be unidirectional.

D. The range for the sensor serving the hydronic heating system is 0-10 PSIG.

E. Temperature operating range: Minus 40 to 175 degrees F.

F. Each transmitter shall have field adjustable span and zero adjustments for field calibration. Accuracy plus or minus 1.0 percent of full scale.

2.13 FLUID PRESSURE SENSOR

A. Provide integral pressure transducer and transmitter with 4-20 mA output signal proportional to the input pressure span.

B. Provide watertight enclosure.

C. Transmitter range shall be selected so that the normal operating setpoint is midway between the upper and lower range of the transmitter. Transmitter range shall be unidirectional.

D. The range for the sensor serving the hydronic heating system is 0-50 PSIG.

E. Temperature operating range: Minus 40 to 200 degrees F.

F. Each transmitter shall have field adjustable span and zero adjustments for field calibration. Accuracy plus or minus 1.0 percent of full scale.

2.14 AIRFLOW MEASURING STATION/DEVICE

A. One or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.

B. Each sensor assembly shall contain two individually wired, hermetically sealed bead-in-glass thermistors. The airflow rate of each sensor assembly shall be equally weighted and averaged by the transmitter prior to output. Devices using less than two thermistors in each sensor assembly are not acceptable.

C. Devices using platinum wire RTDs are not acceptable.

D. Each transmitter shall have a 16-character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics.

E. Airflow accuracy shall be +/-2 percent of Reading over the entire operating airflow range.

F. Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.

G. Temperature accuracy shall be +/-0.15 degrees F over the entire operating temperature range of -20 degrees F to 160 degrees F.

H. The operating humidity range for each sensor probe shall be 0-99 percent RH (non-condensing).

I. Each sensor probe shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter.

J. The number of sensor housings provided for each location shall be as follows:

| Duct or Plenum Area (sq.ft.) | Total # Sensors / Location |
|---|---|
| | |
| <2 | 4 |
| 2 to < 4 | 6 |
| 4 to < 8 | 8 |
| 8 to <16 | 12 |
| >=16 | 16 |

K. Fan inlet sensors may be proposed where appropriate.

L. The transmitter shall communicate directly with the building automation system utilizing a LonWorks protocol.

M. Manufacturer: Ebron Gold Series or equal.

2.15 CURRENT SENSOR

A. Provide current sensors that convert AC current to a proportional (4-20 mA) DC current.

B. Provide reverse voltage and high over current capacity.

C. Provide red LED light to indicated relay status and power.

D. Temperature operating range: 5 to 140 degrees F.

E. Provide UL Listed device.

2.16 CURRENT SENSING RELAY

A. Provide solid-state, self-calibrating, current operated relay suitable for equipment status monitoring. Provide a relay that changes switch contact state in response to an adjustable set point value of current in the monitored A/C circuit.

B. Provide red LED light to indicated relay activation.

C. Temperature operating range: minus 30 to 140 degrees F.

D. Provide UL Listed device that is rated for plenum installation.

## 2.17 RELAYS

A. Applications: Relays external to the controls shall include (but not be limited to) the following:
   1. Control relays for start/stop or open/close control of equipment.
   2. Monitoring relays for electrical circuit on/off or open/closed status detection.
   3. Interposing relays to provide interface between solid state circuitry and ac-driven control relays.

B. Requirements: Relays shall be housed in dust-tight cases conveniently located for wiring and inspection:
   1. Control Relay: Control relays shall be suitable for continuous operation of 120 VAC and be able to interrupt the control circuits of various HVAC equipment. The number of contacts required for the relay shall be determined from the number of independent equipment to be controlled. The number of control relays required for the motor start/stop circuit shall be determined from examination of the equipment to be controlled.
   2. Monitoring Relay: Monitoring relays shall be suitable for continuous operation at the voltages of the circuits to be monitored. The monitoring relays shall be connected in such a way that the operation of the relay contact shall represent the change of status of the monitored circuit (i.e. ON/OFF, etc.) or duplicate the operation of the existing alarm circuit (i.e. high/low, etc.). The addition of the monitoring relay shall not affect the operation of the systems involved.
   3. Interposing Relay: Interposing relays shall be DC driven and be utilized to provide interface between solid state circuitry and ac-driven control relays as required.

## 2.18 CONTROL VALVE

A. Control Valve: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Globe Valve 2 inch and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, and sweat ends.

C. Globe Valve 2-1/2 inch and Larger: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

D. Hydronic system globe valve shall have the following characteristics:
   1. Rating: ANSI Class 125 for service at 125 PSIG and 32/250 degrees F operating conditions.
   2. Internal Construction:
      a. Replaceable plugs and seats of stainless steel or brass.
      b. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
      c. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.

3. Sizing: 3 PSIG maximum pressure drop at design flow rate.
4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.
5. Select heating valves shall fail to a Normally Open to heat position, unless otherwise indicated. Select cooling valves to normally closed to cooling position.
6. Three-way valves: Mixing type, unless otherwise indicated.

## 2.19 CONTROL DAMPER

A. Rectangular:
1. Frame: Five inches by one inch by minimum 0.125 inch 6063-T5 extruded aluminum hat-shaped channel, mounting flanges on both sides of frame, reinforced at corners.
2. Blades: Provide airfoil-shaped, single-piece blades made of heavy-duty 6063-T5 extruded aluminum. Maximum six inch blade width.
3. Bearings: Molded synthetic sleeve, turning in hole in frame.
4. Seals:
   a. Blade: Extruded vinyl type for ultra-low leakage from minus 50 degrees F. to 350 degrees F. Mechanically attached to blade edge.
   b. Jamb: Flexible metal compression type.
5. Linkage: Concealed in frame.
6. Axles: Minimum 1/2-inch diameter plated steel, hex-shaped, mechanically attached to blade.
7. Finish: Mill aluminum.
8. Performance Data:
   a. Temperature Rating: Withstand minus 50 degrees F. to 350 degrees F.
   b. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions:
      1). Closed Position: Maximum pressure of 13 inches W.C. at a 12-inch blade length.
      2). Open Position: Maximum air velocity of 6,000 feet per minute.
   c. Leakage: Maximum 2.0 cubic feet per minute per square foot at 1.0 W.C. for sizes 24 inches wide and above.
   d. Pressure Drop: Maximum 0.03 inch W.C. at 1,500 feet per minute across 24 inch by 24 inch damper.
9. Manufacturer: Ruskin CD50, Louvers and Dampers, Air Balance, Pottorff, or equal.

B. Round:
1. Frame:
   a. Under 6 inches Diameter: 2 inches by 1/2 inch minimum 12 gage galvanized steel tube.
   b. 6 thru 12 inches Diameter: 2 inches by 1/2 inch by minimum 14 gage galvanized steel channel.
   c. Above 12 thru 24 inches Diameter: 2 inches by 1/2 inch by minimum 1/8 inch galvanized steel channel.
   d. Above 24 inches Diameter: 2 inches by 1 inch by minimum 3/16 inch galvanized steel channel.
2. Blade: Provide single-piece construction made of the following material:
   a. 18 inches diameter and smaller: Minimum 12 gage galvanized steel.

b. Over 18 inches diameter: Minimum 10 gage galvanized steel, stiffeners as required.

3. Blade Seals: Closed cell polyethylene foam rubber fully encompassing and mechanically attached to blade edge.
4. Bearings: Self-lubricating stainless steel sleeve.
5. Axles:
   a. 22 inches Diameter and smaller: Minimum 1/2 inch diameter, full length, plated steel, mechanically attached to blade.
   b. Over 22 inches Diameter: Minimum 3/4 inch diameter, full length, plated steel, mechanically attached to blade.
6. Finish: Mill.
7. Performance Data.
   a. Temperature Rating: Withstand maximum 250 degrees F.
   b. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
      1). Closed Position: Maximum pressure of 10 inches W.C.
      2). Open Position: Maximum air velocity of 4,000 feet per minute /min.
   c. Leakage: Maximum 10 cubic feet per minute total at 1 inch W.C.
   d. Pressure Drop: Maximum 0.05 inch W.C. at air volume of 7,000 cubic feet per minute through 24 inch diameter damper.
8. Manufacturer: Ruskin CDR25, Louvers and Dampers, Air Balance, Pottorff, or equal.

## 2.20 VALVE AND DAMPER ACTUATORS

A. General:
1. Provide electronic direct-coupled actuation for control valves and dampers.
2. Proportional actuators shall accept a 0-10 VDC or 0-20 mA control input and provide a 2-10 VDC or 4-20 mA operating range. Damper actuators and control valve actuators serving valves larger than 3/4" shall provide a 2-10 VDC position feedback signal. The feedback signal shall be independent of the input signal.
3. Actuators indicated by Normally Closed or Normally Open designation on drawings or in sequence of operation shall be spring return type.
4. The actuator shall have electronic overload circuitry to prevent damage to the actuator.
5. Provide actuators listed by Underwriters Laboratories Standard 873 Standard for Safety Temperature-Indicating and -Regulating Equipment.

B. Damper Actuator:
1. Provide damper actuator shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage.
2. Spring return actuators shall be capable of both clockwise and counterclockwise spring return operation by simply changing the mounting orientation.
3. Non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque capacity shall have a manual crank for this purpose.
4. Provide actuators in sufficient size, quantity and type to match application. Provide a minimum of one damper actuator for each 24 square feet of damper area. Damper areas shall not exceed manufacturer's ratings.

5. Outside air and return air dampers on mixing boxes shall be linked such that one opens while the other closes. It shall not be possible to close both dampers simultaneously.
6. Dampers: Size for minimum running torque calculated as follows:
   a. Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
   b. Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
   c. Parallel-Blade Damper without Edge Seals: 4 inch-pounds/sq. of damper.
   d. Opposed-Blade Damper without Edge Seals: 3 inch-pounds/sq. ft. of damper.
   e. Dampers with 2 to 3 Inches w.g. of Pressure Drop or Face Velocities of 1000 to 2500 FPM: Multiply the minimum full-stroke cycles above by 1.5.
   f. Dampers with 3 to 4 Inches w.g. of Pressure Drop or Face Velocities of 2500 to 3000 FPM: Multiply the minimum full-stroke cycles above by 2.0.
   g. Values noted above do not include normally open or normally closed open spring return dampers. Provide additional torque as required.
7. Size operators with ample power to overcome friction of damper linkage and air pressure acting on the damper blades.

C. Valve Actuator:
   1. Provide actuators with enough torque and force required for proper valve close-off against the system pressure.
   2. The valve actuator shall be sized based on valve manufacturer's recommendations for flow and pressure differential.

## 2.21 INSTRUMENT ENCLOSURE

A. Steel construction with hinged and lockable doors.

B. NEMA 12 construction only in areas where panels are subject to moisture damage.

C. Wiring connections including I/O and power shall be extended to a numbered, color-coded, and labeled terminal strip for ease of maintenance and expansion.

D. Provide labeling and color coding for wiring. Wiring shall follow a common format typical for the entire facility. Terminal strip color coding and numbering shall follow a common format. Wiring shall be neatly installed in plastic trays or tie-wrapped.

E. Line voltage wiring shall be segregated from I/O wiring and shall be UL listed, 300-volt service and provide adequate clearance for field wiring.

F. Provide a convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers. Provide convenience receptacle for enclosures containing equipment that can be configured or adjusted with a portable computer.

## 2.22 POWER SUPPLY

A. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75 percent of the rated capacity of the power supply.

B. Input: 120 VAC plus 10 percent, 60Hz.

C. Output: 24 VDC.

D. Line Regulation: Plus 0.05 percent for 10 percent line change.

E. Load Regulation: Plus 0.05 percent for 50 percent load change.

F. Provide an appropriately sized fuse and fuse block shall be provided and located next to the power supply.

G. Provide a power disconnect switch shall be provided next to the power supply.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Special Techniques:
1. Wiring:
   a. The HVAC Control Contractor shall provide conduit, wiring, accessories, and wiring connections required for the installation of the control system, as herein specified, unless specifically shown in Divisions 26, 27 and 28.
   b. Conduit and wiring shall comply with the requirements of applicable portions of Divisions 26, 27 and 28 and local and national electric codes, unless specified otherwise in this section.
   c. System input wiring shall be twisted shielded pair, minimum 20 gauge wire. System analog output wiring shall be twisted shielded pair/3-wire as required, minimum 20 gauge wire. Preconfigured cables between Terminal Unit Controllers and Thermostats are acceptable, minimum 24 gauge.
   d. Internal panel device wiring for binary outputs and pilot relay shall be minimum 16 gauge wire.
   e. Provide separate conduit for control system power wiring including but not limited to 120 VAC and greater. I/O sensor wiring and data communication cabling shall be segregated from 120 VAC control system power wiring.
   f. Wiring in mechanical rooms shall be in conduit. Minimum control wiring conduit size 3/4 inch. One half inch conduit may be used for thermostats and valve stub-ups where conduit contains only a single pair.
2. Temperature Sensors:
   a. Temperature sensor assemblies shall be readily accessible and adaptable to each type of application in such manner as to allow for quick, easy replacement and servicing without special tools or skills.
   b. Outdoor installations shall be of weatherproof construction or in appropriate NEMA enclosures. These installations shall be protected from solar radiation and wind effects. Protective shield shall be stainless steel.
   c. Wall Mounted Sensor and Thermostats:
      1). Install wall mounted room sensors at a height of four feet six inches above finish floor level.
      2). Locate sensors as shown on the Drawings.
      3). Provide insulated base for sensors mounted on sheet metal, steel columns or exterior walls. Wire penetrations shall be caulked airtight to prevent thermal convection.
      4). Provide heavy-duty guards for sensors and thermostats in public areas and as shown on the Drawings.

d. Fluid Temperature Sensor: The sensor shall have a separable well suitable for insertion in a pipeline or vessel. Cable connections shall be suitable for the highest temperature expected and low temperature sensors shall be sealed to exclude condensation of atmospheric moisture.
e. Duct Temperature Sensor: The sensor shall measure the representative temperature of the entire cross-section of the duct or plenum. Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only and shall not be located in dead air spaces. Ductwork shall be securely sealed where elements or connections penetrate ducts to avoid measuring false conditions.
f. Mixed Air Temperature Sensors: The sensor shall be of the averaging type. Mount sensors with consideration for stratification of warm and cold air streams. Minimum binding radius for averaging sensors is four inches. Provide a minimum of one foot of averaging sensor element for each square foot of ductwork. Sensing element shall be installed such that it crosses completely through stratified airflow with complete passes. Partial passes are not allowed. If averaging sensor is not available provide one sensor for every four square feet of duct cross section area.
g. Fluid Temperature Sensors: Provide sensors with thermal wells fabricated and installed for the intended service. Wells shall be non-corrosive to the medium being measured and shall have sufficient physical strength to withstand all pressures, (including test pressures) and velocities to which they are subjected. Well shall not restrict flow area to less than 70 percent of line-size-pipe normal flow area. Where piping is smaller than the length of the well or exceeds the area requirements, the well shall be installed at an elbow and installed to effect uniform flow across the well. Sensors installed in wells shall be installed in horizontal piping below the pipe centerline.
h. Low Temperature Detection Thermostats: Mount sensor element similar to Mixed Air Temperature Sensors.

3. Exterior Air Static Pressure Reference Head:
   a. Provide four outside static reference heads and locate as shown on the Drawings.
   b. Mount reference heads above roof line and in accordance with manufacturer recommendations.
4. Interior Air Static Pressure Probe:
   a. Provide interior static pressure probes and locate as shown on the Drawings.
   b. Provide surface mount in mechanical spaces. Provide recessed mount in finished spaces.
5. Differential Fluid Pressure Sensor:
   a. Locate sensors as shown on the Drawings. Mount in accessible location.
   b. Controls subcontractor to furnish differential pressure sensor snubbers. Installation of snubbers by plumbing subcontractor.
6. Fluid Pressure Sensor:
   a. Locate sensors as shown on the Drawings. Mount in accessible location.
   b. Controls subcontractor to furnish fluid pressure sensor snubbers. Installation of snubbers by plumbing subcontractor.
7. Current Sensors:
   a. Provide flow proof for constant volume fans and pumps with a current sensor connected to the motor wiring at the starter. Set upper alarm limit to the maximum rated current of the motor, or as advised by the TAB Agency. Set lower alarm limit at 1/2 the motor running amps.

b. Provide flow proof for variable speed control system through utilization of the variable speed drive serial communication option. Drive will communicate directly with BAS system.

8. Digital Status, Digital Command Points, Lighting Controls:
   a. Provide relays in a separate instrument enclosure or control panel adjacent to the monitored or controlled equipment. The relays shall mounted and connected in a manner that does not violate controlled equipment listing or code requirements.
   b. Provide relays that operate in conjunction with the motor control system. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
   c. Coordinate motor control requirements with Divisions 26, 27 and 28.
   d. Coordinate lighting control requirements with Divisions 26, 27 and 28.
9. Identification:
   a. Panel and Instrument Enclosure Identification: Panels and instrument enclosures shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.
   b. Field Devices: Field devices shall be identified by a typed (not handwritten) securely attached tag label.
   c. Panel or Instrument Enclosure Devices: Devices shall be identified by a typed label securely fastened to the backplane of the local control panel or instrument enclosure.
   d. Wall Mounted Temperature Sensors: Device covers shall be identified by a typed label securely fastened to the front cover. The label shall indicate the terminal unit zone identification tag.
   e. Raceway Identification: The covers to junction and pull boxes of the control system raceways shall be painted blue or have identification labels stating “Control System” affixed to the covers. This requirement includes control system tubing. Labels shall be typed, not hand written.
   f. Wire Identification: Low and line voltage control wiring shall be identified by a number, as referenced to the associated control diagram, at each end of the conductor or cable. Identification number shall be permanently secured to the conductor or cable and shall be typed.

## 3.2 MAINTENANCE

A. Arrange work so that wherever possible serviceable or operable products are located within mechanical or electrical spaces and are accessible.

END OF SECTION 25 3000