

**\*\*\*ADDENDUM ONE\*\*\***

**BID NUMBER B2013002  
CELLBLOCK RENOVATIONS  
Florence K. Murray Judicial Complex  
45 Washington Square  
Newport, Rhode Island 02840**

**February 19, 2013**

**NOTICE:**

This Addendum modifies, amends and supplements designated part of the CONTRACT DOCUMENTS for the project identified as "Cellblock Renovations at Florence K. Murray Judicial Complex", 45 Washington Square, Newport, Rhode Island, dated January 28, 2013 is hereby made a part thereof by reference, and shall be as binding as though inserted in its entirety in the locations designated hereunder. It shall be the responsibility of the Contractor to notify all subcontractor and suppliers he proposes to use for the various parts of the work of any changes or modifications contained in this Addendum. No claim for additional compensation due to lack of knowledge of the contents of this Addendum will be considered.

**Pre-Bid Meeting:**

A Mandatory Pre Bid Conference was held on February 13, 2013 at 7:30 AM at the site. The following items were discussed:

1. Bids are due Tuesday February 26, 2013 in duplicate and delivered to Purchasing, Room 1006, at the RI Traffic Tribunal located at the Pastore Center, 670 New London Ave. Cranston, RI. Bids must be delivered before 10:00 AM to be considered.
2. Bids must be submitted with a 5% Bid Bond for the full cost of the Bid.
3. This project is a prevailing wage project with certified weekly payroll.
4. This project is RI Tax exempt.
5. All employees working within the building regarding this project must submit to a background check and obtain approval from the Courts prior to the start of the project.
6. The project duration shall be a total of five months or less from Notice to Proceed. Hours of work shall be 7:30 AM to 3:30 PM, Monday thru Friday. Work on Saturdays or evenings will be allowed at no additional cost to the project. All overtime work must be coordinated with Steve Kerr's Office.
7. The lower level project work area will be vacant for the duration of the project. Time is of the essence and if the work can be completed in less than five months, it would be greatly appreciated.
8. Parking: There is No Parking around the building. Contractor's employees shall find parking on area streets, parking lots or car pool. Delivery of supplies and equipment to the building and storage within the building shall be coordinated through Steve Kerr's Office.
9. All present at the pre-bid meeting toured the existing lower level cellblock area and outer office areas.

**Specifications:**

1. Section 00 01 10, Table of Contents  
Delete section in its entirety and insert new Table of Contents. See attached.
2. Section 00 42 13, Bid Form.  
Project Reference: Florence K. Murray Judicial Complex  
Delete address: "250 Benefit Street, Providence, RI 02903".  
Replace with address: "45 Washington Square, Newport, RI 02840".
3. Section 08 34 63, Detention Doors and Frames  
Delete reference to electric locks. Doors and frames to have manual mortised security locks with key operation. Provide six keys per door lock.

**\*\*\*ADDENDUM ONE\*\*\***

**PAGE 1 OF 2**

4. Section 09 29 00, Gypsum Board Systems  
Delete section in its entirety and replace with attached specification section.
5. Divisions 22, 23, 26 and 28 have been added to the specifications and are attached to this Addendum in their entirety.

**Drawings:**

1. T1 COVER SHEET:
  - a. LIST OF DRAWINGS:
    - i. Change D1.0 to D1
    - ii. Change A1.0 to A1
    - iii. Change A1.1 to A2
    - iv. Change A2.0 to A3
    - v. Change A3.0 to A4
    - vi. Change A3.1 to A5
2. D1.0 - BASEMENT DEMOLITION PLAN AND ABBREVIATIONS:  
Change sheet number D1.0 to D1
3. A1.0 - BASEMENT FLOOR PLAN, LEGEND, AND WALL TYPES:  
Change sheet number A1.0 to A1
4. A1.1 - BASEMENT REFLECTED CEILING PLAN, DOOR & ROOM FINISH SCHEDULES:  
Change sheet number A1.1 to A2
5. A2.0 - BASEMENT BUILDING SECTIONS AND INTERIOR ELEVATIONS:  
Change sheet number A2.0 to A3
6. A3.0 - BASEMENT SECTION DETAILS, VISION PANEL AND WINDOW DETAILS:  
Change sheet number A3.0 to A4
7. A3.1 - BASEMENT DOOR DETAILS  
Change sheet number A3.1 to A5
8. D1 - BASEMENT DEMOLITION PLAN AND ABBREVIATIONS:  
Delete notes 1, 5 & 19 on Lobby 001 and Hall 002 walls. Existing masonry block wall to remain along with existing plaster ceiling.
9. A2 - BASEMENT REFLECTED CEILING PLAN, DOOR & ROOM FINISH SCHEDULES  
Delete reference to Steel Security Plank Ceiling and change to specification Section 11 19 00 Article 2.8 - Security Ceilings.
10. A2 - BASEMENT REFLECTED CEILING PLAN, DOOR & ROOM FINISH SCHEDULES  
and detail 12/A4 - Vision Panel – Change Cashier/Utility Door Model “Nissen” #532 to #726.
11. A2 - BASEMENT REFLECTED CEILING PLAN, DOOR & ROOM FINISH SCHEDULES  
Door Schedule - Access Doors to be 14GA. Stainless Steel with cylinder lock and key.
12. M2.0 SCHEDULES AND DETAILS (MECHANICAL)  
Delete drawing in its entirety and replace with attached Drawing M2.0.

The Pre-Bid Conference Attendance Sheet is attached to this Addendum.

<p><b>NOTICE TO ALL CONTRACTORS:</b> Contractors shall call our office to verify number of Addendum issued at least 24 hours in advance of bid submission. Failure to acknowledge receipt of this addendum on the bid form may, at the sole discretion of the Owner, serve as justification to reject bid.</p>
--

END OF WRITTEN ADDENDUM

\*\*\*ADDENDUM ONE\*\*\*  
PAGE 2 OF 2

## Edward Rowse Architects

Project #13002  
Date: February 13, 2013  
7:30 AM

**PRE-BID CONFERENCE SIGN-IN**  
**Project: Cellblock Renovations**  
**Florence K. Murray Judicial Complex**

NAME	COMPANY	PHONE/FAX	EMAIL
Ted Rowse	Edward Rowse Architects, Inc 115 Cedar St. Providence, RI 02903	401-331-9200 401-331-9270 F	trowse@rowsearch.com
Stephen J. Kerr	RI Supreme Court-Assistant Court Administrator-Facilities 250 Benefit Street Providence, RI 02903		skerr@courts.ri.gov
Ken Smith	RI Supreme Court-Fac/Operations 250 Benefit Street Providence, RI 02903		ksmith@courts.ri.gov
Carla Ciccone	RI Supreme Court - Purchasing Agent 670 New London Avenue Cranston, RI 02920		cciccone@courts.ri.gov
Shawn Patrick Ryan	RI Supreme Court-Assistant Building Grounds Officer Murray Judicial Complex 45 Washington Square Newport, RI 02840		spryan@courts.ri.gov
ARMANDO LUSI	A.F. LUSI CONSTRUCTION INC	232-1010 232-1480	alusi@lusiconstruction.com
MARC MENARD	NADEAU CORP	508-399-6776 508-399-7210	mmenard@nadeaucorp.com
Michael Peery	PARISEAULT Builders	401-738-0524 739-9270	wike@pariseault.com
RUSSELL VALIANT	MJT CONSTR CO INC	401-272-4741 401-272-4761	RVALIANT@MJTCONSTRUCTIONCO.COM
TOM BURMAN	EW BURMAN INC	738-5100 732-9545	estimating@ewburman.com
Steve DePasquale BOB CORSICCI	Iron Construction Group CENTERSIDE Rd. WARWICK, RI	508-2062 401-490-3144	bc@icgri.com
Fred Abatecola LA	ALPHA OMEGA Const	508-761-4494 508-399-7345	Fred@AOgroup.net
Michael Bahry	Bahry Building Company	401-354-7014 508-557-1784	mbabahrybuilding.com
William Miller	Miller Mechanical	401-435-5500 401-435-0110	MillerMechanical@cox.net
JOSH ROMERANZ	DELTA MECHANICAL	737-3500	J.ROMERANZ@DELTA-MECH.ILL.COM
Carl Nordstrom	Tower Construction 6 2158 Plainfield Pike CRANSTON RI 02921	401-943-0110 401-944 4041	sal@Towerconstructioncorp.com

CELLBLOCK RENOVATIONS  
FLORENCE K. MURRAY JUDICIAL COMPLEX

<u>SECTION NUMBER</u>	<u>TITLE</u>
00 01 10	Table of Contents
00 11 16	Invitation To Bid
00 01 17	List of Drawings
00 21 13	Instructions To Bidders (AIA - A701)
00 22 13	Supplementary Instructions To Bidders
00 42 13	Bid Form
00 43 13	Bid Bond (AIA - A310)
00 52 13	Form Of Agreement (AIA - A101)
00 61 13	Performance and Payment Bonds (AIA - A312)
00 72 13	General Conditions (AIA - A201)
00 73 00	Supplementary General Conditions
00 73 46	Wage Determination Schedule
01 10 00	Summary
01 21 00	Allowance
01 31 00	Project Management and Coordination
01 32 00	Construction Progress Documentation
01 33 00	Submittal Procedures
01 40 00	Quality Requirements
01 50 00	Temporary Facilities and Controls
01 60 00	Product Requirements
01 73 00	Execution
01 74 19	Construction Waste Management & Disposal
01 77 00	Closeout Procedures
01 78 23	Operation and Maintenance Data
01 78 39	Project Record Documents
01 79 00	Demonstration and Training
02 41 91	Selective Demolition
04 20 00	Unit Masonry Assemblies
06 10 53	Miscellaneous Rough Carpentry
08 11 13	Hollow Metal Doors and Frames
08 34 63	Detention Doors and Frames
08 71 00	Door Hardware
09 29 00	Gypsum Board Systems
09 51 13	Acoustical Panel Ceilings
09 91 00	Painting
09 96 13	Abrasion Resistant Coatings
11 19 00	Detention Equipment
21 10 00	Water-Based Fire-Suppression Systems
22 22 22	Interior Plumbing Systems

CELLBLOCK RENOVATIONS  
FLORENCE K. MURRAY JUDICIAL COMPLEX

<u>SECTION NUMBER</u>	<u>TITLE</u>
23 05 00	Common Work Results for HVAC
23 05 19	Meters and Gages for HVAC Piping
23 05 23	General-Duty Valves for HVAC Piping
23 05 29	Hangers and Supports for HVAC Piping and Equipment
23 05 53	Identification for HVAC Piping and Equipment
23 05 93	Testing, Adjusting and Balancing for HVAC
23 07 00	HVAC Insulation
23 09 00	Controls and Instrumentation for HVAC
23 09 93	Sequence of Operations for HVAC
23 21 13	Hydronic Piping
23 31 13	Metal Ducts
23 33 00	Air Duct Accessories
23 37 13	Diffusers, Registers and Grilles
26 05 00	Basic Electric Materials & Methods
26 05 19	Conductors and Cables
26 05 33	Raceways and Boxes
26 24 19	HVAC Electrical Requirements
26 27 26	Wiring Devices
26 28 13	Fuses
26 28 16	Enclosed Switches & Circuit Breakers
26 51 00	Interior Lighting
28 37 00	Fire Alarm System Modifications
Appendix A	BCI Authorization Form
Appendix B	Rhode Island Judicial Purchasing Rules and Regulations and General Terms and Conditions of Purchase

---

**SECTION 09 29 00 - GYPSUM BOARD SYSTEMS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Interior gypsum wallboard
  - 2. Soffit and ceiling suspension systems
- B. Related Sections include the following:
  - 1. Division 6 Section "Rough Carpentry" for wood framing, blocking and furring.

**1.3 DEFINITIONS**

- A. Gypsum Board Terminology: Refer to ASTM C 11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

**1.4 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Samples: For the following products:
  - 1. Trim Accessories: Full-size sample in 12-inch (300-mm) long length for each trim accessory indicated.

**1.5 QUALITY ASSURANCE**

- A. Gypsum Board Finish Mockups: Before finishing gypsum board assemblies, install mockups of at least 100 sq. ft. (9 sq. m) in surface area to demonstrate aesthetic effects and qualities of materials and execution.
  - 1. Install mockups for the following applications:
    - a. Surfaces with texture finishes.
    - b. Surfaces indicated to receive paint finishes.
  - 2. Simulate finished lighting conditions for review of mockups.
  - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.

## 1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Steel Framing and Furring:
  - a. Clark Steel Framing Systems
  - b. Dietrich Industries, Inc.
  - c. MarinoWare; Division of Ware Industries
  - d. National Gypsum Company
  - e. Inimast, Incorporated
2. Gypsum Board and Related Products:
  - a. National Gypsum Company.
  - b. United States Gypsum Co.
  - c. G-P Gypsum Corp.

### 2.2 SUSPENDED CEILING AND SOFFIT FRAMING

- A. Components, General: Comply with ASTM C 754 for conditions indicated.
1. All materials shall be hot-dipped galvanized.
- B. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch (1.59-mm) diameter wire, or double strand of 0.0475-inch (1.21-mm) diameter wire.
- C. Hanger Attachments to Concrete: As follows:
1. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by a qualified independent testing agency.
- D. Hangers: As follows:
1. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch (4.12-mm) diameter.
- E. Grid Suspension System for Ceilings and Soffits: ASTM C 645, direct-hung heavy duty system composed of main beams and cross-furring members that interlock.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Armstrong World Industries, Inc.; Furring Systems/Drywall.
    - b. Chicago Metallic Corporation; Drywall Furring 640 System.
    - c. USG Interiors, Inc.; Drywall Suspension System.
  2. Runners, Tees, Cross Channels, Cross Tees and Wall Track shall be manufactured from minimum 0.020-inch thick steel.

## 2.3 STEEL PARTITION AND SOFFIT FRAMING

### A. Components, General: As follows:

1. As a minimum comply with ASTM C 645 and ASTM C 754 for conditions indicated unless more stringent requirements are indicated or specified.
2. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with ASTM A 653/A 653M, G40 (Z120) zinc coating.

### B. Steel Studs and Runners: ASTM C 645.

1. Minimum Base (uncoated) Metal Thickness: 0.0359-inch (0.91-mm), all interior walls unless indicated otherwise.
2. Minimum Base (uncoated) Metal Thickness: 0.0478-inch (1.24-mm), in locations as follows:
  - a. For head runner, sill runner, jamb and cripple studs at doors and other openings.
  - b. In all locations to receive cementitious backer units or tile finishes.
  - c. Depth: As indicated

## 2.4 DEFLECTION TRACK

### A. Proprietary Deflection Track: Steel sheet top runner manufactured to prevent cracking of gypsum board applied to interior partitions resulting from deflection of structure above; in thickness indicated for studs and in width to accommodate depth of studs.

1. Available Product: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Delta Star, Inc., Superior Metal Trim; Superior Flex Track System (SFT).
  - b. Metal-Lite, Inc.; Slotted Track.

### B. Proprietary Firestop Track: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Available Product: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
  - b. Metal-Lite, Inc.; The System.

### C. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base Metal Thickness: As indicated or 0.0359-inch (0.91-mm) if no thickness is indicated.

### D. Cold-Rolled Channel Bridging: 0.0538-inch (1.37-mm) bare steel thickness, with minimum 1/2-inch (12.7-mm) wide flange.

1. Depth: As indicated, if not indicated a minimum depth of 1-1/2 inches (38.1-mm).
2. Clip Angle: 1-1/2 by 1-1/2 inch (38.1 by 38.1 mm), 0.068-inch (1.73-mm) thick, galvanized steel.

### E. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base Metal Thickness: As indicated or a minimum of 0.0359-inch (0.91-mm) if no thickness is indicated.
2. Depth: As indicated or a minimum depth of 7/8 inch (22.2 mm) if no depth indicated.



- F. Resilient Furring Channels: 1/2-inch (12.7-mm) deep, steel sheet members designed to reduce sound transmission.
  - 1. Configuration: Asymmetrical or hat shaped, with face attached to single flange by a slotted leg (web) or attached to two flanges by slotted or expanded metal legs.
- G. Cold-Rolled Furring Channels: 0.0538-inch (1.37-mm) bare steel thickness, with minimum 1/2-inch (12.7-mm) wide flange.
  - 1. Depth: 3/4 inch (19.1 mm), unless indicated otherwise.
  - 2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare steel thickness of 0.0312 inch (0.79 mm).
  - 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.
- H. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (31.8 mm), wall attachment flange of 7/8 inch (22.2 mm), minimum bare metal thickness of 0.0179 inch (0.45 mm), and depth required to fit insulation thickness indicated.
- I. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power and other properties required to fasten steel members to substrates.

## 2.5 INTERIOR GYPSUM WALLBOARD

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.
- B. Gypsum Wallboard: ASTM C 36.
  - 1. Regular Type:
    - a. Thickness: Unless otherwise indicated, 5/8 inch (15.9 mm) to comply with ASTM C 840 for application system and support system indicated.
    - b. Long Edges: Tapered and featured rounded or beveled for prefilling.
  - 2. Type X:
    - a. Thickness: Unless otherwise indicated, 5/8 inch (15.9 mm) to comply with ASTM C 840 for application system and support system indicated.
    - b. Long Edges: Tapered
- C. Sag-Resistant Gypsum Wallboard: ASTM C 36, manufactured to have more sag resistance than regular-type gypsum board.
  - 1. Thickness: 1/2 inch (12.7 mm).
  - 2. Long Edges: Tapered.
  - 3. Location: Ceiling surfaces and other areas as indicated.

## 2.6 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
  - 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
  - 2. Shapes:
    - a. Cornerbead: Use at outside corners, unless otherwise indicated.
    - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
    - c. L-Bead: L-shaped; exposed long leg receives joint compound.
    - d. Expansion (Control) Joint: Use where indicated.
    - e. Curved-Edge Cornerbead: With notched or flexible flanges; use at curved openings.
- B. Exterior Trim: ASTM C 1047.

1. Material: Hot-dip galvanized steel sheet or rolled zinc.
2. Shapes:
  - a. Cornerbead: Use at outside corners.
  - b. LC-Bead: J-shaped; exposed long flange receives joint compound; use at exposed panel edges.
  - c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

## 2.7 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475.
- B. Joint Tape:
  1. Interior Gypsum Wallboard: Paper.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
  1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
  2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
  3. Fill Coat: For second coat, use setting-type, sandable topping compound.
  4. Finish Coat: For third coat, use drying-type, all-purpose compound.
  5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

## 2.8 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
  1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
  1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
  2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Suspended Ceilings: Coordinate installation of ceiling suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers at spacing required to support ceilings and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

### 3.3 INSTALLING STEEL FRAMING, GENERAL

- A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.
- B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."
- C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.
  1. Isolate ceiling assemblies where they abut or are penetrated by building structure.
  2. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.
    - a. Use deflection track where indicated.
    - b. Use firestop track where indicated.
- D. Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.

### 3.4 INSTALLING STEEL SUSPENDED CEILING AND SOFFIT FRAMING

- A. Suspend ceiling hangers from building structure as follows:
  1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
  3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
  4. Secure hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  5. Do not attach hangers to steel deck tabs.
  6. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  7. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- B. Installation Tolerances: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member and transversely between parallel members.
- C. Sway-brace suspended steel framing.
- D. For exterior soffits, install cross bracing and framing to resist wind uplift.

- E. Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

### 3.5 INSTALLING STEEL PARTITION AND SOFFIT FRAMING

- A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.
  - 1. Where studs are installed directly against exterior walls, install foam-gasket isolation strip between studs and wall.
- B. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
  - 1. For fire-resistance-rated and STC-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
- C. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.
- D. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
  - 1. Install two studs at each jamb, unless otherwise indicated.
  - 2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint.
  - 3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
- E. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- F. Z-Furring Members:
  - 1. Erect insulation vertically and hold in place with Z-furring members spaced 24 inches (610 mm) o.c.
  - 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (600 mm) o.c.
  - 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (300 mm) from corner and cut insulation to fit.
  - 4. Until gypsum board is installed, hold insulation in place with 10-inch (250-mm) staples fabricated from 0.0625-inch (1.59-mm) diameter, tie wire and inserted through slot in web of member.

### 3.6 APPLYING AND FINISHING PANELS, GENERAL

- A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.

- B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.
- C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- D. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- G. Attach gypsum panels to framing provided at openings and cutouts.
- H. Form control and expansion joints with space between edges of adjoining gypsum panels.
- I. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
  - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
  - 2. Fit gypsum panels around ducts, pipes, and conduits.
  - 3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch (6.4- to 9.5-mm) wide joints to install sealant.
- J. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch (6.4- to 12.7-mm) wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- K. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.
- L. Space fasteners in panels that are tile substrates a maximum of 8 inches (200 mm) o.c.

### 3.7 PANEL APPLICATION METHODS

#### A. Single-Layer Application:

- 1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
- 2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
  - a. Stagger abutting end joints not less than one framing member in alternate courses of board.
  - b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
- 3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

- B. Multilayer Application on Partitions/Walls: Apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
  - 1. Z-Furring Members: Apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
- C. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- D. Multilayer Fastening Methods: Fasten base layers and face layers separately to supports with screws.
- E. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

### 3.8 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints at locations indicated on Drawings. If not indicated, as a minimum install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

### 3.9 FINISHING GYPSUM BOARD ASSEMBLIES

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
  - 1. Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
  - 2. Level 2: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where panels are substrate for tile and where indicated.
  - 3. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at surfaces to receive light-textured finishes, wallcoverings and flat paints over light textures.
  - 4. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at surfaces to receive gloss and semi-gloss finishes, nontextured flat paints and where indicated.
  - 5. Level 5: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges, and apply skim coat of joint compound over entire surface for gypsum board ceilings to receive paint. Produce surfaces free of tool marks and ridges ready for decoration of type indicated.

## 3.10 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, Architect will conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
1. Notify Architect seven days in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.
  2. Before notifying Architect, complete the following in areas to receive gypsum board ceilings:
    - a. Installation of 80 percent of lighting fixtures, powered for operation.
    - b. Installation of ceiling support framing.

END OF SECTION 09 29 00

---

## SECTION 21 10 00 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following fire-suppression piping inside the building:
  - 1. Automatic Wet-pipe sprinkler systems.
- B. Related Sections include the following:
  - 1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.

#### 1.3 DEFINITIONS

- A. CPVC: Chlorinated polyvinyl chloride plastic.
- B. CR: Chlorosulfonated polyethylene synthetic rubber.
- C. High-Pressure Piping System: Fire-suppression piping system designed to operate at working pressure higher than standard 175 psig.
- D. PE: Polyethylene plastic.
- E. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.
- B. High-Pressure Piping System Component Working Pressure: Listed for 250 psig minimum.
- C. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.
  - 1. Margin of Safety for Available Water Flow and Pressure: 10 - 20 percent, including losses through water-service piping, valves, and backflow preventers.
  - 2. Sprinkler Occupancy Hazard Classifications:
    - a. Building Service Areas: Ordinary Hazard, Group 1.
    - b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
    - c. General Storage Areas: Ordinary Hazard, Group 1.



- d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
  - e. Office and Public Areas: Light Hazard.
  - f. Plastics Processing Areas: Extra Hazard, Group 2.
3. Minimum Density for Automatic-Sprinkler Piping Design:
- a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
  - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
  - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
  - d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
  - e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
  - f. Special Occupancy Hazard: As determined by authorities having jurisdiction.
4. Maximum Protection Area per Sprinkler: Per UL listing.
5. Maximum Protection Area per Sprinkler:
- a. Office Spaces: 225 sq. ft.
  - b. Storage Areas: 130 sq. ft.
  - c. Mechanical Equipment Rooms: 130 sq. ft.
  - d. Electrical Equipment Rooms: 130 sq. ft.
  - e. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.
6. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:
- a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
  - b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
  - c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes.
- D. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to State Building Codes NFPA 13 and [ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."].

## 1.5 SUBMITTALS

- A. Product Data: For the following:
1. Piping materials, including dielectric fittings, flexible connections, and sprinkler specialty fittings.
  2. Pipe hangers and supports, including seismic restraints.
  3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
  4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Fire-hydrant flow test report.
- D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.

- E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13, NFPA 14 and NFPA 25. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- F. Welding certificates.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
  - 1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
    - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
  - 1. NFPA 13, "Installation of Sprinkler Systems."
  - 2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."
  - 3. NFPA 25 "Standard For The Inspection, Testing And Maintenance Of Water – Based Fire Protection Systems".

## 1.7 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

## 1.8 RECORD DRAWINGS

- A. The contractor shall keep daily updated accurate records of all deviations in work as actually installed from work indicated on the contract drawings. Each Contractor shall record clearly, neatly, accurately, and promptly as work progresses the following data:
  - 1. Changes made resulting from change orders or instructions or sketches issued by the A/E.
  - 2. Changes in routing made to avoid conflict with other trades or structural conditions.
  - 3. Final location of equipment and panels if different than contract documents.
- B. The record drawings shall be kept at the job site, available to the owner at all times and labeled as "Project Record Information – Job Set". When work is completed, one complete

set of marked-up original prints, updated CADD drawings with all changes listed above and a CD with CADD files shall be delivered to the A/E for approval.

- C. All CADD files requested by the Contractor will be given to the contractor at a cost of \$200.00 per drawing/sheet.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

### 2.2 STEEL PIPE AND FITTINGS

- A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed threaded ends.
  - 1. Cast-Iron Threaded Flanges: ASME B16.1.
  - 2. Malleable-Iron Threaded Fittings: ASME B16.3.
- B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.
  - 1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
    - a. Manufacturers:
      - 1) Anvil International, Inc.
      - 2) Tyco Fire Suppression & Building Products
      - 3) Victaulic Co. of America.
      - 4) The Viking Corporation
      - 5) Ward Manufacturing.
      - 6) (Approved Equal)
- C. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.
  - 1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
  - 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- D. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, [hot-dip galvanized where indicated and] with [factory- or field-formed, square-cut] [factory- or field-formed, square-cut- or roll] [factory- or field-formed, roll]-grooved ends.
  - 1. Grooved-Joint Piping Systems:

- a. Manufacturers:
    - 1) Anvil International, Inc.
    - 2) Tyco Fire Suppression & Building Products
    - 3) Victaulic Co. of America.
    - 4) The Viking Corporation
    - 5) Ward Manufacturing.
    - 6) (Approved Equal)
  - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
  - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- E. Threaded-End, Schedule 40 Steel Pipe: ASTM A 135 or ASTM A 795 or ASTM A 795 and ASME B36.10M, Schedule 40 wrought-steel pipe; hot-dip galvanized where indicated and with factory- or field-threaded ends.
- 1. Cast-Iron Threaded Flanges: ASME B16.1.
  - 2. Malleable-Iron Threaded Fittings: ASME B16.3.
- F. Plain-End, Schedule 40 Steel Pipe: ASTM A 135 or ASTM A 795; or ASTM A 795 and ASME B36.10M, Schedule 30 wrought-steel pipe hot-dip galvanized where indicated.
- 1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
    - a. Manufacturers:
      - 1) Anvil International, Inc.
      - 2) Tyco Fire Suppression & Building Products
      - 3) Victaulic Co. of America.
      - 4) The Viking Corporation
      - 5) Ward Manufacturing.
      - 6) (Approved Equal)
- G. Plain-End, Schedule 40 Steel Pipe: ASTM A 135 or ASTM A 795, or ASTM A 795 and ASME B36.10M, Schedule 40 wrought-steel pipe hot-dip galvanized where indicated.
- 1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
  - 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- H. Grooved-End, Schedule 40 Steel Pipe: ASTM A 135 or ASTM A 795, or ASTM A 795 and ASME B36.10M, Schedule 40 wrought-steel pipe hot-dip galvanized where indicated; with factory- or field-formed, roll-grooved ends.
- 1. Grooved-Joint Piping Systems:
    - a. Manufacturers:
      - 1) Anvil International, Inc.
      - 2) Tyco Fire Suppression & Building Products
      - 3) Victaulic Co. of America.
      - 4) The Viking Corporation

- 5) Ward Manufacturing.
  - 6) (Approved Equal)
  - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
  - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- I. Threaded-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10, and with factory- or field-formed threaded ends.
- 1. Cast-Iron Threaded Flanges: ASME B16.1.
  - 2. Malleable-Iron Threaded Fittings: ASME B16.3.
- J. Plain-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10.
- 1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
    - a. Manufacturers:
      - 1) Anvil International, Inc.
      - 2) Tyco Fire Suppression & Building Products
      - 3) Victaulic Co. of America.
      - 4) The Viking Corporation
      - 5) Ward Manufacturing.
      - 6) (Approved Equal)
- K. Plain-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10.
- 1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
  - 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- L. Grooved-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10, and with factory- or field-formed, roll-grooved ends.
- 1. Grooved-Joint Piping Systems:
    - a. Manufacturers:
      - 1) Anvil International, Inc.
      - 2) Tyco Fire Suppression & Building Products
      - 3) Victaulic Co. of America.
      - 4) The Viking Corporation
      - 5) Ward Manufacturing.
      - 6) (Approved Equal)
    - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.

- c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
  - M. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 2 ½” and greater; and NFPA 13-specified wall thickness in NPS 6 to NPS 10.
    - 1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
      - a. Manufacturers:
        - 1) Anvil International, Inc.
        - 2) Tyco Fire Suppression & Building Products
        - 3) Victaulic Co. of America.
        - 4) The Viking Corporation
        - 5) Ward Manufacturing.
        - 6) (Approved Equal)
  - N. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 2 ½” and greater; and NFPA 13 specified wall thickness in NPS 6 to NPS 10.
    - 1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
    - 2. Steel Flanges and Flanged Fittings: ASME B16.5.
  - O. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 2 ½” and greater;; with factory- or field-formed, roll-grooved ends.
    - 1. Grooved-Joint Piping Systems:
      - a. Manufacturers:
        - 1) Anvil International, Inc.
        - 2) Tyco Fire Suppression & Building Products
        - 3) Victaulic Co. of America.
        - 4) The Viking Corporation
        - 5) Ward Manufacturing.
        - 6) (Approved Equal)
      - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
      - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- 2.3 DIELECTRIC FITTINGS
- A. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.
  - B. Dielectric Unions: Factory-fabricated assembly, designed for 250-psig minimum working pressure at 180 deg F. Include insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.

1. Manufacturers:
  - a. Epco Sales, Inc.
  - b. Hart Industries International, Inc.
  - c. Watts Industries, Inc.; Water Products Div.
  - d. Zurn Industries, Inc.; Wilkins Div.
  - e. (Approved Equal)
  
- C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 175-psig minimum working-pressure rating as required for piping system.
  1. Manufacturers:
    - a. Epco Sales, Inc.
    - b. Watts Industries, Inc.; Water Products Div.
    - c. (Approved Equal)
  
- D. Dielectric Flange Insulation Kits: Components for field assembly shall include CR or phenolic gasket, PE or phenolic bolt sleeves, phenolic washers, and steel backing washers.
  1. Manufacturers:
    - a. Advance Products and Systems, Inc.
    - b. Calpico, Inc.
    - c. Pipeline Seal and Insulator, Inc.
    - d. (Approved Equal)
  
- E. Dielectric Couplings: Galvanized steel with inert and noncorrosive thermoplastic lining and threaded ends and 300-psig working-pressure rating at 225 deg F.
  1. Manufacturers:
    - a. Calpico, Inc.
    - b. Lochinvar Corp.
    - c. (Approved Equal)
  
- F. Dielectric Nipples: Electroplated steel with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved ends and 300-psig working-pressure rating at 225 deg F.
  1. Manufacturers:
    - a. Perfection Corporation.
    - b. Precision Plumbing Products, Inc.
    - c. Victaulic Co. of America.
    - d. (Approved Equal)
  
- 2.4 SPRINKLER SPECIALTY FITTINGS
  - A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum working-pressure rating if fittings are components of high-pressure piping system.
  - B. Outlet Specialty Fittings:

1. Manufacturers:
    - a. Anvil International, Inc.
    - b. Tyco Fire Suppression & Building Products
    - c. Victaulic Co. of America.
    - d. The Viking Corporation
    - e. Ward Manufacturing.
    - f. (Approved Equal)
  2. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.
  3. Snap-On and Strapless Outlet Fittings: UL 213, ductile-iron housing or casting with gasket and threaded outlet.
- C. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
1. Manufacturers:
    - a. AGF Manufacturing Co.
    - b. Tyco Fire Suppression & Building Products
    - c. Victaulic Co. of America.
    - d. The Viking Corporation
    - e. (Approved Equal)
- D. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.
1. Manufacturers:
    - a. Tyco Fire Suppression & Building Products
    - b. Victaulic Co. of America
    - c. (Approved Equal)

## 2.5 SPRINKLERS

- A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have 250-psig minimum pressure rating if sprinklers are components of high-pressure piping system.
- B. Manufacturers:
  1. Reliable Automatic Sprinkler Co., Inc.
  2. Tyco Fire Suppression & Building Products
  3. Victaulic Co. of America.
  4. Viking Corp.
  5. (Approved Equal)
- C. Automatic Sprinklers: Quick (fast) Response With heat-responsive glass bulb element complying with the following:
  1. UL 199, for nonresidential applications.
  2. UL 1626, for residential applications.
  3. UL 1767, for early-suppression, fast-response applications.
- D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.



1. Open Sprinklers: UL 199, without heat-responsive element.
  - a. Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
  - b. Orifice: 17/32 inch, with discharge coefficient K between 7.4 and 8.2.
  
- E. Sprinkler types, features, and options as follows:
  1. Institution sprinklers, made with a small, breakaway projection.
  2. Pendent sprinklers.
  3. Quick-response sprinklers.
  4. Recessed sprinklers, including escutcheon.
  5. Sidewall, dry-type sprinklers.
  6. Upright sprinklers.
  
- F. Sprinkler Finishes: Chrome plated, bronze, and painted. (Coordinate colors with Architect).
  
- G. Special Coatings: Wax, lead, and corrosion-resistant paint.
  
- H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
  1. Ceiling Mounting: Chrome-plated steel, one piece, flat Plastic, white finish, one piece, flat.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13, and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.
- B. Report test results promptly and in writing.

#### 3.2 EXAMINATION

- A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.3 PIPING APPLICATIONS, GENERAL

- A. Shop weld pipe joints where welded piping is indicated.
- B. Do not use welded joints for galvanized-steel pipe.

- C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

### 3.4 SPRINKLER SYSTEM PIPING APPLICATIONS

- A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:
  - 1. NPS 1-1/2 and Smaller: Threaded-end, black, Schedule 40 steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
  - 2. NPS 1-1/2 and Smaller: Plain-end, black, Schedule 40 steel pipe; locking-lug fittings; and twist-locked joints.
  - 3. NPS 1-1/2 and Smaller: Plain-end, black, Schedule 40 steel pipe; steel welding fittings; and welded joints.
  - 4. NPS 1-1/2 and Smaller: Plain-end, Type L, hard copper tube; wrought-copper fittings; and brazed joints.
  - 5. NPS 1-1/2 and Smaller: SDR 13.5, CPVC pipe; Schedule 40, CPVC fittings; and solvent-cemented joints.
  - 6. NPS 2: Threaded-end, black, Schedule 40 steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
  - 7. NPS 2-1/2 to NPS 3-1/2: Plain-end, black, Schedule 10 steel pipe; steel welding fittings; and welded joints.
  - 8. NPS 2-1/2 to NPS 3-1/2: Grooved-end, black, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

### 3.5 JOINT CONSTRUCTION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.
- B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 (DN 200) with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.
- C. Mechanically Formed, Copper-Tube-Outlet Joints: Use UL-listed tool and procedure. Drill pilot hole in copper tube, form branch for collar, dimple tube to form seating stop, and braze branch tube into formed-collar outlet.
- D. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
  - 1. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.

### 3.6 PIPING INSTALLATION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.

- B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
  - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
- E. Install sprinkler piping with drains for complete system drainage.
- F. Hangers and Supports: Comply with NFPA 13 for hanger materials.
  - 1. Install standpipe system piping according to NFPA 14.
  - 2. Install sprinkler system piping according to NFPA 13.
- G. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.
- H. Fill wet-pipe sprinkler system piping with water.

### 3.7 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

### 3.8 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 3. Energize circuits to electrical equipment and devices.
  - 4. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
  - 5. Coordinate with fire alarm tests. Operate as required.
  - 6. Verify that equipment hose threads are same as local fire department equipment.
- B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

### 3.9 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.
- C. Protect sprinklers from damage until Substantial Completion.

END OF SECTION 21 10 00

## SECTION 22 22 22 - INTERIOR PLUMBING SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

##### A. SECTION INCLUDES

- 1. Sanitary, waste and vent piping
  - 2. All cold water, hot water and hot water return piping
  - 3. Final connections to all fixtures and equipment
  - 4. Plumbing fixtures
  - 5. Insulation
- B. Other items in the work covered in other sections of the specifications, as shown and specified herein.
  - C. Examine all sections of specification for requirements affecting the work of this section.
  - D. Provide all manufactured items and equipment in accordance with manufacturer's recommendations. Provide all necessary specialties and accessories, including anchors and supports.
  - E. Include in the bid price all utility company and municipal back charges for all materials furnished and work performed by them in conjunction with this contract..

#### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms
- C. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- D. The following are industry abbreviations for plastic materials:
  - 1. PVC: Polyvinyl chloride plastic
- E. The following are industry abbreviations for rubber materials:
  - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
  - 2. NBR: Acrylonitrile-butadiene rubber.

- F. "Furnish and install" and "Provide" means to supply, erect, install and connect in readiness for regular operation, the particular work referred to, unless otherwise specified.
- G. "Underground" shall mean pipe, conduit or equipment that is buried exterior to or within the building.
- H. "Finished grade" as used herein, means the final grade elevations indicated on the drawings.
- I. Piping shall mean and include pipe, fittings, hangers, and valves.
- J. Tempered water shall be considered the same as hot water throughout the specifications.
- K. The term "capped flush" on existing piping means cap existing lines, concealed, beyond finish wall, ceiling or floor line, so proper finish can be applied.

#### 1.4 SHUTDOWNS

- A. Coordinate all phases of the work with Owner and do all work with the least inconvenience to the Owner.
- B. Coordinate all shutdowns with Owner and do all work, etc., under Owner's approved schedule.
- C. Coordinate all shutdowns with Owner and do all work, etc., under Owner's approved schedule, including requirements for overtime.

#### 1.5 EXISTING CONDITIONS

- A. Bidders are advised to visit the site and inform themselves as to conditions under which this work will be performed prior to submitting prices. Failure to do so, will, in no way relieve the successful bidder from the responsibility of furnishing any materials or performing any work in accordance with the true intent and meaning of the drawings and specifications..
- B. No claim for extra compensation will be recognized if difficulties are encountered which an examination of the site conditions and contract documents prior to executing the contract would have revealed.
- C. This Contractor shall be responsible for ordering and furnishing the correct quantity of material required. Routing and equipment arrangements shown on the drawings are approximate only and are not warranted to be accurate.
- D. Arrangements shall be made with the Owner prior to the visit for inspection of the existing buildings.
- E. Field verify all inverts, sizes, locations, etc. at each location, prior to starting work.
- F. Do not reuse piping, unless otherwise noted.
- G. Remove and dispose of all plumbing fixtures, lab, kitchen equipment, piping (sanitary, storm, gas, water), etc. Cap all lines in existing walls, floors, or ceilings not to be removed, flush with floors, walls, or ceilings as specified.
- H. Provide temporary lines required during construction to keep existing system(s) in proper

working order all at no additional cost.

- I. Disconnect and reconnect at new locations all equipment that is to be relocated and provide all necessary valves, fittings, regulators, reducers, etc., as required.
- J. Correct and repair any damage to fixtures and piping at no additional cost.
- K. Remove and dispose of piping in way of new construction. Cap or plug, as required.
- L. Relocate piping, to remain, in way of new construction at no additional cost.
- M. Test all water lines being reused and repair all leaks that develop at no additional cost.

#### 1.6 EXISTING STORM DRAINAGE SYSTEM

- A. All roof drain leaders, underground and areaways are to remain. Locate all risers and underground piping on as-built drawings.

#### 1.7 RELATED SECTIONS

- A. Cutting and patching - Division 1.
- B. Coring of holes in concrete - Division 1.
- C. Excavation, including backfill and resurfacing - Division 2.
- D. Concrete work - Division 3.
- E. Flashings and counterflashing - Division 7.
- F. Access panels - Division 8.
- G. Field painting of piping, hangers, etc. - Division 9.
- H. Toilet accessories - Division 10.
- I. Electrical connections - Division 22.

#### 1.8 CODES, ORDINANCES AND PERMITS

- A. All work performed under this section of the specifications shall be done in accordance with the applicable National, State and local codes, laws and ordinances and State Fuel Gas and Plumbing Codes.
- B. All materials and work provided shall be in accordance with, but not limited to, the following:
  - 1. American National Standards Institute (ANSI).
  - 2. American Society for Testing and Materials (ASTM)
  - 3. Building Officials and Code Administrators (BOCA)
  - 4. National and State Electrical Code (NEC)
  - 5. National Electrical Manufacturer's Association (NEMA)
  - 6. National Fire Protection Association Codes and Standards (NFPA)

7. Occupational Safety and Health Act (OSHA)
8. State Building Code
9. Standards of Underwriters Laboratories (UL)

- C. Where code references are given, the latest issue of that code in effect at the time of bidding shall be used. Code references given to indicate the minimum quality and performance acceptable. Where specifications and/or drawings indicate more stringent requirements, the specification shall govern.
- D. Permits: Be responsible for filing all documents, payment of all fees and securing of all inspections and approvals necessary for the installation and operation of all systems furnished under this section.

#### 1.9 PROTECTION

- A. Protect materials, fixtures and fittings. Temporarily close all pipe openings to prevent obstruction and damage. Board over, water closets, lavatories and sinks and protect other fixtures with pasted-on paper.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- C. Post notices prohibiting the use of the fixtures prior to completion.

#### 1.10 CUTTING AND FITTING

- A. Do the cutting and fitting necessary for the installation of the plumbing work and maintain fire integrity of floor to floor construction.
- B. Take care to prevent injury, discoloration or defacement of other finish materials; and do no cutting or fitting of finish material.

#### 1.11 STARTERS AND MOTOR CONTROLS

- A. Provide a starter and the specified motor controls with each motor furnished.
- B. Size each starter to have a capacity rating within the required limits of the motor which it serves, and furnish it with overload elements selected to provide overload relays, one in each phase.
- C. Unless otherwise indicated, furnish starters mounted indoors with NEMA Type 1 enclosures; and furnish those exposed to the weather with NEMA Type 3R enclosures.
- D. Starter and control devices: Equal to Square D, Allen Bradley or Furnas.
- E. Electrical Characteristics

In general, and unless specifically indicated otherwise in the specifications of noted on the drawings, all building service, fire protection and miscellaneous equipment shall be of the following characteristics:

1. Motors up to and including 1/3 HP shall be suitable for 120 volt, on phase operation.
2. Motors larger than 1/3 HP shall be suitable for 480 volt, three phase operation.

1.12 CLEANING

- A. Upon completion of the installation, clean and remove all oil and debris. Clean and polish and leave bright all fixtures and metal work intended to be exposed. Clean out the piping systems and all fixtures, traps and cleanouts. Leave all work in perfect operating condition.
- B. Should any pipe, duct or any part of the apparatus be stopped by refuse after the apparatus has been accepted, pay for the disconnecting, cleaning and reconnection, wherever necessary, for the purpose of location and removing the obstruction. Pay for repairs to adjoining work required thereby.

1.13 DRAWINGS

- A. The drawings are diagrammatic, and not intended to show every detail of construction or arbitrary location of piping. Where building construction makes it advisable or necessary to change location of piping or fixtures, without increasing the scope of work, perform such work without additional cost, on written order or consent of the Engineer.
- B. Install the work as shown. In case of conflict with building parts, or the work of other trades, immediately request a decision be rendered so that there may be no delay in the building construction.
- C. Submit for written approval, single line diagrams of any proposed changes or modification to the drawings, at least one week before prices are due.

1.14 QUALITY ASSURANCE

- A. Submit catalog cuts and brochures for approval of all proposed materials.
- B. Where items of equipment and/or materials are specified or materials are specified or identified herein by manufacturer's names, model or catalog numbers, only such specified items may be used.
- C. Submit, in booklet form, all plumbing fixtures and related accessories for any fixtures and/or equipment different than the manufacturers listed. Submit catalog cuts of both manufacturers.
- D. Submit complete maintenance and operational charts and manuals for all equipment and fixtures specified, indicated or required for this work.
- E. On completion of the work, attach 1-1/2" diameter brass or embossed plastic as manufactured by Seton Nameplate Company consecutively numbered tags to all valves, also furnish two (2) typewritten charts (framed and glazed) showing all valve numbers with their location and riser controls. Identify all equipment with laminated plastic (lamicoid) nameplates fastened to the equipment as approved. These numbered valves to be shown on As-Built Drawings.
- F. Keep on file, at job site, a clean set of prints to clearly and accurately note all changes, wherever work is installed other than shown. After completion of work, provide a correct set of mylars (3 mil) for "As-Built Drawings".
- G. All CADD files requested by the contractor will be given to the contractor at a cost of \$200.00 per sheet.



#### 1.15 ACCESSIBILITY

- A. Be responsible for sufficiency of shafts and chases, with adequate clearances for the proper installation of the work. Cooperate with all other contractors, whose work is in the same space, and advise the Contractor of all requirements. Keep such spaces and clearances to the minimum size required.
- B. Locate all equipment, which must be operated, serviced or maintained, in fully accessible locations. Equipment includes, but is not limited to: valves, traps, cleanouts and drain points. If required for better accessibility, provide access doors. Make minor deviations to allow for better accessibility, however, review such changes with the Architect/Engineer.

#### 1.16 COORDINATION

- A. Arrange for pipe spaces, chases, slots and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

#### 1.17 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

- A. Refer to General Conditions (and Supplementary Conditions), Shop Drawings, Product Data and Samples and add the following:
  - 1. Within thirty (30) days after the date of notice to proceed and before purchasing any materials or equipment, submit to the Architect for review, a complete list, in six (6) copies, of all materials to be incorporated in the work. This listing shall be arranged by the order of occurrence in the specifications, followed by the items on the drawings not specifically included in the specifications.
  - 2. After the list has been processed by the Architect, submit complete shop drawings and product data of all equipment. These submittals shall be submitted within thirty (30) days after the processing date of the original submittal list.
  - 3. All submittals shall be complete and shall be in three-ring loose-leaf binders. No consideration will be given to partial submittals, except with prior approval of the Architect. Each item shall have a cover page stating project, specification and paragraph reference number, of drawing reference number, and scheduled equipment identification number, if applicable.
  - 4. The review of submittals does not relieve this Contractor from the responsibility of shop drawing errors in details, sizes, quantities, wiring diagram arrangements and dimensions which deviate from the specifications, contract drawings, and/or job conditions as they exist.
  - 5. Changes to work already performed made necessary by delays in shop drawing review are the responsibility of this Contractor.
  - 6. Copies of equipment and system guarantees shall be submitted with shop drawing package.
- B. Refer to General Conditions (and Supplementary Conditions) for substitution of equipment.
- C. If apparatus or materials are substituted for those specified under this section, and such

substitutions necessitate changes in or additional connects, supports or construction, same shall be provided at no additional cost to the Owner. This Contractor shall assume cost and entire responsibility thereof. Architect's permission to make such substitution shall not relieve this Contractor from full responsibility for work.

#### 1.18 RECORD DRAWING

- A. The General Contractor shall provide two (2) sets of blackline on white record drawings to this Contractor, one set of which shall be maintained at the site and one set of which shall, at all times, be accurate, clear and complete, showing the actual location of all equipment and piping. The record drawings shall be available to the Architect's/Engineer's field representative at all times.
- B. Any addenda sketches, supplementary drawings and change orders issued during the course of construction shall be transferred to the record drawings.
- C. At the completion of this contract, this Contractor shall submit through the General Contractor an accurate checked set of record drawings.
- D. Non-availability of record drawings or inaccuracies therein shall postpone the final inspection until they are available.
- E. After approval of these record drawings, photo reproductions of the original tracings shall be revised to incorporate all the changes on the record drawings. These photo reproductions shall be certified by this Contractor as correct and delivered to the Architect together with two (2) sets of blackline prints.
- F. All costs related to the foregoing requirements shall be paid for this Contractor.
- G. All valves shown on these drawings shall be numbered with numbers corresponding to those on the valve charts.

#### 1.19 USE OF ELECTRONIC DRAWING FILES

- A. If requested, the Engineer will provide electronic copies of selected CAD (Computer Aided Design) drawing files for the Contractor's use in the preparation of shop drawings, coordination drawings, or as-built drawings related to his project, subject to the terms and conditions in the following paragraphs.
- B. The Engineer's electronic files are prepared on AutoCad. The Engineer will provide drawing files through Release 2004.
- C. Data contained on these electronic files is part of the Engineer's instruments of service and shall not be used by the Contractor or anyone else receiving this data through or from the Contractor for any purpose other than as a convenience in the preparation of shop drawings, coordination drawings, or as-built drawings for the referenced project. Any other use or reuse by the Contractor or by others will be at the Contractor's sole risk and without liability or legal exposure to the Engineer. In accepting these files, the Contractor shall agree to make no claim and shall waive, to the fullest extent permitted by law, any claim or cause of action of any nature against the Engineer, its officers, directors, employees, agents of the Engineer, which may arise out of or in connection with the Contractor's use of the electronic files.
- D. Furthermore, the Contractor shall to the fullest extent permitted by law, indemnify and hold

harmless the Engineer from all claims, damages, losses and expenses, including attorney's fees arising out of or resulting from the Contractor's use of these electronic files.

- E. These electronic files are not contract documents. Significant differences may exist between these electronic files and corresponding hard copy contract documents due to software incompatibility, software translation, addenda, change orders or other revisions. The engineer makes no representation regarding the accuracy or completeness of these electronic files. In the event that a conflict arises between the hard copy contract documents prepared by the Engineer and the electronic files, the hard copy contract documents shall govern. The Contractor is responsible for determining if any conflict exists.

By use of these electronic files, the Contractor is not relieved of his duty to fully comply with the contract documents, including and without limitation, the need to check, confirm and coordinate all work with that of other contractors for the project.

- F. Because of the potential that the information presented on the electronic files can be modified, unintentionally or otherwise, the Engineer reserves the right to remove all indication of their respective ownership and/or involvement from each electronic file provided.
- G. A service fee of \$200.00 per sheet shall be remitted directly to the Engineer prior to delivery of the electronic files. Arrangements shall be made directly with the Engineer for files prepared by them. Electronic files will not be released until payment is received. A written release to be prepared by the Engineer will be required as well.
- H. Under no circumstances shall delivery of the electronic files for use by the Contractor be deemed a sale by the Engineer, who make no warranties, either expressed or implied, of merchantability and fitness for any particular purpose. In no event shall the Engineer or its consultant (s) be liable for any loss of profit or any consequential damages arising out of the use of these electronic files.

## 1.20 WARRANTY

- A. Refer to General Conditions and add the following:
  - 1. Standard equipment guarantees offered by the manufacturer for on (1) year or greater shall be in addition to that as required by this contract.
  - 2. Copy of manufacturer's equipment guarantees shall be submitted with this Contractor's written guarantee.

## PART 2 - PRODUCTS

### 2.1 SOIL, WASTE, AND VENT PIPING:

- A. Underground Piping: (unless otherwise indicated)
  - 1. Extra heavy cast iron bell and spigot pipe (tar coated).
  - 2. Service weight cast iron bell and spigot pipe (tar coated).
  - 3. All cast iron soil pipe and fittings is to conform to the latest CISPI Standards 301, CISPI 310, ASTM A 888, ASTM C 564 or ASTM A 74 Standards
  - 4. Solid plastic piping, PVC Schedule 40 DWV, (FHA UM-79a) buried in sand 6" minimum around pipe. (Sand around pipe is to be provided under Division 2;

coordinate such installation.)

B. Aboveground Piping: (unless otherwise indicated)

1. No-hub cast iron soil pipe, with Husky SD Series 4000 couplings, or Mission Heavyweight (HW), 4-band couplings; with anchors and restraints as per CISPI requirements.
2. Solid plastic piping, PVC Schedule 40 DWV, (FHA UM-79a).
3. Galvanized steel piping (Schedule 40) with galvanized drainage fittings.
4. Type M or L copper (with copper DWV sweat fittings).
5. Provide cast iron waste and vent pipe 2" and larger.
6. Waste and vent piping 1-1/2 inch and smaller:
  - a. Galvanized with galvanized drainage fittings.
  - b. Type L or M copper with sweat DWV fittings.
  - c. Solid plastic piping, PVC DWV Schedule 40, (FHA UM-79a).
  - d. Solid plastic piping, PVC DWV Schedule 40, on horizontal branch lines only.
7. Do not use copper tubing for water closet or urinal waste and vent piping.
8. Provide chrome plating for all exposed piping to plumbing fixtures in toilet rooms, and finished rooms, etc., including chrome plated traps.
9. Chrome plate all exposed traps and water supplies, whether insulated or not, including piping covered with Trap-Wrap.
10. Kitchen areas and all other exposed areas shall be chrome plated copper with sweat fittings.
11. Vapor vent piping to be galvanized.

2.2 Cleanouts flush with grade, bronze; equal to Zurn ZN-1454-4, vandalproof.

2.3 SLEEVES, INSERTS AND ESCUTCHEONS

- A. For all openings required in concrete floors, concrete walls and masonry walls; install sleeves of proper size, when the forms are erected and before concrete is poured or masonry is set. Provide wrought iron and steel pipe sleeves for all sleeves through floors or walls, sizes as approved, and packed as required. Extend sleeves one inch above floor for exposed piping passing through the floor.
- B. Seal all sleeves, core holes, etc. through floors, walls and ceilings with Nelson "Flame-Seal" Fire Stop Putty, 3-M Systems, Hilti Systems, or Metacaulk Fire stopping. Install in accordance with manufacturer's printed instructions.
- C. Fire stopping is to meet UL ratings for each penetration type and material for floors, walls and ceilings. Coordinate with Architectural Drawings for exact requirements and hourly ratings at various conditions.
- D. Provide catalog cuts, in a three ring binder, of various systems, materials, etc. to be used.
- E. Fit all exposed uncovered pipes passing through walls, in cabinets, floors and ceilings with chromium plated spun or split type escutcheons with clamping device for holding in position.
- F. Typical for all piping.

## 2.4 HANGERS AND ANCHORS

- A. Support all piping from the building structure by means of approved hangers and cast iron concrete inserts or lag bolts. Support piping to maintain required grading and pitching of lines, to prevent vibration and to secure piping in place, and arrange so as to provide for expansion and contraction. Provide approved anchors.
- B. Provide all soil, waste, vent stacks and other pipe risers with friction clamp at each floor level and where required.
- C. Provide clevis ring type hangers for piping with adjustable device, and machine threaded hanger rods. Provide copperized hangers for water piping. Size of rods shall follow schedule in NFPA Bulletin No. 13.
- D. Provide hangers with double nuts.
  - 1. Submit physical samples for approval.
- E. All piping is to be supported from top chords of joists, only.
- F. Provide insulation protection shields: galvanized 20 gauge by 10" long for all insulated piping where hanger is installed outside the insulation sized to suit pipe size and insulation thickness.
- G. "A" band is acceptable upon approval by Architect/Owner & Engineer.
- H. For plastic piping, tape all metal hangers, clamps, etc., prior to attachment (for plastic protection).
  - 1. Option: Provide plastic coated hangers.
- I. Provide supports at midpoint between floors for PVC piping. Submit detail.
- J. Provide Grinnell expansion case concrete fasteners #117 for piping 3" and over where drilling of concrete is required. Submit expansion fasteners.

## 2.5 ABOVEGROUND WATER PIPING

- A. Install all piping in accordance with manufacturer's published recommendations and requirements and governing water department.
- B. Provide fittings, bends, offsets, flanges, etc. of approved pattern. Make branch connections from hot water risers to fixtures with appropriate joints to receive expansion stresses.
- C. Provide pressure gauges (0-200#) Ashcroft 3-1/2" dial or approved equal with individual shut-off valves, with gauge savers.
- D. Provide Type L for all domestic water piping; cold, hot and hot water returns.
- E. Use SilvaBrite 100 Lead-Free solder on cold water and hot water piping. Provide non-corrosive, lead-free type flux.
- F. Provide pipe manufactured by Cerro, Anaconda, and United Wire; with streamlined sweat fittings at each change in direction.

1. No bent tubing will be accepted.
- G. Install air chambers at the ends of all branches and where required to eliminate hammering. Pay all expenses required to eliminate hammering after occupancy. Air chambers shall be at least 20 times the diameter of pipe. Terminate all water risers with air chambers.
1. Coordinate with drawings and this section for additional locations of water hammer arrestors.
- 2.6 WATER HAMMER ARRESTORS
- A. Provide Zurn Shoktrol #Z-1700, stainless steel, J.R. Smith or Watts #15; with adaptors, sizes as required to suit manufacturer's recommendations, PDI and ASSE Standards and job conditions. Submit drawings with detailed locations and types to be used.
  - B. Provide water hammer arrestors at all fixture batteries with more than three (3) fixtures, unless noted otherwise.
  - C. Provide stainless steel access panels at all water hammer arrestors, for ease of maintenance.
- 2.7 DIELECTRIC FITTINGS
- A. Provide approved dielectric fittings when changing from ferrous to non-ferrous piping, fittings, valves, etc.; as manufactured by Watts, 3000 Series.
  - B. Where copper or brass contact ferrous material, provide sheet lead wrapped around either to avoid electrolysis.
- 2.8 VALVES (By domestic manufacturer)
- A. Gate Valves - 1" to 3" size: Nibco Company, Figure S-113; Jenkins or Crane.
  - B. Check Valves: up to 3" size Nibco S-413-B (over 3", F-918-B) Jenkins or Watts.
  - C. Ball Valves:
    1. 1/2" to 2" - Watts No. B-6080, full port.
    2. 2-1/2" to 4" - Watts No. B-6000 Series.
    3. 1/2" to 2" - Watts No. B-6080-BS, full port Balancing Valve.
    4. Provide Latch Lock Handles on valves where valves are called for to be locked see drawings for locations at emergency fixtures. Valves are to be pad locked in the open position. Provide pad locks all keyed alike with 10 ( TEN ) keys.
    5. 1 1/2" - Watts No. CSM-61-M1, full port Balancing Valve or Nibco.
  - D. Provide holes drilled in valve handles for valve tags.
  - E. Drain Cocks: Watts B-6000-CC, with chain and cap, 1/2 inch draw-off type.
    1. Provide draw-offs at low points.
  - F. Valves are to be wired ( By Others ) to kill switch provided by Electrical Contractor.

- G. Provide stainless steel ball and stem in lieu of chrome plated brass ball.

## 2.9 INSULATION

- A. Cold Water: 1/2 inch fiberglass or approved equal, low pressure pipe insulation, fire retarded with Universal (white) vapor barrier finish. Provide material by Owens-Corning, Johns-Manville or Certainteed.
  - 1. Provide insulation on mains, risers, drops, branch mains only and all exposed piping.
- B. Hot Water and Hot Water Return: Insulation similar to cold water.
  - 1. Provide insulation on mains, risers, drops and branch mains.
  - 2. Provide 1/2" insulation on pipe size up to 1-1/2".
  - 3. Provide 1" thick insulation on hot water and hot water return piping only.
- C. Hot Water, Tempered Water and Hot Water Return: Insulation similar to cold water.
  - 1. Provide 1" thick insulation on hot water, tempered water and hot water return piping only.
- D. Fittings and Valve Insulation:
  - 1. Hydraulic setting combination insulating and finishing cement.
  - 2. Molded or fabricated fitting covers of equal thickness and identical in composition to adjacent pipe insulation.
    - a. Zeston Premolded Fittings.
  - 3. All materials, including vapor barrier jackets, glass cloth jackets, adhesives, etc. shall be fire-retardant.
- E. Insulate all water pipe, valves and fittings, etc.
- F. Insulation is not required on horizontal piping immediately behind fixtures in pipe chases (only).
- G. Reinstall existing pipe covering damaged, disturbed, or removed during the course of construction at no additional cost. Identically match existing insulation thickness.

## 2.10 ACCESS PANELS

- A. Provide Type "A" Milcor Style "K" or "M" access panels, Karp or Acudor; sizes as required to obtain access to concealed valves, water hammer arrestors, traps and cleanouts. Provide rated panels in rated walls. Provide stainless steel panels with vandal proof screws.
- B. Provide vandal-proof units in all areas.
- C. Coordinate installation of access panels with the work of Division 9.

## PART 3 – EXECUTION

3.1 SOIL, WASTE AND VENT PIPING PIPING:

- A. Install no-hub couplings in drainage and vent system in accordance with CISPI Standard 310 and all local requirements.
- B. Install PVC waste and vent piping in accordance with the latest published Manufacturers installation instructions and requirements.
- C. Provide all coated cast iron pipes (where buried) free from sand holes, cracks, or other defects of uniform weight, size and thickness, run concealed in finished partitions.
- D. Provide adequate waste from fixtures, evenly pitched and properly secured with adjustable iron hangers. Install all pipes as specified, below grade, and pitch at the rate of 1/4 inch per foot or as approved.
- E. Rubber joints will be acceptable.
- F. Extend all soil and waste pipes out full size through the roof or connected to a common vent above the fixtures as shown. Where vents are located within 10 feet of a fresh air intake, terminate at least 1'-0" above intake.
- G. Bends and Branches:
  - 1. Provide all necessary bends, branches, etc. Make all changes in direction, fixture connections, etc. with Y branches and 45 degree elbows; offsets on vertical lines at an angle not less than 45 degrees with the vertical, being at a less angle wherever practicable. Use long sweep bends at bottom of stacks. Use certain combination and revert fittings only upon approval, after a specific one or type is submitted for approval.
- H. Cleanouts:
  - 1. Provide with brass caps and screws, same size as pipe and screwed gas tight, where indicated and at the ends of all branches, and at each change in direction of horizontal building drain greater than 45 degrees, on soil and waste traps, and in such other portions where cleanouts are required. Provide cleanouts on drain lines at a maximum of 100 feet, unless otherwise indicated.
    - a. Where waste and roof drain stacks enter drains near walls or piers causing difficult access to end cleanouts, provide a horizontal cleanout on stack just above floor, with a long 1/4 inch sweep end at foot of stack. Where such conditions occur in walls or partitions, the cleanout cover shall be accessible through an opening left in wall and covered with a flush type access panel, or as indicated.
    - b. Install cleanouts flush with finished floors.
    - c. Grease and work all cleanouts for ease of maintenance.

3.2 TRAPS AND VENTS

- A. Separately trap every fixture, vent all traps.
- B. Install all trap screws (brass) below water line.
- C. Run the main stacks of back ventilation parallel and as close as possible to the soil pipe



stack, and connect to the vent continuation of soil stack at least 1'-0" above rim of the highest plumbing fixture on the stack. Make offsets in vent piping with 45 degree fittings where possible. Pitch horizontal vent lines toward a waste line.

- D. Group vents that are near one another to go through roof, as shown.

### 3.3 JOINTS

- A. Make all joints in cast iron pipe with picked oakum, packed tightly into the space between pipes to a depth of 1-1/2 inches, and the remaining space filled in by one pouring of molten lead, caulked in a manner which will insure tight joints without straining the bell. After caulking, make the lead practically flush with the ends of the bells.
- B. Rubber joints are also acceptable, except where otherwise noted, including hangers and sway braces; install in accordance with manufacturer's recommendations.
- C. Provide neoprene gasketing system, in lieu of lead caulk, conforming to ASTM C564, as an option. Provide gaskets marked for use with extra heavy soil pipe. Install all work in accord with manufacturer's recommendations, in addition to this specification. Provide extra bracing as required.
- D. Provide stainless steel couplings, Husky Series 4000 or Mission Heavyweight (HW), with neoprene gaskets for use with no-hub soil pipe. Install in accordance with manufacturer's recommendations including hangers and sway braces.
- E. Threaded Joints:
  - 1. American National taper screw threads, with graphite and oil compound applied to the male threads or Teflon tape.
  - 2. Provide Blue Magic for all gas piping and Select Whyte for all other piping; as manufactured by Whitlaw.
- F. Plastic Piping:
  - 1. Clean fittings and joints with solvent cleaner (purple primer) to receive PVC solvent weld (or cement) joint materials.
  - 2. Provide approved expansion joints and/or restraining fittings, on risers which pass thru two floor levels, at every other floor.
  - 3. Install in complete accordance with manufacturers recommendations. Do not allow masonry and/or concrete to be against PVC piping.
  - 4. Threading of P.V.C. piping is not allowed.
  - 5. Joint all PVC piping by socket type manoff adaptor fittings where connected to threaded fittings.
  - 6. Where connected to bell of cast iron soil appropriate spigot manoff connector socket type adaptor must be used with lead caulk joints.
  - 7. Where connected to no-hub cast iron soil pipe, use appropriate spigot manoff connector socket type adapter with no-hub couplings, Husky Series 400 or Mission Heavyweight (HW).

### 3.4 HANGERS AND ANCHORS:

- A. Horizontal Piping: Support the following materials at the following maximum distance intervals:

1. Cast Iron Soil Pipe: 5 feet.
  2. Threaded Pipe: 10 feet.
  3. Copper Tubing (1-1/2 inch or less): 6 feet.
  4. Copper Tubing (1-1/2 inch or over): 10 feet.
- B. Plastic (PVC) Pipe (1-1/2 inch or less): 3 feet. (2 inches or over - 4 feet).
- C. Vertical Piping: Support at every floor level, except support P.V.C. additionally at midpoints between floor levels.

### 3.5 DOMESTIC WATER PIPING

- A. Pay all charges incurred and obtain all necessary applications, permits and approvals.
- B. Do all work in accordance with and under the supervision of the municipality, pay all inspection fees established by municipality for inspection as required.
- C. Pay all charges incurred and continue service to building.
- D. Ream all cut tube to full inside diameter of pipe. Install all piping in accordance with manufacturer's recommendations and requirements, and local water company standards.

### 3.6 VALVES

- A. Provide valves located as follows and as indicated:
1. At foundation wall, both sides of meter, foot of all supply risers, branches to separate fixtures, cold and hot supplies, at hot water storage tanks and wall hydrants.
  2. Provide each fixture supply with a separate angle or straight stop, finished like the pipe it serves.
  3. At the foot of each riser on the upper side of the control valve, provide a 1/2" Tee and drain cock in addition to valve.
- B. Provide bronze gate valves with stationary spindle, solid wedge and follower gland in stuffing box, made for 125 pound steam working pressure or 175 pounds W.W.V.

### 3.7 INSULATION

- A. Submit samples of each type of material specified herein for approval.
- B. Apply insulation in strict accordance with manufacturer's recommendations.
- C. Provide insulating material with a maximum thermal conductance (C Value) of 0.50, low pressure pipe.
- D. Cold Water: Seal all joints and seams with white or colorless vapor adhesive.
- E. Hot Water and Hot Water Return: Except fastening agent shall be outward clench staples as manufactured by Bostitch.
- F. Insulate fittings, valves, etc., with Fiberglas Aerocors or approved equal, to the same thickness as the adjacent pipe insulation, and finished with the same finish.

### 3.8 FIXTURES

- A. Grout water closets with sealant.
- B. For above floor discharge, provide sealant at wall as required.
- C. Grout vanities with sealant.
- D. If no-hub carriers are used, secure drainage line to slab by means of "U" bolts or additional adequate anchoring.

### 3.9 TESTING

- A. Pressure test new piping only. Do not test any existing piping. All system leaks which occur due to testing are to be repaired at no additional cost to the Owner.
- B. Test all piping and make water-or-gas-tight before insulation is applied, or before concealment.
  - 1. Sanitary Piping: Before the installation of any fixtures, cap the ends of the system and fill all lines with water to the roof, 10 LF head will be acceptable, and let stand until a thorough inspection has been made by Local Inspector and the Engineer.
  - 2. Test hot and cold water piping to a hydrostatic pressure of 125 pounds per square inch for a period of 24 hours.
  - 3. Test outside water services to 200# for a period of two hours.
  - 4. Sterilization of water distribution system; as soon as the water distribution system has been flushed out, sterilize the system in accordance with the requirements of the Health Department having jurisdiction or, in the absence of such, by any other method satisfactory to the Owner.
  - 5. Test gas piping to 25 psi of air for a period of six (6) hours for above ground installation, and 100 psi for all underground work.
  - 6. Peppermint and/or Smoke Test as required by BOCA Code.
  - 7. Test nitrogen and ammonia piping for twenty-four (24) hours at 125#.

### 3.10 EQUIPMENT CONNECTIONS

- A. Connect plumbing lines to all mechanical equipment and all fixtures of this and other sections of this specification. Provide necessary traps, backflow preventers, tail pieces, stops and supplies, to heating equipment and other appurtenances necessary for a complete installation. All exposed piping in finished rooms to be chrome on brass.

### 3.11 INSTRUCTION OF OWNER'S PERSONNEL

- A. Fully instruct the Owner's representative in the complete operation, adjustment and maintenance of the entire installation as directed. Arrange with the suppliers of installed equipment and/or systems to provide the services of expert technicians to instruct owner's operating personnel in the use, care and emergency repair of equipment and/or systems. The period of instruction will be as to satisfy the Architect and/or Engineer that such instructions have accomplished their purpose.

### 3.12 INSTRUCTION MANUAL

- A. One month prior to the completion of all work and the final inspection of the installation by the Owner, submit for approval two copies of a complete Instruction Manual, bound in a three-ring binder, typewritten and suitably indexed, containing the following minimum data:
1. Brief description of each system covering its basic operating characteristics.
  2. List of all equipment with manufacturer's name and model number of each item.
  3. Manufacturer's literature describing each item of equipment.
  4. Copy of each valve chart.
  5. Copy of each automatic control diagram with respective sequence of operation.
  6. Parts list of each major item of equipment.
  7. Detailed step-by-step instructions for starting and shut down of each system.
  8. Detailed maintenance instructions for each system.

END OF SECTION 22 22 22

## SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

### PART 1 - GENERAL

#### 1.1 GENERAL REQUIREMENTS

- A. Drawings and General Provisions of Contract, including General and Modifications to General Conditions and Division 1 Specification Sections, apply to work specified in this Section.
- B. Equality of materials, articles, assembly or systems, other than those named or described in this Section, will be determined in accordance with the provisions given to Substitutions.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Dielectric fittings.
  - 3. Mechanical sleeve seals.
  - 4. Sleeves.
  - 5. Escutcheons.
  - 6. Inserts.
  - 7. HVAC demolition.
  - 8. Equipment installation requirements common to equipment sections.
  - 9. Concrete bases.
  - 10. Supports and anchorages.
  - 11. Excavation, trenching and backfilling.
  - 12. Openings in walls.
  - 13. Cutting and patching
  - 14. Painting.
  - 15. Electrical wiring.

#### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

- F. "Contractor" means specifically sub-contractor working under his respective Section of the Specifications.
- G. "Furnish" and "Provide" mean to supply, erect, install and connect up complete in readiness for regular operation, particular work referred to, unless otherwise specified.
- H. "Piping" includes, in addition to pipe, all fittings, valves, hangers and other accessories relating to such piping.
- I. "Ductwork" includes, in addition to ducts, all fittings, hangers, dampers, elbows, transitions, access panels, breaker strips, flexible connections and other accessories relating to ductwork.
- J. "Supply" means purchase and delivery of material to the site.
- K. "Install" means to erect in place the supplied item.

#### 1.4 SUBMITTALS

- A. Submit color samples for pipe coding system.
- B. Submit copies for approval and record of:
  - 1. All Tests.
  - 2. Balancing Report.
  - 3. Valve Chart.
  - 4. Pipe Color Code Chart.
  - 5. Maintenance Manuals.
  - 6. All products and materials supplied under Division 23.
- C. Any additional cost or loss, or damage arising from the substitution of any material or method for those originally specified shall be borne by the Contractor, notwithstanding review or acceptance of such substitution by the owner or the Architect, unless the substitution was made at the written request of the Owner. Any cost for re-design of any components of the contract documents shall be borne by the Contractor, unless the substitution was made at the written request of the Owner.
- D. Submittals shall be used by the contractor to coordinate location and size of access requirements, and location of piping, duct, drain, and electrical connections. Where the submittal is lacking proper information, the contractor shall obtain certified drawings or manufacturers installation brochures and instructions for the equipment before proceeding with the work.

#### 1.5 QUALITY ASSURANCE

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

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

1.6 SCOPE OF WORK

- A. Provide all labor, materials, equipment, controls and accessories necessary to complete the work shown on the Drawings or herein specified.
- B. The work to be done under this Division includes all related work shown on the Drawings and or included in these Specifications.

1.7 MATERIALS

- A. Any device, material or construction required to complete the job that is not specifically covered by description herein shall be of commercial-grade material normally used for the purpose and installed in a manner consistent with the conditions of use. Items exposed to the elements shall be weatherproofed or protected. All such items shall be submitted for review before being purchased or installed.

1.8 CODES AND STANDARDS

- A. Materials and equipment shall be designed, constructed, installed and tested in accordance with this Specification and the latest editions of the following applicable standards in addition to state and local codes applying. All products shall bear the label of approval from the appropriate agency.

Agencies:

National Environmental System Contractors Assoc.	NESCA
Air Moving and Conditioning Association	AMCA
American Society of Heating, Refrigerating and Air Conditioning Engineers	ASHRAE
American Society of Mechanical Engineers	ASME
Federal Construction Safety Standards (U.S. Dept. of Labor)	FCSS
American Society of Testing Materials	ASTM
National Electric Code	NEC
National Electrical Manufacturers Association	NEMA
National Fire Code	NFC
Occupational Safety and Health Act of '70	OSHA
International Building Code (Latest Edition)	IBC
National Sanitation Foundation	NSF
Air Conditioning and Refrigeration Inst.	ARI
Underwriters Laboratories, Inc.	UL
Building Officials & Code Administrators International, Inc.	BOCA
International Code Council	ICC
National Fire Protection Association	NFPA
Sheet Metal and Air Conditioning Contractors National Association	SMACNA
American National Standards Institute	ANSI
American Welding Society	AWS
Cast Iron Soil Pipe Institute	CISPI
Clean Air Act Amendment of 1990 (Title VI. Section 608)	CAA
Cooling Tower Institute	CTI
International Mechanical Code	IMC

- B. Any materials or workmanship called for in the above-mentioned requirements which are not specified or shown on the Drawings, shall be furnished and installed by the Contractors as though same had been specifically mentioned or indicated.
- C. If these Contractors fail to notify the A/E at this time, and install work in variance with the above-mentioned codes and regulations, they shall assume responsibility and expense to rectify the installation to the satisfaction of the A/E and Owner.
- D. Secure all local, state and federal permits necessary in connection with the installation of the equipment, including licenses and approvals and pay fees required for same.
- E. All work shall be performed in strict accordance with the above-mentioned standards, local and state codes.
- F. File all necessary Plans and Documents with Local Authorities and obtain the necessary Certificates of Inspection for work. Deliver same to A/E prior to request for acceptance and final payment.
- G. Notify A/E of any deviation from codes of work indicated or herein specified before installation of work is affected.

#### 1.9 WORK PROCEDURE

- A. The Contractor shall, in good workmanlike manner, perform all work and furnish all supplies and materials, machinery, equipment and means, herein and otherwise specified, necessary or proper to perform and complete all work required by the Plans and Specifications in order to have a complete and satisfactory installation acceptable to the A/E.

#### 1.10 COOPERATION WITH OTHER TRADES / COORDINATION DRAWINGS

- A. Cooperate to fullest extent with all other trades to best expedite the entire work.
- B. Furnish all information pertaining to materials, sizes, locations, means of support, etc., to all other trades requiring such information.
- C. Where work of Contractor will be installed in close proximity to work of other trades, or where there is evidence that work of Contractor will interfere with work of other trades, he shall assist in working out space conditions to make satisfactory adjustment.
- D. Contractor shall prepare composite working "COORDINATION" drawings and sections at suitable scale not less than  $\frac{1}{4}" = 1'-0"$  clearly showing how his work is to be installed in relation to work of other trades. The contractor shall identify any conflicts and request assistance from the Architect / Engineer for assistance in resolving a field condition in order to complete the work required. No additional compensation will be granted or awarded for resolving coordination issues since this is considered part of this contractors duties.

#### 1.11 ELECTRICAL ROOM REQUIREMENTS

- A. Do not install any piping, ductwork or equipment in or through electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms, unless piping or ductwork of equipment is intended to serve these rooms. Additionally, no ductwork or piping will be installed above electric panels. If the Contractor violates this requirement, he shall remove and/or relocate all items as required at his expense and to the satisfaction of the Architect.



## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. All products shall be new and without defects.
- B. Products required by construction but not specifically described herein shall be as selected by the Contractor subject to the approval of the A/E.

### 2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### 2.3 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.

### 2.4 UNIONS / DIELECTRIC FITTINGS

- A. Use dielectric unions, flanges, or waterways to connect dissimilar metal parts.
- B. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.
- D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
- E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

## 2.5 SLEEVES

- A. Through outside masonry walls and below grade masonry walls, use schedule 40 ductile iron, caulked watertight.
- B. Through masonry floors or interior masonry walls and fire rated assemblies, use Schedule 40 galvanized steel pipe.
- C. Through interior non-fire rated stud partitions, use 22-gauge galvanized sheet metal.
- D. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- E. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- F. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- G. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.

## 2.6 ESCUTCHEONS

- A. Escutcheons for pipes passing through outside walls shall be solid cast brass, flat type, secured to pipe with a set screw, Ritter Pattern & Casting Co., #1.
- B. Escutcheons for pipes passing through floors shall be split hinged, cast brass type designed to fit pipe on one end and cover sleeve projection through floor on other end, Ritter Pattern & Casting Company, #36A.
- C. Escutcheons for pipes passing through interior walls, partitions and ceilings shall be split-hinged, cast brass, chromium plated type, Ritter Pattern & Casting Co., #3A.
- D. Beaton & Corbin and/or Caldwell products will be acceptable.

## 2.7 INSERTS

- A. Inserts shall be individual or strip type, of pressed steel construction galvanized only with accommodation for removable nuts and threaded rods up to  $\frac{3}{4}$ " diameter, permitting lateral adjustment. Individual inserts shall have an opening at top to allow reinforcing rods up to  $\frac{1}{2}$ " diameter to be passed through insert body and shall be Fee & Mason Manufacturing Company, Figure 178. Strip inserts shall have attached rods with hooked ends to allow fastening to reinforcing rods and shall be Fee & Mason Manufacturing Company, Figure 190. Grinnell or Carpenter Patterson materials will be acceptable.
- B. At Contractor's option, inserts may be galvanized, malleable iron, Universal type, Grinnell, Figure 279, for pipe sized up to  $3\frac{1}{2}$ ", Figure 282, for all sizes up to 8".

- C. Where subject to corrosive atmospheres use stainless steel products.

## PART 3 - EXECUTION

### 3.1 INTERPRETATION OF DRAWINGS

- A. Mechanical equipment and such other apparatus as may require maintenance and operation from time to time shall be made easily accessible. Although the equipment may be shown on the Drawings in certain locations, the construction may disclose that such locations do not make its position readily accessible. In such cases, the Owner or his Representative shall be notified before advancing the construction to a stage where a change will reflect additional expense.
- B. Compare actual site conditions with the Drawings and Specifications and include additional work which careful examination would disclose. Before the bidding period, advise the A/E of any omission, error or conflict in the Plans and Specifications.
- C. Equipment, ductwork and piping locations, as shown, are diagrammatic and approximate only unless fixed by dimensions. Actual field conditions and physical characteristics of the product govern exact locations. Where possible, adhere to locations on Drawing consistent with building construction and equipment installed by others.
- D. Contractor shall not scale measurements from the Drawings but check with General Contractor's latest Drawings, shop drawings, and equipment manufacturers installation guides before proceeding with any work.
- E. Work layouts shall be the responsibility of the Contractor, following minimum requirements as set forth in these Specifications and accompanying Drawings.
- F. Where head room or space conditions appear inadequate, A/E shall be notified before proceeding with installation. If directed by A/E, Contractor shall, without extra charge, make reasonable modifications in layout as needed to prevent conflicts with work of other trades or for proper execution of work.
- G. If, in Contractor's opinion, work is shown or specified in manner or amount as to make it impossible to install a first-class piece of work or fulfilling intent of a perfectly efficient job when complete, refer same to A/E in writing before submitting proposals.
- H. Should Contractor fail to refer such instances to A/E as required above, no excuse for poor, defective or incomplete work will be accepted.

### 3.2 SHOP DRAWINGS

- A. All equipment shall be submitted for approval under these Sections to the A/E.
- B. Do not place orders for any equipment until final approval is received. Allow at least two weeks for submittal review.
- C. If material or equipment is installed before it is approved, Contractor shall be liable for removal and replacement at no extra charge to the Owner.
- D. Contractor shall consult manufacturers' installation brochures and instructions to determine exact location of connection points. Take special care to allow for proper space for maintenance, removal of coils, filters and equipment. Provide offset pipe and union arrangements for ease of removal of coils and equipment. Provide accessories required or

recommended by the manufacturer. Locate drains for proper pitch and trapping for coils, space for control valves, and other components. Coordinate with electrical contractor by advising of proper location of attachment of electrical devices to be clear of areas of maintenance or access.

### 3.3 WARRANTY

- A. Refer to General Conditions. The warranty period for the work under this Section is for one year from date of acceptance. These contractors shall provide free day-and-night service, parts and labor for the complete installation of the entire system for this period.

### 3.4 CONTRACTOR'S RESPONSIBILITY

- A. Contractor shall be held responsible for any injuries to people, employees or damage done to building premises or adjoining areas or to other work resulting from execution on his part of work, in any manner whatsoever.
- B. Contractor shall be responsible for proper protection of his work, materials, people or employees from injury or loss done by others and shall make good such injury at his own expense.
- C. The Engineer shall not be responsible for the safety of Contractor's employees.

### 3.5 CUTTING AND PATCHING

- A. All rough cutting and patching required for installation of the mechanical system shall be the responsibility of this contractor. All finish patching relative to this contractor's work shall be the responsibility of other trades in accordance with other sections of this specification. Coordinate all work for a complete and finished installation.

### 3.6 TESTING

- A. Contractor shall submit to the A/E for record and approval a written report for each test conducted. Report shall indicate date of test, system tested, method of testing, name of person or agency witnessing test, and results of tests. If test records are not kept and submitted, it will be assumed that the test was not completed and Contractor will be required to perform the test at A/E 's direction.
- B. All piping, ducts and equipment shall be tested. Contractor shall furnish Labor, materials, instruments and power required for testing unless otherwise indicated under particular section of Specifications.
- C. Tests shall be performed in presence of and to satisfaction of A/E and/or such other parties as may have jurisdiction.
- D. Pressure test shall be applied to piping only before connection of equipment. In no case shall piping, equipment or accessories be subjected to pressures exceeding their ratings.
- E. Defective work shall be promptly repaired or replaced and tests shall be repeated until particular system and/or component parts receive approval of the A/E.
- F. Any damages resulting from tests shall be repaired and damaged materials replaced.

- G. Duration and style of tests shall be as determined by authorities having jurisdiction but in no case less than time prescribed in each Section of Specifications. In general, pressure for tests shall be 1.5 times working pressure unless prescribed otherwise by code, specific specification section or ASTM Guidelines.
- H. Equipment and systems which normally operate during certain seasons of year shall be tested during appropriate season. Test shall be performed on individual equipment, systems and their controls for proper operation, functioning and performance. Latter shall be operated simultaneously with equipment of system being tested.
- I. During testing procedure, remove accessories liable to damage during tests.
- J. Notice shall be furnished to A/E at least two days prior to any testing. Contractor shall be solely responsible for any delays, damages, etc., resulting from failure to notify.
- K. Instruments required under this Contract for permanent installation may be used for testing if re-adjusted and recalibrated for the service for which intended.

### 3.7 CLEANING OF SYSTEM

- A. All piping, ducts and equipment shall be thoroughly cleaned of foreign matter after being placed in operation. System shall be disconnected, cleaned and reconnected wherever necessary to locate and remove obstructions. Any work damaged in course of removing obstructions shall be repaired or replaced when system is reconnected at no additional cost to the Owner.

### 3.8 SLEEVES, INSERTS, ANCHOR BOLTS

- A. Sleeves shall be located by this Contractor and set by the General Contractor, subject to A/E approval. Provide General Contractor with such information in ample time to prevent unnecessary cutting and patching. Mechanical Contractor shall be responsible for and subsequent cutting and patching of openings if sleeves have been omitted due to failure of setting them properly or in time. Fasten sleeves securely to avoid dislocation during concrete pouring.
- B. In placing sleeves, inserts, anchor bolts or any other material to be embedded in masonry and concrete or built into structure, Contractor shall cooperate with all other trades and shall consult with A/E in regard to their exact locations wherever there is any interference with structural members.
- C. Contractor will be held responsible for location of and maintaining in proper positions, sleeves, inserts and anchor bolts supplied and/or set in place by him. In event that failure to do so requires cutting and patching of finished work, it shall be done at Contractor's expense.
- D. All pipes and conduits passing through floors, walls or partitions shall be provided with sleeves having an internal diameter two inches larger than outside diameter of pipe.
- E. Sleeves through outside walls shall be painted with one coat of bitumastic paint inside and outside. Sleeves shall extend ½" beyond each side of wall. Space between sleeve and pipe shall be packed with oakum to within two inches of each face of wall. Remaining space shall be packed and made watertight with a waterproof compound.
- F. Sleeves through masonry floors or interior masonry walls shall be set flush with finished wall or ceiling surfaces.
- G. Sleeves through interior stud partitions shall be set flush with finished surfaces of partitions.

### 3.9 ESCUTCHEONS

- A. Escutcheons shall be installed on pipes wherever they pass through floors, ceilings, wall partitions and outside walls where exposed to view.

### 3.10 OPERATING INSTRUCTIONS

- A. Operation of system:
  - 1. Contractor is responsible for construction and installation of all mechanical systems and shall supply the services of competent personnel for a period of three days to instruct owner's personal. As such, Contractor may be required during the first year to review every phase of all mechanical systems with Owner's personnel and also to instruct and supervise Owner's personnel in the proper operation and maintenance of said system. Time shall be recorded by Contractor and signed by Owner or Representative.
  - 2. Contractor shall also provide three sets of complete operating instructions of all systems installed, bound in a manual. Manual shall contain one approved copy of each shop drawing and submitted data, printed instructions as to care and maintenance of system, and bound in a hard cover and arranged in the following sequence:
    - a. Table of Contents
    - b. Description of Installation
    - c. Care and Maintenance: Including a check and follow-up chart for greasing and oiling of all mechanical equipment and a copy of instructions as to up-keep of motors.
    - d. Manufacturer's Listing: In alphabetical order, of all equipment installed on job, together with a listing of material supplied, manufacturer's address, name and address of local manufacturer's agent.
    - e. Copy of Valve Charts
    - f. Copy of Pipe System complete with color samples.

### 3.11 PROJECT CLOSEOUT AND TROUBLE SHOOTING

- A. Each trade shall designate one person to methodically test, adjust, trouble shoot and effect repairs to all equipment, devices and systems. The person shall be available on one hour's notice to answer trouble calls and to fully investigate and repair the cause of the problem. Each trade shall submit the name and phone number of the designated person to the Owner, Engineer and Architect. After final acceptance, this same person shall be available on eight hour's notice for free day-and-night service during the guarantee period.
- B. Contractor shall demonstrate all sequences of control to the Engineer. The temperature control and balancing sub-contractors shall accompany the Engineer during check-out procedure and shall demonstrate proper balancing positions of minimum fresh-air settings. Personnel shall be equipped with tools and spare parts to make minor repairs and adjustments.
- C. Contractor shall demonstrate compliance with balancing of systems in the presence of the Engineer by actual measurement of water and air flows at a minimum of three locations randomly selected by the Engineer. If requested by the Engineer, re-balancing shall be done at no additional charge.

### 3.12 FIRE STOPPING

- A. Each trade is responsible for fire stopping of its own work.
- B. Fire stopping material shall be typical of HILTI Fire Barrier.
- C. Each trade must submit intended fire stopping material and methods for each application with UL listed approved designs.

### 3.13 HVAC DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
  - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
  - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
  - 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
  - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
  - 8. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

### 3.14 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.

- G. Install piping at indicated slopes.
  - H. Install piping free of sags and bends.
  - I. Install fittings for changes in direction and branch connections.
  - J. Install piping to allow application of insulation.
  - K. Select system components with pressure rating equal to or greater than system operating pressure.
  - L. Install escutcheons for penetrations of walls, ceilings, and floors.
  - M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
  - N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
    - 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
    - 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
    - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
  - O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
    - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
  - P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
  - Q. Verify final equipment locations for roughing-in.
  - R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- 3.15 PIPING JOINT CONSTRUCTION
- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
  - B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.



- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

### 3.16 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### 3.17 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 23 05 00

## SECTION 23 05 19 - METERS AND GAGES FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Bimetallic-actuated thermometers.
  2. Liquid-in-glass thermometers.
  3. Thermowells.
  4. Dial-type pressure gages.
  5. Gage attachments.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Product certificates.
- D. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ashcroft Inc.
  2. Ernst Flow Industries.
  3. Marsh Bellofram.
  4. Miljoco Corporation.
  5. Nanmac Corporation.
  6. Noshok.
  7. Palmer Wahl Instrumentation Group.
  8. REOTEMP Instrument Corporation.
  9. Tel-Tru Manufacturing Company.
  10. Trerice, H. O. Co.
  11. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  12. Weiss Instruments, Inc.
  13. WIKA Instrument Corporation - USA.
  14. Winters Instruments - U.S.
- B. Standard: ASME B40.200.
- C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.

- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.
- E. Connector Type(s): Union joint with unified-inch screw threads.
- F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- H. Window: Plain glass.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus 1 percent of scale range.

## 2.2 LIQUID-IN-GLASS THERMOMETERS

### A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Flo Fab Inc.
  - b. Miljoco Corporation.
  - c. Palmer Wahl Instrumentation Group.
  - d. Tel-Tru Manufacturing Company.
  - e. Terice, H. O. Co.
  - f. Weiss Instruments, Inc.
  - g. Winters Instruments - U.S.
2. Standard: ASME B40.200.
3. Case: Cast aluminum 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue[ or red] organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
  - a. Design for Air-Duct Installation: With ventilated shroud.
  - b. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

### B. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ernst Flow Industries.

- b. Marsh Bellofram.
  - c. Miljoco Corporation.
  - d. Palmer Wahl Instrumentation Group.
  - e. REOTEMP Instrument Corporation.
  - f. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  - g. Weiss Instruments, Inc.
  - h. WIKA Instrument Corporation - USA.
2. Standard: ASME B40.200.
  3. Case: Plastic 9-inch nominal size unless otherwise indicated.
  4. Case Form: Adjustable angle unless otherwise indicated.
  5. Tube: Glass with magnifying lens and red organic liquid.
  6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
  7. Window: Glass.
  8. Stem: Aluminum and of length to suit installation.
    - a. Design for Air-Duct Installation: With ventilated shroud.
    - b. Design for Thermowell Installation: Bare stem.
  9. Connector: 1-1/4 inches with ASME B1.1 screw threads.
  10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

### 2.3 DUCT-THERMOMETER MOUNTING BRACKETS

- A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

### 2.4 THERMOWELLS

- A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing.
4. Material for Use with Steel Piping.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: ASME B1.20.1 pipe threads.
7. Internal Threads: ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

### 2.5 PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

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

- a. AMETEK, Inc.; U.S. Gauge.
  - b. Ashcroft Inc.
  - c. Ernst Flow Industries.
  - d. Flo Fab Inc.
  - e. Marsh Bellofram.
  - f. Miljoco Corporation.
  - g. Noshok.
  - h. Palmer Wahl Instrumentation Group.
  - i. REOTEMP Instrument Corporation.
  - j. Tel-Tru Manufacturing Company.
  - k. Trerice, H. O. Co.
  - l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  - m. Weiss Instruments, Inc.
  - n. WIKA Instrument Corporation - USA.
  - o. Winters Instruments - U.S.
2. Standard: ASME B40.100.
  3. Case: Liquid-filled / Sealed type(s); cast aluminum; 6-inch nominal diameter.
  4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
  5. Pressure Connection: Brass, with ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
  6. Movement: Mechanical, with link to pressure element and connection to pointer.
  7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
  8. Pointer: Dark-colored metal.
  9. Window: Glass.
  10. Ring: Stainless steel.
  11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

## 2.6 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with ASME B1.20.1 pipe threads and surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of stainless-steel pipe with pipe threads.
- C. Valves: stainless-steel needle with ASME B1.20.1 pipe threads.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install thermowells with socket extending **to center of pipe** and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- I. Install remote-mounted pressure gages on panel.
- J. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- K. Install valve and syphon fitting in piping for each pressure gage for steam.
- L. Install flow indicators in piping systems in accessible positions for easy viewing.
- M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- N. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- O. Install permanent indicators on walls or brackets in accessible and readable positions.
- P. Install connection fittings in accessible locations for attachment to portable indicators.
- Q. Install thermometers in the following locations:
  - 1. Inlet and outlet of each hydronic zone.
  - 2. Inlet and outlet of each hydronic boiler.
  - 3. Two inlets and two outlets of each chiller.
  - 4. Inlet and outlet of each hydronic coil in air-handling units.
  - 5. Two inlets and two outlets of each hydronic heat exchanger.
  - 6. Inlet and outlet of each thermal-storage tank.
  - 7. Outside-, return-, supply-, and mixed-air ducts.
- R. Install pressure gages in the following locations:
  - 1. Discharge of each pressure-reducing valve.
  - 2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
  - 3. Suction and discharge of each pump.

### 3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

### 3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

### 3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each hydronic zone shall be:
  - 1. Liquid-filled / Sealed, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- B. Thermometers at inlet and outlet of each hydronic boiler shall be:
  - 1. Liquid-filled / Sealed, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- C. Thermometers at inlets and outlets of each chiller shall be:
  - 1. Liquid-filled / Sealed, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- D. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be:
  - 1. Liquid-filled / Sealed, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- E. Thermometers at inlets and outlets of each hydronic heat exchanger shall be:
  - 1. Liquid-filled / Sealed, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- F. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be:
  - 1. Liquid-filled / Sealed, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- G. Thermometers at inlet and outlet of each thermal-storage tank shall be:
  - 1. Liquid-filled / Sealed, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- H. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be:
  - 1. Liquid-filled / Sealed, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- I. Thermometer stems shall be of length to match thermowell insertion length.

### 3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: Minus 40 to plus 160 deg F .
- B. Scale Range for Condenser-Water Piping: 0 to 180 deg F.
- C. Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F.
- D. Scale Range for Steam and Steam-Condensate Piping: 20 to 240 deg F .
- E. Scale Range for Air Ducts: 20 to 240 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each pressure-reducing valve shall be liquid filled / sealed.
- B. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be liquid filled / sealed.
- C. Pressure gages at suction and discharge of each pump shall be liquid filled / sealed.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: **0 to 150 psi.**
- B. Scale Range for Heating, Hot-Water Piping: **0 to 150 psi.**
- C. Scale Range for Steam Piping: **0 to 200 psi.**

END OF SECTION 23 05 19



## SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING

### PART 1 - GENERAL

#### SUMMARY

- A. Section Includes:
  - 1. Ball valves.
  - 2. Globe valves
  - 3. Check valves.
  - 4. Relief valves.
  - 5. Gate valves.
  - 6. Strainers
  - 7. Vacuum breakers.
  - 8. Automatic flow valves.
  - 9. Combination balancing / flow measurement / shut off valves.
  
- B. Related Sections:
  - 1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
  - 2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

#### SUBMITTALS

- C. Product Data: For each type of valve indicated.

#### QUALITY ASSURANCE

- D. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
  
- E. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

### PART 2 - PRODUCTS

#### GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.
  
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
  
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
  
- D. Valve Actuator Types:

1. Handwheel: For valves other than quarter-turn types.
  2. Handlever: For quarter-turn valves NPS 6 and smaller (except plug valves).
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Gate Valves: With rising stem.
  2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
  3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
  2. Solder Joint: With sockets according to ASME B16.18.
  3. Threaded: With threads according to ASME B1.20.1.

#### VALVES AND SPECIALTIES

- A. Valves on condenser water, chilled water, hot water and fuel oil services shall be 125 psi unless noted otherwise.
- B. Pressure ratings of valves for steam and condensate services shall be as specified.
- C. Provide balancing valves where shown on Drawings.
- D. Valves shall have name of manufacturer and guaranteed working pressure cast or stamped on bodies.
- E. Valves of similar type shall be by single manufacturer. Provide chain operators for valves 7 feet and higher above floor.
- F. Butterfly Valves
1. Provide butterfly valves for shutoff on chilled, hot and condenser water services 2 1/2" and larger. Do not use butterfly valves for balancing service.
  2. Valves shall be rated 175 psi maximum working pressure, iron body, threaded lug with resilient EPDM seats, bronze disc and 416 stainless stem, by Centerline, DeZurik, Keystone, or Bray.
  3. Valves 6" and larger shall have gear or chain operators.
  4. Valves smaller than 6" shall have seven
  5. Test valves at 110% of rated pressure.
- G. Ball Valves
1. Provide bronze body ball valves with reinforced teflon seats, seals, bearings and packing.
  2. Ball valves shall be used for chilled, hot and condenser water services in sizes 2" and smaller.
  3. Do not use ball valves for balancing service.
  4. Valves on insulated piping shall have 2" extended stems.
  5. Valves shall be by Apollo, Cannon, Nibco, Milwaukee, or Watts.
  6. Valves shall be rated 600 psi.
- H. Globe Valves

1. Provide globe valves for throttling steam and medium pressure condensate services by Crane, Jenkins, Milwaukee, Stockham or Walworth.
2. Valves 2 1/2" and larger shall be iron body, flanged ends, bronze mounted, outside screw and yoke, renewable seat.
3. Valves 2" and smaller shall be bronze body, screwed ends, bronze trim.
4. Valves shall be ANSI B16.5 rated for 300 PSI service.

I. Check Valves

1. Check valves sized 2 1/2" and larger shall be iron body, flanged ends, bronze mounted, swing pattern.
2. Check valves 2" and smaller shall be bronze, screwed ends, swing pattern.
3. Check valves for hot water, chilled water and condenser water pump discharge shall be spring loaded, silent check, by APCO, Milwaukee, Mueller or Stockham.

J. Relief Valves

1. Relief valves shall be brass with external lever, ASME approved.
2. Pipe discharge to floor drain with open connection at floor.
3. Pipe chiller refrigerant relief devices through roof to atmosphere.

K. Gate Valves

1. Provide gate valves for shut off on steam and steam condensate services by Crane, Jenkins, Milwaukee, Stockham or Walworth.
2. Valve shall be rated for 125 psi steam working pressure valves shall have iron bodies, and silicon brass stems.
4. Valves 3" and smaller shall have solid bronze wedges, Valves larger than 3" shall have solid iron wedges with bronze face rings.
5. Valves 2" and under shall be threaded, valves 2-1/2" and over shall be flanged.
6. Valves having 250 PSI steam working pressure valves 2" and under shall be bronze body with silicon brass stems and solid bronze wedges. Valves shall have threaded connections.
7. Valves having 250 PSI steam working pressure valves 2-1/2" and over shall be iron body, iron wedges with bronze face rings and have flanged connections.
8. Packing materials shall be non-asbestos.

L. Strainers

1. Strainers 2" and smaller shall be 250 lb. bronze body, stainless steel, screen with 20 mesh screen opening, Y pattern, screwed ends, Sarco Type BT, Mueller, Watts or Armstrong.
2. Strainers 2" and larger shall be 500 lb. bronze body, stainless steel, screen with 20 mesh screen opening, Y pattern, flanged, Sarco Type AF
3. Provide blow off valve on each strainer.
4. Pump suction strainers 2" and smaller shall have 0.062 screen openings. Pump suction strainers 2" and larger shall have 0.125 screen openings.
5. Strainer gaskets shall not contain asbestos.

M. Vacuum Breakers

1. Provide threaded vacuum breakers with ball, spring, O-ring flexible seat, and screen.
2. Ball shall be 440 stainless steel; seat shall be EPR.
3. Spring shall be 316 stainless steel; screen and cap shall be 304 stainless steel and threaded collar shall be 416 stainless steel.
4. Body shall be brass.

5. Vacuum breakers shall be Johnson Series VB8 size 1-1/4 IPS, or equivalent by Watts or ITT Hoffman.
6. Provide unions for threaded end valves to facilitate removal from pipe.

N. Automatic Flow Control Valves

1. Provide automatic pressure compensating flow control valves by Griswold, or Autoflow where indicated on the drawings.
2. Valves shall have the capacities and pressure differential characteristics, as indicated, and conform to the following specifications.
3. Valves 2" and smaller shall be threaded bronze valves 2-1/2" and larger shall be flanged iron or steel body.
4. Valves shall be factory set and shall automatically limit the rate of flow to required engineered capacity within +5% accuracy over an operating pressure differential of at least 14 times the minimum required for control.
5. The control mechanism of the valve shall consist of self-contained, open-chamber cartridge assembly with unobstructed flow passages that eliminate accumulation of particles and debris. All internal working parts shall be stainless steel or nickel plated brass. Body shall be ductile iron, cast iron or bronze.
6. The cartridge assembly shall consist of a spring loaded cup. The cup shall utilize the full available differential pressure across the valve to actuate the cup and, thereby, reduce friction and hysteresis and eliminate binding.
7. Valves shall be available in minimum of three pressure differential ranges, with the minimum range requiring less than 2 psig to control flow. Valve bodies shall be provided with inlet and outlet tappings suitable for connection of instruments for verification of flow rates and temperature and shall be marked to show direction of flow. Valve bodies shall be rated for use at not less than 150% of system designed operating pressures.
8. Certified performance data for the flow control valve, based on independent laboratory tests, supervised and witnessed by a registered professional engineer, shall be available.
9. All flow control valves shall be supplied by a single source responsibility.
10. Each automatic flow control valve shall be furnished with a valve kit consisting of 1/4" x 2" minimum size nipples, quick disconnect valves (to be located outside of insulation), and fittings suitable for use with the measuring instruments specified, as well as temperature.
11. Provide a metal identification tag, with chain, for each installed valve. The tag to be marked with zone identification, valve model number and rated flow in GPM.
12. Flow control valve shall be warranted for period of five years from date of startup.
13. Provide owner with dual hose meter kit including pressure gauge with 4-1/2" dial, 3-way push button operated valve, 5' long dual connection hoses, dual shutoff and vent valves, dual special valves for connection to standard valve kit, flow conversion chart and carrying case.

O. Combination Balancing/Flow Measurement/Shut-off Valves

1. Valves shall be Y-pattern style with multi-turn handwheel.
2. Valves shall be capable of being installed in any direction without affecting flow measurement and shall provide the following functions:
  - a. Precise flow measurement.
  - b. Precision flow balancing.
  - c. Positive shut-off with no drip seat.
  - d. 3/4" drain port suitable for hose bib fitting. (Sizes 2" and below.)
3. Valves shall have four, 360° adjustment turns (2" and below), eight, 360° adjustment turns (2-1/2" - 6"), twelve, 360° adjustment turns (8", 10"), and sixteen, 360°

adjustment turns (12"). Handwheels shall have digital indicators with hidden memory and tamper-proof setting features.

4. Valves 2" and below shall be non-ferrous, pressure die-cast, non-porous metal copper alloy, with soldered ends.
5. Valves 2-1/2" and over shall be ductile iron body with all other metal parts of non-ferrous copper alloy. End connections shall be flanged or grooved.
6. Pressure ratings shall be 300 psi for 2" and below and 250 psi for flanged and 300 psi for grooved ends.
7. Each valve shall have pressure/temperature readout ports with EPDM seals and attached shut-off valves.
8. One, computerized hand-held, balancing meter shall be furnished to the Owner. The Testing and Balancing Contractor shall utilize this instrument for his work. The meter shall include the following:
  - a. Flow measurement direct in GPM.
  - b. Differential pressure measurement.
  - c. Temperature measurement.
  - d. Automatic calibration.
  - e. Automatic air purging.
  - f. Extended data logging functions.
9. Balance valves 2" and under shall be Tour and Anderson Model STAS.
10. Valves 2-1/2" and over shall be Tour and Anderson Models STAF-SG or STAG.
11. The handheld meter shall be Tour and Anderson Model CBI with PCB data logging features.
12. Balance valves manufactured by Macon or Victaulic shall be considered equivalent.

P. Suction Diffusers

1. Suction diffuser/strainers shall have 200 psi cast iron body and stainless steel strainer with 5/32" perforations. Units shall include flanged connections, removable gasketed cover and straightening vanes. Diffusers shall be Taco, B&G or Mueller.
2. Provide 16 mesh start-up strainer.
3. Provide blow off tapping on bottom of unit.
4. Provide full size inlet and outlet.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### 3.2 VALVE INSTALLATION

- G. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- H. Locate valves for easy access and provide separate support where necessary.
- I. Install valves in horizontal piping with stem at or above center of pipe.
- J. Install valves in position to allow full stem movement.
- K. Install chainwheels on operators for gate valves 4" and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- L. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

### 3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

### 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
  - 1. Shutoff Service: Ball, butterfly or gate valves.
  - 2. Throttling Service, Except Steam: Globe or ball valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
  - 2. For Copper Tubing, NPS 2-1/2 to NPS 4 : Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
  - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
  - 5. For Steel Piping, NPS 2-1/2 to NPS 4 : Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

### 3.5 CHILLED-WATER VALVE SCHEDULE

#### A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125 and Class 150 bronze disc.
3. Ball Valves: One piece, full port, brass or bronze.
4. Bronze Swing Check Valves: Class 125 and Class 150 bronze disc
5. Bronze Gate Valves: Class 125 and Class 150 bronze disc.
6. Bronze Globe Valves: Class 125 and Class 150 bronze disc

#### B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, stainless-steel disc.
3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, stainless-steel disc.
4. High-Performance Butterfly Valves: Class 150 and Class 300, single flange.
5. Iron Swing Check Valves: Class 125 and Class 250, metal seats.
6. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.
7. Iron Gate Valves: Class 125 and Class 250, OS&Y.
8. Iron Globe Valves: Class 125 and Class 250.

### 3.6 HEATING-WATER VALVE SCHEDULE

#### A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125 and Class 150 bronze disc.
3. Ball Valves: One piece, full port, brass or bronze.
4. Bronze Swing Check Valves: Class 125 and Class 150 bronze disc
5. Bronze Gate Valves: Class 125 and Class 150 bronze disc.
4. Bronze Globe Valves: Class 125 and Class 150 bronze disc

#### B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, stainless-steel disc.
3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, stainless-steel disc.
4. High-Performance Butterfly Valves: Class 150 and Class 300, single flange.
5. Iron Swing Check Valves: Class 125 and Class 250, metal seats.
6. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.
7. Iron Gate Valves: Class 125 and Class 250, OS&Y.
8. Iron Globe Valves: Class 125 and Class 250.

END OF SECTION 23 05 23

## SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Metal pipe hangers and supports.
  2. Trapeze pipe hangers.
  3. Thermal-hanger shield inserts.
  4. Fastener systems.
  5. Equipment supports.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses.
1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
  2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
  3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
1. Revise list below to suit Project.
  2. Trapeze pipe hangers.
  3. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Remaining paragraph is defined in Division 01 Section "Submittal Procedures" as an "Informational Submittal." Retain paragraph if retaining procedures for welder certification in "Quality Assurance" Article.
- E. Welding certificates.



#### 1.4 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

### PART 2 - PRODUCTS

#### 2.1 METAL PIPE HANGERS AND SUPPORTS

##### A. Carbon-Steel Pipe Hangers and Supports:

- 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
- 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
- 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
- 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

##### B. Stainless-Steel Pipe Hangers and Supports:

- 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
- 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
- 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

##### C. Copper Pipe Hangers:

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

#### 2.2 TRAPEZE PIPE HANGERS

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

#### 2.3 FASTENER SYSTEMS

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

## 2.4 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## 2.5 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
  - 1. Verify suitability of fasteners in two subparagraphs below for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick.
  - 2. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 3. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- L. Insulated Piping:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
  - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
  - 4. Shield Dimensions for Pipe: Not less than the following:
    - a. NPS 1/4 to NPS 3-1/2 : 12 inches long and 0.048 inch thick.
    - b. NPS 4: 12 inches long and 0.06 inch thick.
    - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
  - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
  - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### 3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches .

### 3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

### 3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  - 6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  - 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  - 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
  - 9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb.
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.
  8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Hangers for horizontal lines, except as noted below and in Section 230500 -

1. Vibration Isolation and Seismic Restraint, shall be spaced no greater than as follows:

Pipe Size	Rod Diameter	Maximum Spacing	
		Copper	Steel
1/2"	3/8"	5' - 0"	7' - 0"
3/4"	3/8"	5' - 0"	7' - 0"
1"	3/8"	6' - 0"	7' - 0"
1 1/4"	3/8"	7' - 0"	7' - 0"
1 1/2"	3/8"	8' - 0"	9' - 0"
2"	3/8"	8' - 0"	10' - 0"
2 1/2"	1/2"	9' - 0"	11' - 0"
3"	1/2"	10' - 0"	12' - 0"
4" - 5"	5/8"	12' - 0"	14' - 0"
6" - 8"	3/4"	14' - 0"	17' - 0"

2. Copper tubing shall be supported with split ring hangers, copperized with supporting rod.
3. Cast iron soil pipe shall be hung one hanger for each pipe length, close to hub.
4. PVC pipe shall be supported no more than 4'-0" on center.
5. Use insulation protection saddles or shields for all insulated cold piping and where hanger is outside the insulation. Secure all saddles and shields to the insulation to prevent slippage or shifting that may cause the shield to fall to the ground. Saddles shall be spot welded to hangers.

- R. Hangers for vertical pipes shall be spaced no greater than as follows:

PIPING MATERIAL	MAX. VERTICAL SPACING
Cast Iron Pipe	15'-0"
Copper Pipe/Tubing	10'-0"
Galvanized Steel Pipe	15'-0"
PVC Pipe	4'-0"
CPVC Pipe/Tubing	3'-0"

END OF SECTION 23 05 29

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 GENERAL PROVISIONS

- A. General Provisions for Mechanical Work Section 23000 shall apply to all work performed under this Section of the Specifications and shall be considered as included herein.

1.02 SCOPE

- A. Provide identification devices specified in this section.

1.03 RELATED SECTIONS

- A. All Sections of Division 23 apply to work in this Section.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
  - 1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
    - a. The following colors shall be used for piping identification unless noted otherwise:

<b>Service</b>	<b>Legend</b>	<b>Background Color</b>
Hot water supply	HWS	Yellow
Hot water return	HWR	Yellow
Chilled Water Supply	CHWS	Yellow
Chilled Water Return	CHWR	Yellow

Note: Color banding shall meet latest edition of NSI and OSHA requirements.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.



- C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8 ½ "x 11" bond paper. Tabulate valve number, piping system, system abbreviation (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Section 15010.
- D. Maintenance Data: Include product data and schedules in maintenance manuals; in accordance with requirements of Section 15010.

#### 1.06 WARRANTIES

- A. Provide one year maintenance warranty for all pieces of equipment. See Division 1 for additional warranty requirements.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, products are limited to Seton, Brady or Brimar whom have a minimum of 5 years experience in the manufacturing of mechanical identification products.

#### 2.02 MECHANICAL IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 15 sections. Where more than single type is specified for application, selections is Installer's option, but provide single selection for each product category.

#### 2.03 PAINTED IDENTIFICATION MATERIALS

- A. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 duct work.
- B. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
- C. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.

#### 2.04 PLASTIC PIPE MARKERS

- A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.
- B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.

- C. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
- D. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
  - 1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
  - 2. Adhesive lap joint in pipe marker overlap.
  - 3. Laminated or bonded application of pipe marker to pipe (or insulation).
  - 4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than ¾" wide; full circle at both ends of pipe marker, tape lapped 1 ½".
- E. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and or required length), fastened by one of the following methods:
  - 1. Laminated or bonded application of pipe marker to pipe (or insulation).
  - 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1 ½" wide, full circle at both ends of pipe marker, tape lapped 3".
  - 3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.
- F. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.
  - 1. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

## 2.05 VALVE TAGS

- A. Brass Valve Tags: Provide 1/16" (1.5mm) thick polished brass valve tags with stamp-engraved piping system abbreviation in 3/8" (8mm) high letters and sequenced valve numbers ¾" 918mm) high, and with 1/8" (3mm) hole for fastener.
  - 1. Provide 1 ½" (37mm) diameter tags, except as otherwise indicated.
  - 2. Provide size and shape as specified or scheduled for each piping system.
  - 3. Fill tag engraving with black enamel.
- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- C. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

## 2.06 VALVE SCHEDULE FRAMES

- A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

## 2.07 EQUIPMENT LABELS

- A. All equipment labels shall be made of 3 ply 3/16" engraved phenolic with low glare finish. Labels shall be electrically non-conductive and abrasion resistant. Labels shall have mounting holes and adhesive backing.

## PART 3 - EXECUTION

### 3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces which required insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- B. Where air or hydronic systems have been balanced, the Contractor shall permanently mark, ON THE DEVICE, the correct balancing setting of each valve, damper, or similar device.

### 3.02 DUCTWORK IDENTIFICATION

- A. General: Identify air supply, return, exhaust, intake and relief ductwork with stenciled signs and arrow, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork color).
- B. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50 foot spacing along exposed runs.
- C. Access Doors: Provide plastic duct access door markers on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information. Where acoustic ceilings are below the access, provide duplicate marker on ceiling tile, ceiling grid, or ceiling access panel.

### 3.03 PIPING SYSTEM IDENTIFICATION

- A. General: install pipe markers on each system listed on the color chart Paragraph 1.04.B.1.a. indicate nominal pipe size (i.e. 4" HS) and include arrows to show normal direction of flow.
- B. Locate pipe markers and color bands as follows wherever piping and ductwork is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations and concealed above ceiling spaces.
  - 1. Near each valve and control device.
  - 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
  - 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
  - 4. At access doors, manholes and similar access points which permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.

- 6. Spaced intermediately at maximum spacing of 50 feet along each piping run, except reduce spacing to 25 feet in congested areas of piping and equipment.
- 7. On piping above removable acoustical ceilings.

3.04 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, and HVAC terminal devices 50 mm and smaller and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
  - 1. Tagging Schedule: Valve tags shall be sequential.
- B. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by the Owner.

3.05 EQUIPMENT LABELS

- A. Equipment labels shall include, but not limited to the following applicable information:

Schedule Tag	CFM
Equipment Served	Static Pressure
Equipment Manufacturer	Head
Equipment Model	GPM
Horsepower	Valve CV
Fan RPM	lbs/HR
Voltage	Inlet Pressure
Sheaves	Outlet Pressure
Belt Size, Model, Quantity	Pressure Drop
Zone Served	Type of Service
	Filter Size & Quantity

- B. Provide equipment labels for:

Reheat Coils	Variable Frequency Drives
All Fans & Air Handling Units	Temperature Control Panels
Room Terminal Units	Control Valve
VAV Boxes	

3.06 ADJUSTING AND CLEANING

- A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.07 EXTRA STOCK

- A. Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 12) for each piping system, additional

pipng system identification markers, and additional plastic laminate engraving blanks of as-sorted sizes.

1. Where stenciled markers are provided (ductwork only), clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

END OF SECTION 230553

## SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Balancing Air Systems:
    - a. Constant-volume air systems.
  - 2. Balancing Hydronic Piping Systems:
    - a. Constant-flow hydronic systems.
    - b. Variable-flow hydronic systems.

#### 1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

#### 1.3 SUBMITTALS

- A. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- B. Certified TAB reports.

#### 1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
  - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
  - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.
- B. Certify TAB field data reports and perform the following:
  - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section **Metal Ducts** and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
  1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
  - 1. Permanent electrical-power wiring is complete.
  - 2. Hydronic systems are filled, clean, and free of air.
  - 3. Automatic temperature-control systems are operational.
  - 4. Equipment and duct access doors are securely closed.
  - 5. Balance, smoke, and fire dampers are open.
  - 6. Isolating and balancing valves are open and control valves are operational.
  - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- 1. A "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- 2. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.



- D. Take and report testing and balancing measurements in U.S. standard **inch-pound (IP)** units.

### 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

### 3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
  - 2. Measure fan static pressures as follows to determine actual static pressure:
    - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure static pressure directly at the fan outlet or through the flexible connection.
    - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.

- d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
  3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    - a. Report the cleanliness status of filters and the time static pressures are measured.
  4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
  5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
  6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
  7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.
    - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
  2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
  3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
  2. Adjust patterns of adjustable outlets for proper distribution without drafts.

### 3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
  - 1. Open all manual valves for maximum flow.
  - 2. Check liquid level in expansion tank.
  - 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
  - 4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
  - 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
  - 6. Set system controls so automatic valves are wide open to heat exchangers.
  - 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
  - 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

### 3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
  - 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    - a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Engineer and comply with requirements in Division 23 Section "Hydronic Pumps."
  - 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
    - a. Monitor motor performance during procedures and do not operate motors in overload conditions.
  - 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
  - 4. Report flow rates that are not within plus or minus 10 percent of design.
- B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

- C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
- D. Set calibrated balancing valves, if installed, at calculated presets.
- E. Measure flow at all stations and adjust, where necessary, to obtain first balance.
  - 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
  - 1. Determine the balancing station with the highest percentage over indicated flow.
  - 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
  - 3. Record settings and mark balancing devices.
- H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
- J. Check settings and operation of each safety valve. Record settings.

### 3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

### 3.9 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  - 1. Manufacturer's name, model number, and serial number.
  - 2. Motor horsepower rating.
  - 3. Motor rpm.
  - 4. Efficiency rating.
  - 5. Nameplate and measured voltage, each phase.
  - 6. Nameplate and measured amperage, each phase.
  - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

### 3.10 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
  - 1. Measure and record the operating speed, airflow, and static pressure of each fan.
  - 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
  - 3. Check the refrigerant charge.
  - 4. Check the condition of filters.
  - 5. Check the condition of coils.
  - 6. Check the operation of the drain pan and condensate-drain trap.
  - 7. Check bearings and other lubricated parts for proper lubrication.
  - 8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
  
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
  - 1. New filters are installed.
  - 2. Coils are clean and fins combed.
  - 3. Drain pans are clean.
  - 4. Fans are clean.
  - 5. Bearings and other parts are properly lubricated.
  - 6. Deficiencies noted in the preconstruction report are corrected.
  
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
  - 1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
  - 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
  - 3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
  - 4. Balance each air outlet.

### 3.11 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
  - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: +/- 10%.
  - 2. Air Outlets and Inlets: +/- 10%.
  - 3. Heating-Water Flow Rate: +/- 10%.
  - 4. Cooling-Water Flow Rate: +/- 10%.

### 3.12 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions

to HVAC systems and general construction to allow access for performance measuring and balancing devices.

- B. Status Reports: Prepare **monthly** progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

### 3.13 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
  - 1. Pump curves.
  - 2. Fan curves.
  - 3. Manufacturers' test data.
  - 4. Field test reports prepared by system and equipment installers.
  - 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
  - 1. Title page.
  - 2. Name and address of the TAB contractor.
  - 3. Project name.
  - 4. Project location.
  - 5. Architect's name and address.
  - 6. Engineer's name and address.
  - 7. Contractor's name and address.
  - 8. Report date.
  - 9. Signature of TAB supervisor who certifies the report.
  - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  - 11. Summary of contents including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  - 12. Nomenclature sheets for each item of equipment.
  - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
  - 14. Notes to explain why certain final data in the body of reports vary from indicated values.
  - 15. Test conditions for fans and pump performance forms including the following:
    - a. Settings for outdoor-, return-, and exhaust-air dampers.
    - b. Conditions of filters.
    - c. Cooling coil, wet- and dry-bulb conditions.

- d. Face and bypass damper settings at coils.
  - e. Fan drive settings including settings and percentage of maximum pitch diameter.
  - f. Inlet vane settings for variable-air-volume systems.
  - g. Settings for supply-air, static-pressure controller.
  - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
- 1. Quantities of outdoor, supply, return, and exhaust airflows.
  - 2. Water and steam flow rates.
  - 3. Duct, outlet, and inlet sizes.
  - 4. Pipe and valve sizes and locations.
  - 5. Terminal units.
  - 6. Balancing stations.
  - 7. Position of balancing devices.

### 3.14 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

### 3.15 SPECIAL REQUIREMENTS

- A. If readings shown on the balancing report or from actual site visit are not acceptable to the Engineer, the Balancing Contractor shall spot test (witnessed by the Engineer) as many pieces of equipment or air outlets at no additional cost.

END OF SECTION 23 05 93

## SECTION 23 07 00 - HVAC INSULATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Insulation Materials:
  - a. Cellular glass.
  - b. Flexible elastomeric.
  - c. Mineral fiber.
  - d. Polyolefin.
  - e. Polystyrene.
2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied jackets.
10. Tapes.
11. Securements.
12. Corner angles.

##### B. Related Sections:

1. Division 21 Section "Fire-Suppression Systems Insulation."
2. Division 22 Section "Plumbing Insulation."
3. Division 23 Section "Metal Ducts" for duct liners.

##### C. Requirements:

1. Insulate supply & return heating hot water piping.
2. Insulate supply and return chilled water piping.
3. Insulate supply and return dual temperature water piping.
4. Insulate all copper AC condensate piping.
5. Insulate all supply, return and outside air ducts.

#### 1.2 SUBMITTALS

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

##### B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.



4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

C. Field quality-control reports.

### 1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

## PART 2 - PRODUCTS

### 2.1 HEATING HOT WATER PIPING

- A. Fiberglass pipe insulation shall be by Owens Corning type SSL-II or approved equal, with factory applied all-service jacket (ASJ) and two-component adhesive closure system, rated for a maximum service temperature of 850F. For large pipe sizes where SSL-II is not available, the single adhesive SSL closure may be substituted. Circumferential joints shall be sealed by butt strips having a two-component sealing system.
1. Piping 1-1/2" and smaller shall have a minimum insulation thickness of 1 1/2".
  2. Piping larger than 1-1/2" shall have a minimum insulation thickness of 2".
  3. Insulation thickness is based on a "k" value not exceeding 0.27 Btu per inch/h•ft<sup>2</sup>•°F.
- B. Fittings and valves shall be insulated with pre-formed fiberglass fittings. Thickness shall be equal to adjacent pipe insulation. Finish shall be with pre-formed PVC fitting covers.
- C. Flanges, couplings and valve bonnets shall be covered with an oversized pipe insulation section sized to provide the same insulation thickness as on the main pipe section. An oversized insulation section shall be used to form a collar between the two insulation sections with low-density blanket insulation being used to fill gaps. Jacketing shall match that used on straight pipe sections. Where fittings are to be left exposed, insulation ends should be beveled away from bolts for easy access.

### 2.2 HOT WATER PIPING EXPOSED TO THE WEATHER

- A. Piping located outdoors and exposed to the weather shall be insulated as indicated in this section of the specifications. The insulation shall then be protected with one of the following weatherproof finishes:

1. Metal jacketing shall be 0.016" (0.4 mm) minimum aluminum or stainless steel with moisture barrier, secured in accordance with the jacket manufacturer's recommendations. Joints shall be applied so they will shed water and shall be sealed completely.
2. UV resistant PVC jacketing may be applied in lieu of metal jacketing provided jacketing manufacturer's limitations with regard to pipe size, surface temperature, and thermal expansion and contraction are followed.
3. Fittings shall be insulated as prescribed above, jacketed with preformed fitting covers matching outer jacketing used on straight pipe sections, with all joints weather sealed.

### 2.3 CHILLED WATER AND DUAL TEMPERATURE PIPING

- A. Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547 and meet ASTM C 585 for sizes required in the particular system. It shall be of a self-drying type suitable for installation on piping systems. Product shall include a factory applied integral vapor retarder extending under the evaporator area of the wick and covering not less than 98% of the circumference of the product. Exposed evaporator area shall be not less than 0.1 sq. ft./linear ft. of product. Vapor retarder shall be fungi resistant when tested per ASTM C 1338. Acceptable Manufacturers are Owens Corning VaporWick® Pipe Insulation or pre-approved equal.
  1. Piping 1 ½" and smaller shall have a minimum insulation thickness of 1 ½".
  2. Piping larger than 1-1/2" shall have a minimum insulation thickness of 1½".
  3. Insulation thickness is based on a "k" value not exceeding 0.27 Btu per inch/h•ft<sup>2</sup>•°F.
- B. Fittings and valves shall be insulated per manufacturer's instructions:
  1. Fittings and valves shall be wrapped continuously with wicking material prior to installing insulation to ensure a continuous path for removal of condensation.
  2. Standard site fabricated connections (e.g. mitered, segmented, or fish mouth) are recommended for bends and fittings.
  3. Standard PVC fittings with blanket insulation or molded/preformed fiberglass fittings may be used.
  4. Standard oversizing practices shall be used for valves and flanges.

### 2.4 CHILLED WATER AND DUAL TEMPERATURE PIPING EXPOSED TO THE WEATHER

- A. Fiberglass pipe insulation shall be by Owens Corning or approved equal, with factory applied all-service jacket (ASJ) and two-component adhesive closure system. For large pipe sizes where SSL-II is not available, the single adhesive SSL closure may be substituted. Circumferential joints shall be sealed by butt strips having a two-component sealing system.
- B. Fittings and valves shall be insulated with pre-formed fiberglass fittings. Thickness shall be equal to adjacent pipe insulation. Finish shall be with pre-formed PVC fitting covers.
- C. Flanges, couplings and valve bonnets shall be covered with an oversized pipe insulation section sized to provide the same insulation thickness as on the main pipe section. An oversized insulation section shall be used to form a collar between the two insulation sections with low-density blanket insulation being used to fill gaps. Jacketing shall match that used on straight pipe sections. Where fittings are to be left exposed, insulation ends should be beveled away from bolts for easy access.
- D. Piping shall be insulated with a thickness determined according to the worst weather extremes expected. The insulation shall then be protected with one of the following weather-proof finishes:

1. Metal jacketing shall be 0.016" (0.4 mm) minimum aluminum or stainless steel with moisture barrier, secured in accordance with the jacket manufacturer's recommendations. Joints shall be applied so they will shed water and shall be sealed completely.
2. UV resistant PVC jacketing may be applied in lieu of metal jacketing provided jacketing manufacturer's limitations with regard to pipe size, surface temperature, and thermal expansion and contraction are followed.
3. Fittings shall be insulated as prescribed above, jacketed with preformed fitting covers matching outer jacketing used on straight pipe sections, with all joints weather sealed.

## 2.5 DUCT INSULATION

- A. Supply, return, and outside air intake ductwork shall be insulated with 2" thick, 1.5 # density fiberglass duct insulation as manufactured by Owens Corning or approved equal. Insulation shall have a foil-faced vapor barrier.
- B. All supply, return and exhaust ductwork in the mechanical room shall be lined internally sound lined with 1-½ " Acoustical Duct Liner by Johns Manville Model Linqcoustic HP.

### **OR**

- C. Where noted on drawings, supply, return, and exhaust ducts shall also be internally sound lined with ½ " Imcoa sheet closed cell engineered polymer foam insulation.

## 2.6 DUCT INSULATION EXPOSED TO WEATHER

- A. Insulate with 3" polyiso board insulation.
- B. Wrap board insulation with Venture Tape VentureClad1577CW® is a patented, zero permeability, absolute vapor barrier for insulation cladding and jacketing applications. A 5-ply, self adhesive material installs quickly and easily with no special tools required.
- C. Product is available in natural aluminum, white, black, and stucco embossed texture finish. Finish to be approved by Engineer, Architect and Owner.

## 2.7 AC CONDENSATE PIPING

- A. Copper AC condensate: 1" Armaflex.
- B. PVC AC condensate: No insulation.

## 2.8 ARMAFLEX INSULATION

- A. Provide and install insulation on all piping and equipment as listed manufactured by Armacell.
  1. Copper AC Condensate: 1" thick insulation
  2. Refrigeratn Piping: 1" thick insulation with PVC Jacket.
- B. Insulation material shall be a flexible, closed-cell elastomeric insulation in tubular form model APArmaflex SS and AP Armaflex Sheet. Product shall meet the requirements as defined in ASTM C 534, "Specification for preformed elastomeric cellular thermal insulation in sheet and tubular form."

- C. Insulation material shall have a closed-cell structure to prevent moisture from wicking, which makes it an efficient insulation.
- D. Insulation material shall be manufactured without the use of CFC's HFC's or HCFC's. It shall also be formaldehyde free, low VOC's, fiber free, dust free and resists mold and mildew.
- E. Materials shall have a flame spread index of less than 25 and a smoke-developed index of less than 50 when tested in accordance with ASTM E 84, latest revision. In addition, the product, when tested, shall not melt or drip flaming particles, the flame shall not be progressive and all materials shall pass simulated end-use fire tests.
- F. Materials shall have a maximum thermal conductivity of 0.27 Btu-in./h-ft<sup>2</sup>-°F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.
- G. Materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96, Procedure A, latest revision. The material shall be manufactured under an independent third party supervision testing program covering the properties of fire performance, thermal conductivity and water vapor transmission.
- H. Armaflex not allowed for use as piping insulation, unless otherwise specified.

2.9 PVC PIPE JACKET

- A. Provide and install Zeston 300 Series PVC heavy-duty fitting covers and Zeston PVC pipe jacket on all insulated piping in the mechanical room specifically designed for industrial and commercial applications.
- B. The following colors shall be used for existing and new piping jacket and fitting covers in the mechanical room only (all other locations shall be provided in standard white color):

<b>Service</b>	<b>Legend</b>	<b>Jacket Color</b>
Heating Hot Water Supply	Heating Water Supply	Red
Heating Hot Water Return	Heating Water Return	Red
Chilled Water Supply	Chilled Water Supply	Blue
Chilled Water Return	Chilled Water Return	Blue

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches on center.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches on center.
  - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Manholes.
  - 5. Handholes.
  - 6. Cleanouts.

### 3.3 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches** below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

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

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.5 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches on center.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.



C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

### 3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.7 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at **6 inches** on center.
  4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
  4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
  2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
  2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
  3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  4. Install insulation to flanges as specified for flange insulation application.
- E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches on center.
    - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches on center. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

- c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not overcompress insulation during installation.
  - e. Impale insulation over pins and attach speed washers.
  - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch on center. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches on center.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches on center.
- F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches on center.
    - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches on center. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress insulation during installation.
    - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch on center. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
  - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches on center.

### 3.8 POLYOLEFIN INSULATION INSTALLATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

#### B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

#### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

#### D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.9 POLYSTYRENE INSULATION INSTALLATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

#### B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

#### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

#### D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed section of polystyrene insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

### 3.10 FIELD-APPLIED JACKET INSTALLATION

#### A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

#### B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches on center. and at end joints.
- D. Where PVDC jackets are indicated, install as follows:
1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
  2. Wrap factory-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
  3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
  4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch circumference limit allows for 2-inch overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
  5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

### 3.11 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

### 3.12 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
  1. Flat Acrylic Finish: two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

### 3.13 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
  - 2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
  - 3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.14 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
  - 1. Indoor, concealed supply and outdoor air.
  - 2. Indoor, exposed supply and outdoor air.
  - 3. Indoor, concealed return located in nonconditioned space.
  - 4. Indoor, exposed return located in nonconditioned space.
  - 5. Outdoor, concealed supply and return.
  - 6. Outdoor, exposed supply and return.
- B. Items Not Insulated:
  - 1. Fibrous-glass ducts.
  - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
  - 3. Factory-insulated flexible ducts.
  - 4. Factory-insulated plenums and casings.
  - 5. Flexible connectors.
  - 6. Vibration-control devices.
  - 7. Factory-insulated access panels and doors.

### 3.15 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:

1. None.
2. PVC: 20 mils thick.
3. Aluminum, Smooth: 0.016 inch thick.

D. Ducts and Plenums, Exposed:

1. None.
2. PVC: 20 mils thick.
3. Aluminum, Smooth: 0.016 inch thick.

E. Piping, Concealed:

1. None.
2. PVC: 20 mils thick.
3. Aluminum, Smooth: 0.016 inch thick.

F. Piping, Exposed:

1. None.
2. PVC: 20 mils thick.
3. Aluminum, Smooth: 0.016 inch thick.

3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

END OF SECTION 23 07 00



SECTION 23 09 00 - CONTROLS AND INSTRUMENTATION

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. General Provisions for Mechanical General Requirements Section 15010 shall apply to all work performed under this section of the specifications and shall be considered a part of this section.

1.2 GENERAL

- A. Furnish and install, as hereinafter specified, an electric/electronic temperature control system. The system shall be comprised of independent Stand-Alone Controllers, electric/electronic control equipment, thermostats, sensors, controllers, valves, panels, and related hardware and other accessory equipment, along with a complete system of electrical control wiring to fill the intent of the specifications and provide for a complete and operable system. Systems and components manufactured under ISO-9001 certification are preferred. Acceptable manufacturers shall be Johnson, Andover or Siemens.
- B. All control equipment shall be fully proportioning unless specifically called out to be two position, and the latest state-of-the-art in manufacture and design. Unless otherwise specified, the following control and actuation shall be employed for the different systems:

<u>System</u>	<u>Control</u>	<u>Actuation</u>
Fan Coil Units	Electric	Electronic
Exhaust Fans	Electric	Electronic

- C. The control systems shall be installed by competent control mechanics and electricians regularly trained by the manufacturer of the control equipment. All control equipment shall be the product of one (1) manufacturer and all ATC components shall be capable of interfacing with the HVAC equipment. The factory trained control contractor must maintain adequate staff and offer standard services to fully support the owner in the timely maintenance, repair, and operation of the control system. Contractors who do not maintain such staff and offer services or must develop some for this project are not acceptable. Bids from franchised dealers or others whose principal business is not the installation and service of temperature control systems will not be acceptable.
- D. All products shall be provided with the following agency approvals. With the submittal documents, verification that the approvals exist for all submitted products, shall be provided. Systems or products not currently offering the following approvals, are not acceptable.

UL-916; Energy Management System  
UL-873; Temperature Indication and Regulating Equipment  
UL-864; Subcategories UUKL, QVAX, UDTZ; Fire and Smoke Control Systems  
FCC; Part 15, Subpart J, Class A Computing Devices

All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National Codes.

### 1.3 SCOPE

- A. The control system provided shall consist of all microprocessors, transformers, transducers, relays, thermostats, dampers, damper operators, air terminal operators, valves, valve operators and all other necessary control components, along with a complete system of, interlocking and communication wiring /cabling to fill the intent of the specification and provide for a complete and operable system. Provide damper operators for equipment such as mixing dampers, where such operators are not supplied by the equipment manufacturers. Contractor shall provide time clock to index units from occupied mode to unoccupied mode.
- B. Emergency ventilation shutdown and all interlocking wiring required shall be provided by the ATC Subcontractor.
- C. The ATC Subcontractor shall review and study all HVAC, Electrical and Plumbing drawings and entire specification to familiarize himself with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc., he has to provide. Numerous references to the ATC Subcontractor are made throughout this specification identifying work to be performed under this Section in addition to work specifically indicated under this paragraph.
- D. All interlocking wiring and installation of control devices shall be provided by the ATC Subcontractor. Close coordination shall be exercised between the ATC Subcontractor and the HVAC Subcontractor and equipment manufacturers so that installation will be provided in a manner to result in fully operable systems, as intended in these specifications.
- E. Interfacing control and monitoring of manufacturer supplied controls shall be by this contractor.
- F. Provide incidental 110V power wiring to panels and control transformers where not shown on electrical drawings.

### 1.4 INCIDENTAL WORK BY OTHERS

- A. The following incidental work shall be furnished by the designated Subcontractor under the supervision of the ATC Subcontractor:
  - 1. The HVAC subcontractor shall coordinate required work with ATC and, without limiting the generality thereof, the work he is to perform for the ATC shall include the following:
    - a. Install automatic valves, sensor wells and other similar equipment that are specified to be supplied by the ATC Subcontractor.
    - b. Provide, on magnetic starter furnished, all necessary auxiliary contracts, with buttons and switches in required configurations.
    - c. Provide necessary blank-off plate (safing) required to install dampers that are smaller than duct size.
    - d. Provide access doors or other approved means of access through ceiling and walls for service to control equipment.
  - 2. The Electrical Subcontractor shall:

- a. Provide all power wiring (110 VAC or greater) to motors.

## 1.5 ELECTRIC WIRING

- A. All electric wiring, wiring connections and all interlocking required for the installation of the temperature control system, as herein specified, shall be provided by the ATC Subcontractor, unless specifically shown on the Electrical drawings or called for in the Electrical specifications. Power to valves and actuators shall be by the ATC Subcontractor, except as specifically noted in the Electrical drawings and specifications.
- B. All wiring shall comply with the requirements of the Electrical Section of the specifications.

## 1.6 SUBMITTAL BROCHURE

- A. The following shall be submitted for Approval:
  - 1. Control drawings with detailed piping and wiring diagrams, including bill of material and a written sequence of operation for each system controlled by the ATC Contractor. Diagrams shall include individual wiring and tubing marking designation, interlock details and wiring details of interfaces to other manufacturers system.
  - 2. A symbol key and an overall Architecture Diagram.
  - 3. Panel layouts and nameplate lists for all local and central panels.
  - 4. Valve schedules showing size, configuration, capacity and location of all equipment.
  - 5. Data sheets for all control system components.
  - 6. Control strategies (software flow charts) must be included within the second ATC shop drawing submittal. The listing of each strategy must be in English and demonstrate the desired ATC sequence of operation. Submittal must be complete with proposed schedules, listing of setpoints and end device point listing and addresses.

## 1.7 GUARANTEE

- A. The system specified herein and shown on the drawings shall be guaranteed to be free from original defects in both material and workmanship and shall perform to manufacturer specification for a period of one (1) year of normal use and service, excepting damages from other causes. Systems which are manufactured ISO-9001 certification are preferred. This guarantee shall become effective starting the date the Contract work is accepted as complete by the Architect on behalf of the Owner and in accordance with the General Provisions/Conditions.
- B. Upon completion of the installation, the ATC Subcontractor shall submit to the Owner an agreement to provide the necessary programmed maintenance, to keep the various control systems in proper working condition beyond the guarantee period. Additionally, this contractor shall submit to the owner its standard agreement to support the system operation. This service must include operators support, application support, remote diagnostic support as well as database management support. This service shall be available 365 days/year, 24 hours a day.

- C. This programmed maintenance agreement shall fully describe the maintenance work to be performed and shall advise as to the cost of this work prior to awarding of Contract.

## 1.8 INSTRUCTION AND ADJUSTMENT

- A. Upon completion of the project, the ATC Subcontractor shall:
  - 1. Fine-tune and “de-bug” all software control loops, routines, programs and sequences of control associates with the control system supplied.
  - 2. Completely adjust and make ready for use, all transmitters, relays, valves, etc., provided under this Section. This contractor shall furnish copies of complete, detailed, calibrating checkout and commissionary documentation for each controller. Documentation shall list each procedure and shall be signed by the control specialist performing the service.
  - 3. Furnish a complete set of system operation manuals, including standard manufacturers’ operating manuals, complete as-built installation diagrams, and complete software hardcopy documentation, as well as a magnetic media back-up.
  - 4. Provide an on-site training program for the Owner’s staff in the operation and use of the control system. Training shall include two (2) segments, as follows:
    - a. Segment 1 shall include 4 hours of classroom and hands-on training. This segment shall instruct personnel in the system configuration, component characteristics, control strategy on each controlled system and all requirements for daily operation and use of the system. This segment shall give the Owner’s representative a working proficiency in the day-to-day operational requirements (i.e., system monitoring, alarm acknowledgment, HVAC system troubleshooting techniques, setpoint and time schedule adjustments, manual override, etc.).
    - b. Segment 2 shall include 8 hours of onsite training. This segment will be geared for the Owner’s designated prime operator. An emphasis on overall software management and manipulation shall be made, to allow the prime operator(s) to make control strategy and overall facility and system management changes as required. Attendees shall have attended Segment 1.
    - c. All training shall take place at the site and at times mutually agreed to between the ATC Subcontractor and the Owner. The ATC Subcontractor shall provide to the Owner’s designated representative, at least three (3) weeks before each segment, a course syllabus outline and schedule. The ATC Subcontractor shall provide all training material, reference material and training aids, as required, all as part of his Contract cost.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT

- A. General
  - 1. The system shall be comprised of network of Stand-Alone controllers. Controls for each system shall be provided as described in the sequences of operation and shall interface to the with the control equipment specification.

## 2.2 STAND-ALONE CONTROLLERS

- A. Stand-Alone Controllers shall be Honeywell manual, round thermostat with heat/ cool and fan on/off/auto option.

## 2.3 AUTOMATIC CONTROL VALVES

- A. Control valves shall three-way pattern as shown, constructed for tight shut off and shall operate satisfactorily against system pressures and differentials. Valves with size up to and including 2" shall be screwed with 250 psi ANSI pressure body rating; 2 1/2" and larger valves shall be flanged configuration. Proportional control valves shall be sized for a maximum pressure drop of 4.0 psig at rated flow (except as noted). Two-position control valves shall be line size and shall be provided with a 250 psi static pressure body rating.
- B. All valves shall be capable of operating in sequence when required by the sequence of operation. All control valves shall be sized by the control manufacturer and shall be guaranteed to meet heating and cooling loads specified.
- C. All control valves shall be suitable for the pressure conditions and shall close against the differential pressure involved. Valve operator connection type (screwed or flanged) shall conform to pipe system.
- D. All valves sequenced with other valves, or control devices, shall be equipped with pilot positioners or panel mounted positive positioning relays to ensure proper control sequencing.
- E. Hot water control valves shall be normally open, single seated type with equal percentage flow characteristics. The valve discs shall be composition type with bronze trim.
- F. Chilled water control valves shall be single seated type with equal percentage flow characteristics, normally closed. The valve discs shall be composition type with bronze trim.
- G. Valves shall be sized on the exact pressure drop for the equipment served to prevent over or under sizing the valves. Provide a separate submittal with all of this information included.

## 2.4 MISCELLANEOUS CONTROL PANELS

- A. Details of each panel shall be submitted for review prior to fabrication. Locations of each panel shall be convenient for adjustment and service. Provide engraved nameplate beneath each panel mounted control device clearly describing the function of said device and range of operation. All manual switches shall be flush mounted on the hinged door.
- B. All electrical devices within the panels shall be factory pre-wired to a numbered terminal strip. All wiring within the panel shall be in accordance with NEMA and UL Standards and shall meet all Local Codes.

END OF SECTION 23 09 00

SECTION 23 09 93 – SEQUENCE OF OPERATIONS

PART 1 - GENERAL

1.1 GENERAL

- A. Provide controls to make systems function in accordance with good practice considering energy conservation and actual intended use for all equipment that is not covered by these descriptions. All starters shall have HAND/OFF/AUTO function. Label all starters with phenolic nameplates indicating equipment serviced.

1.2 SEQUENCE OF OPERATION

A. Fan Coil Units

1. Heating Occupied

Outside air damper shall open. The room thermostat shall cycle the unit fan & modulate the control valve as required to maintain the space temperature setting of 72 degrees (adjustable) as sensed by the remote mounted temperature sensor.

2. Heating unoccupied

Outside air damper shall be closed. The room thermostat shall cycle the unit fan & modulate the control valve as required to maintain the space set-back temperature setting of 65 degrees (adjustable) as sensed by the remote mounted temperature sensor.

3. Cooling Occupied

Outside air damper shall open. The room thermostat shall cycle the unit fan & open control valve in two position fashion as required to maintain the space temperature setting of 75 degrees (adjustable) as sensed by the remote mounted temperature sensor.

4. Cooling unoccupied

Outside air damper shall be closed. The unit fan shall be de-energized and valve shall be closed.

5. Fan coil units that serve cells shall not have an unoccupied mode.

B. Exhaust Fan

Exhaust fan EF-1 shall run continuously in the occupied mode and be off in the unoccupied mode.

C. Emergency Ventilation Shutdown

Tie new fancoil units into existing system. Upon activation new fancoils and new exhaust fan shall stop and outside air dampers shall close.

END OF SECTION 23 09 93

## SECTION 23 21 13 – HYDRONIC PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
1. Hot-water heating piping.
  2. Chilled-water piping.
  3. Condensate-drain piping.
  4. Air-vent piping.

#### 1.2 SUBMITTALS

- B. Product Data: For each type of the following:
1. All pipe and fittings.
  2. Pressure-seal fittings.
  3. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
  4. Air control devices.
  5. Hydronic specialties.
- C. Shop Drawings: Detail, at minimum  $\frac{1}{4}"=1'-0"$  scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
- D. Field quality-control test reports.
- E. Operation and maintenance data.

#### 1.3 QUALITY ASSURANCE

- F. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- G. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

### PART 2 - PRODUCTS

#### 2.1 COPPER TUBE AND FITTINGS

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

- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Fittings: ASME B16.22.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International, Inc.
    - b. S. P. Fittings; a division of Star Pipe Products.
    - c. Victaulic Company of America.
  - 3. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting with copper tube dimensioned grooved ends (flaring of tube and fitting ends to IPS dimensions is not permitted).
  - 4. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated Grade EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.
- E. Wrought-Copper Unions: ASME B16.22.

## 2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
- F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
  - 1. Material Group: 1.1.
  - 2. End Connections: Butt welding.
  - 3. Facings: Raised face.
- G. Grooved Mechanical-Joint Fittings and Couplings:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:



- a. Anvil International, Inc.
  - b. Central Sprinkler Company; a division of Tyco Fire & Building Products.
  - c. National Fittings, Inc.
  - d. S. P. Fittings; a division of Star Pipe Products.
  - e. Victaulic Company of America.
3. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
4. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- a. Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with ASME B31.1 and B31.9.
    - 1) 2" through 8" Sizes: Installation-ready, stab-on design with Grade EHP EPDM gasket suitable for hot water systems up to 250 deg F. Similar to Victaulic Style 107H QuickVic™.
    - 2) 10" and 12" Sizes: Standard rigid coupling with Grade E EPDM gasket suitable for hot water systems up to 230 deg F. Similar to Victaulic Style 07 Zero-Flex®.
    - 3) 14" and Larger Sizes: AGS grooved coupling with two ductile iron housings cast with a wide key profile and flat bolt pads for metal-to-metal contact. Wide-width, pressure-responsive, synthetic rubber gasket of a FlushSeal® design, Grade E EPDM suitable for hot water up to 230 deg F. Similar to Victaulic Style W07.
  - b. Flexible Type: Use in locations where vibration attenuation and stresses relief are required. Flexible couplings may be used for vibration isolation at equipment connections. A minimum of three (3) couplings, for each connector shall be placed in close proximity to the close proximity to the source of the vibration.
    - 1) 2" through 8" Sizes: Installation-ready, stab-on design with Grade EHP EPDM gasket suitable for hot water systems up to 250 deg F. Similar to Victaulic Style 177 QuickVic™.
    - 2) 10" and 12" Sizes: Standard flexible coupling with Grade E EPDM gasket suitable for hot water systems up to 230 deg F. Similar to Victaulic Style 75 or 77.
    - 3) 14" and Larger Sizes: AGS grooved coupling with two ductile iron housings cast with a wide key profile and flat bolt pads for metal-to-metal contact. Wide-width, pressure-responsive, synthetic rubber gasket of a FlushSeal® design, Grade E EPDM suitable for hot water up to 230 deg F. Similar to Victaulic Style W77.
5. Flange Adapters: Ductile iron housing conforming to ASTM A536, flat faced, designed for incorporating flanged components with ANSI Class 125 and 150 bolt-hole patterns to a grooved piping system. Similar to Victaulic Style 741 and W741. For Class 300 flanges. Similar to Victaulic Style 743.

## 2.3 PLASTIC PIPE AND FITTINGS

- H. CPVC Plastic Pipe: ASTM F 441/F 441M, Schedules 40 and 80, plain ends as indicated in Part 3 "Piping Applications" Article.
- I. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.
- J. PVC Plastic Pipe: ASTM D 1785, Schedules 40 and 80, plain ends as indicated in Part 3 "Piping Applications" Article.
- K. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

## 2.4 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BA9-1, silver alloy for joining copper with bronze or steel.
- F. Solvent Cements for Joining Plastic Piping:
  - 1. CPVC Piping: ASTM F 493.
    - a. Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    - b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
    - a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    - b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- G. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

## 2.5 TRANSITION FITTINGS

### A. Plastic-to-Metal Transition Fittings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Charlotte Pipe and Foundry Company.
  - b. IPEX Inc.
  - c. KBi.
3. CPVC and PVC one-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cement-joint end.

### B. Plastic-to-Metal Transition Unions:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Charlotte Pipe and Foundry Company.
  - b. IPEX Inc.
  - c. KBi.
  - d. NIBCO INC.
3. MSS SP-107, CPVC and PVC union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

## 2.6 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

### C. Dielectric Unions:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Capitol Manufacturing Company.
  - b. Central Plastics Company.
  - c. Hart Industries International, Inc.
  - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
3. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Couplings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Calpico, Inc.
  - b. Lochinvar Corporation.
3. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

2.7 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."
- C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Armstrong Pumps, Inc.
  - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
  - c. Flow Design Inc.
  - d. Gerand Engineering Co.
  - e. Griswold Controls.
  - f. Taco.
  - g. Tour & Andersson
3. Body: Bronze, ball or plug type with calibrated orifice or venturi.
4. Ball: Brass or stainless steel.
5. Plug: Resin.
6. Seat: PTFE.
7. End Connections: Threaded or socket.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. Multiple-turn digital readout handwheel and concealed memory feature with locking, tamper-proof setting.
11. CWP Rating: Minimum 125 psig.
12. Maximum Operating Temperature: 250 deg F.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Bell & Gossett Domestic Pump; a division of ITT Industries.
    - b. Flow Design Inc.
    - c. Gerand Engineering Co.
    - d. Griswold Controls.
    - e. Macon
  3. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
  4. Ball: Brass or stainless steel.
  5. Stem Seals: EPDM O-rings.
  6. Disc: Glass and carbon-filled PTFE.
  7. Seat: PTFE.
  8. End Connections: Flanged or grooved.
  9. Pressure Gage Connections: Integral seals for portable differential pressure meter.
  10. Handle Style: Lever, with memory stop to retain set position.
  11. CWP Rating: Minimum 125 psig.
  12. Maximum Operating Temperature: 250 deg F.
- E. Diaphragm-Operated, Pressure-Reducing Valves:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Amtrol, Inc.
    - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    - c. Conbraco Industries, Inc.
    - d. Spence Engineering Company, Inc.
    - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  3. Body: Bronze or brass.
  4. Disc: Glass and carbon-filled PTFE.
  5. Seat: Brass.
  6. Stem Seals: EPDM O-rings.
  7. Diaphragm: EPT.
  8. Low inlet-pressure check valve.
  9. Inlet Strainer: removable without system shutdown.
  10. Valve Seat and Stem: Noncorrosive.
  11. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- F. Diaphragm-Operated Safety Valves:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Amtrol, Inc.
    - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    - c. Conbraco Industries, Inc.
    - d. Spence Engineering Company, Inc.

- e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 3. Body: Bronze or brass.
  - 4. Disc: Glass and carbon-filled PTFE.
  - 5. Seat: Brass.
  - 6. Stem Seals: EPDM O-rings.
  - 7. Diaphragm: EPT.
  - 8. Wetted, Internal Work Parts: Brass and rubber.
  - 9. Inlet Strainer: removable without system shutdown.
  - 10. Valve Seat and Stem: Noncorrosive.
  - 11. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
  
- G. Automatic Flow-Control Valves:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Flowcon International.
    - b. Flow Control Industries.
    - c. Flow Design Inc.
  - 3. Body: Brass or ferrous metal.
  - 4. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
  - 5. Combination Assemblies: Include bronze or brass-alloy ball valve.
  - 6. Identification Tag: Marked with zone identification, valve number, and flow rate.
  - 7. Size: Same as pipe in which installed.
  - 8. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
  - 9. Minimum CWP Rating: 300 psig.
  - 10. Maximum Operating Temperature: 250 deg F.

## 2.8 AIR CONTROL DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Spirotherm – No Exceptions
- C. Manual Air Vents:
  - 1. Body: Bronze.
  - 2. Internal Parts: Nonferrous.
  - 3. Operator: Screwdriver or thumbscrew.
  - 4. Inlet Connection: NPS 1/2.
  - 5. Discharge Connection: NPS 1/8.
  - 6. CWP Rating: 150 psig.
  - 7. Maximum Operating Temperature: 225 deg F.

## 2.9 HYDRONIC PIPING SPECIALTIES

### A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

### B. Grooved End Strainers:

1. Y-Pattern, 2 inch to 18 inch: ASTM A 536, ductile iron body, Type 304/304L stainless steel metal removable basket with 0.62, 0.125 or 156 inch diameter perforations, blow down port fitted with pipe plug, 300 psig pressure rating. Similar to Victaulic Series 732 or W732.
2. T-Pattern, 2 inch to 24 inch: ASTM A 536 ductile iron or ASTM A 53 carbon steel body, Type 304/304L stainless steel mesh removable basket with No. 12, 6, or 4 mesh sizes, removable coupling and end cap, or T-bolt hinged closure/cap for strainer maintenance, up to 750 psig pressure rating. Similar to Victaulic Series 730 or W730. Combinations of grooved mechanical couplings and short nipples may also be used.

### C. EPDM Bellow, Flexible Connectors are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

### D. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

#### A. Hot-water heating piping, aboveground, NPS 2 and smaller shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

#### B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger shall be any of the following:

1. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints or
2. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

#### C. Hot-Water Heating Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered or brazed joints. Use the fewest possible joints.

#### D. Chilled-water piping, aboveground, NPS 2 and smaller, shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

#### E. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any one of the following:

1. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
  2. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- F. Chilled-Water Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered or brazed joints. Use the fewest possible joints.
- G. Condensate-Drain Piping: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- H. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.
- I. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- J. Air-Vent Piping:
1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
  2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- K. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

### 3.2 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing and throttling duty valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

### 3.3 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe



- and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
  - C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
  - D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
  - E. Install piping to permit valve servicing.
  - F. Install piping at indicated slopes.
  - G. Install piping free of sags and bends.
  - H. Install fittings for changes in direction and branch connections.
  - I. Install piping to allow application of insulation.
  - J. Select system components with pressure rating equal to or greater than system operating pressure.
  - K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
  - L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
  - M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
  - N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
  - O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
  - P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
  - Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
  - R. Install flanges or grooved couplings in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
  - S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
  - T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

- U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

### 3.5 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.
- B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
  - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
  - 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 2. NPS 1: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 4. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  - 5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  - 6. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
  - 7. NPS 3: Maximum span, 12 feet; minimum rod size, 1/2 inch.
  - 8. NPS 3-1/2: Maximum span, 13 feet; minimum rod size, 1/2 inch.
  - 9. NPS 4: Maximum span, 14 feet; minimum rod size, 5/8 inch.
- E. Install hangers for drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.
  - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
  - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  - 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  - 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 1/2 inch.
  - 7. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
- F. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

### 3.6 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
  - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- I. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
- J. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

### 3.7 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

- C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
- D. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.
- E. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
  - 1. Install tank fittings that are shipped loose.
  - 2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

### 3.8 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

### 3.10 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
  - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
  - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
  - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
  - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
  - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
  - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
  - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
  - 3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
  5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
  6. Prepare written report of testing.
- C. Perform the following before operating the system:
1. Open manual valves fully.
  2. Inspect pumps for proper rotation.
  3. Set makeup pressure-reducing valves for required system pressure.
  4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
  5. Set temperature controls so all coils are calling for full flow.
  6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
  7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13

## SECTION 23 31 13 - METAL DUCTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

##### B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

#### 1.3 SUBMITTALS

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

##### B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.

4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
  - a. Lighting fixtures.
  - b. Air outlets and inlets.
  - c. Speakers.
  - d. Sprinklers.
  - e. Access panels.
  - f. Perimeter moldings.

E. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports, AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports or AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

## PART 2 - PRODUCTS

### 2.1 RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Square throat round heel elbows are not allowed. Any square throat round heel elbows found installed by this contractor will be ordered to remove and replace with square throat square heel elbows with vanes at no additional cost to the project.

### 2.2 ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Lindab Inc.
    - b. McGill AirFlow LLC.
    - c. SEMCO Incorporated.
    - d. Sheet Metal Connectors, Inc.
    - e. Spiral Manufacturing Co., Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support



intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.4 DUCT LINER (ANTI MICROBIAL GROWTH)

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation; Insulation Group.
    - b. Johns Manville.
    - c. Knauf Insulation.
    - d. Owens Corning.
  2. Maximum Thermal Conductivity:
    - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F (24 deg C) mean temperature.
    - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F (24 deg C) mean temperature.
  3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
  4. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
    - a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick aluminum; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
  2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
  3. Butt transverse joints without gaps, and coat joint with adhesive.
  4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
  5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
  6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.

7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
  - a. Fan discharges.
  - b. Intervals of lined duct preceding unlined duct.
  - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
  - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.5 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
  1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
  2. Tape Width: 4 inches.
  3. Sealant: Modified styrene acrylic.
  4. Water resistant.
  5. Mold and mildew resistant.
  6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
  7. Service: Indoor and outdoor.
  8. Service Temperature: Minus 40 to plus 200 deg F.
  9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
  10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Water-Based Joint and Seam Sealant:
  1. Application Method: Brush on.
  2. Solids Content: Minimum 65 percent.
  3. Shore A Hardness: Minimum 20.
  4. Water resistant.
  5. Mold and mildew resistant.
  6. VOC: Maximum 75 g/L (less water).
  7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.

8. Service: Indoor or outdoor.
  9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
  2. Type: S.
  3. Grade: NS.
  4. Class: 25.
  5. Use: O.
  6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
  2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
  3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.
- 2.6 HANGERS AND SUPPORTS
- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## 2.7 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.; a division of Cooper Industries.
  2. Ductmate Industries, Inc.
  3. Hilti Corp.
  4. Kinetics Noise Control.
  5. Loos & Co.; Cableware Division.
  6. Mason Industries.
  7. TOLCO; a brand of NIBCO INC.
  8. Unistrut Corporation; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction].
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.

- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.[ Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."]

### 3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### 3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 2. Outdoor, Supply-Air Ducts: Seal Class A.
  - 3. Outdoor, Exhaust Ducts: Seal Class C.

4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

### 3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  1. Where practical, install concrete inserts before placing concrete.
  2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
  5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.6 DUCT CLEANING

- A. Clean all new and existing duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
  - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
  - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
  - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
  - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
  - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
  - 1. Air outlets and inlets (registers, grilles, and diffusers).
  - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
  - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
  - 4. Coils and related components.
  - 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
  - 6. Supply-air ducts, dampers, actuators, and turning vanes.
  - 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
  - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
  - 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
  - 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
  - 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
  - 5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
  - 6. Provide drainage and cleanup for wash-down procedures.
  - 7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.



### 3.7 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

### 3.8 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
  - 1. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior or stainless steel.
- B. Supply Ducts:
  - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
    - a. Pressure Class: Positive 2-inch wg.
  - 2. Ducts Connected to Constant-Volume Air-Handling Units:
    - a. Pressure Class: Positive 3-inch wg.
  - 3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
    - a. Pressure Class: Positive 4-inch wg.
  - 4. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive 4-inch wg.
- C. Return Ducts:
  - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
    - a. Pressure Class: Positive or negative 2-inch wg.
  - 2. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 3-inch wg.
  - 3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive 4-inch wg.
- D. Exhaust Ducts:
  - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
    - a. Pressure Class: Positive 3-inch wg.
  - 2. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive 4-inch wg.
  - 3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.

- a. Exposed to View: Type 304, stainless-steel sheet finish.
  - b. Concealed: Carbon-steel sheet (welded).
  - c. Welded seams and joints.
  - d. Pressure Class: Positive or negative 4-inch wg.
  - e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
  - f. SMACNA Leakage Class: 3.
4. Ducts Connected to Dishwasher Hoods:
- a. Type 304, stainless-steel sheet.
  - b. Exposed to View: stainless steel finish.
  - c. Concealed: aluminum or 304 stainless steel finish.
  - d. Welded seams and flanged joints with watertight EPDM gaskets.
  - e. Pressure Class: Positive or negative 4-inch wg.
  - f. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
  - g. SMACNA Leakage Class: 3.
5. Ducts Connected to Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air:
- a. Type 316 stainless-steel sheet.
  - b. PVC-coated, galvanized sheet steel with thicker coating on duct interior.
  - c. Pressure Class: Positive or negative 6-inch wg.
  - d. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
  - e. SMACNA Leakage Class: 3.
6. Ducts Connected to Equipment Not Listed Above:
- a. Pressure Class: Positive or negative 4-inch wg.
  - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
    - a. Pressure Class: Positive or negative 2-inch wg.
  2. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 2-inch wg.
  3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 2-inch wg.
- F. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
  2. PVC-Coated Ducts:
    - a. Exposed to Airstream: Match duct material.
  3. Stainless-Steel Ducts:
    - a. Exposed to Airstream: Match duct material.

4. Aluminum Ducts: Aluminum.

G. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
  - a. Velocity 1000 fpm or Lower:
    - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
    - 2) Mitered Type RE 4 with vanes.
  - b. Velocity 1000 to 1500 fpm:
    - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
  - c. Velocity 1500 fpm or Higher:
    - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
  - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
  - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
    - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
    - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
    - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
    - 4) Radius-to Diameter Ratio: 1.5.

- b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
- c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or welded.

H. Branch Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
  - a. Rectangular Main to Rectangular Branch: 45-degree entry.
  - b. Rectangular Main to Round Branch: Spin in.
- 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
  - a. Velocity 1000 fpm or Lower: 90-degree tap.
  - b. Velocity 1000 to 1500 fpm: Conical tap.
  - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13

## SECTION 23 33 00 - AIR DUCT ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Smoke dampers.
6. Flange connectors.
7. Turning vanes.
8. Duct-mounted access doors.
9. Flexible connectors.
10. Flexible ducts.
11. Duct accessory hardware.

#### 1.2 SUBMITTALS

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

##### B. LEED Submittal:

1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."

##### C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
  - a. Special fittings.
  - b. Manual volume damper installations.
  - c. Control damper installations.
  - d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
  - e. Wiring Diagrams: For power, signal, and control wiring.

##### D. Operation and maintenance data.

#### 1.3 QUALITY ASSURANCE

##### A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

##### B. Comply with AMCA 500-D testing for damper rating.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G60.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and top grade finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

### 2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Air Balance Inc.; a division of Mestek, Inc.
  - 2. Greenheck Fan Corporation.
  - 3. Nailor Industries Inc.
  - 4. Ruskin Company.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 4-inch wg.
- E. Frame: 0.063-inch thick extruded aluminum, with welded corners and mounting flange.
- F. Blades: Multiple opposed blades, with sealed edges.
- G. Blade Action: Opposed Blade.
- H. Blade Seals: Low leak, Neoprene, mechanically locked.
- I. Blade Axles:
  - 1. Material: Galvanized steel.

2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Galvanized steel.
- K. Return Spring: Adjustable tension.
- L. Accessories:
  1. Adjustment device to permit setting for varying differential static pressure.
  2. Counterweights and spring-assist kits for vertical airflow installations.
  3. Electric actuators.
  4. Chain pulls.
  5. Screen Mounting: Front mounted in sleeve.
    - a. Sleeve Thickness: 20-gage minimum.
    - b. Sleeve Length: 6 inches minimum.
  6. Screen Mounting: Rear mounted.
  7. Screen Material: Aluminum.
  8. Screen Type: Bird.
  9. 90-degree stops.

### 2.3 MANUAL VOLUME DAMPERS

#### A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Air Balance Inc.; a division of Mestek, Inc.
  - b. McGill AirFlow LLC.
  - c. Nailor Industries Inc.
  - d. Ruskin Company.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
  - a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
  - b. Mitered and welded corners.
  - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
  - a. Multiple or single blade.
  - b. Parallel- or opposed-blade design.
  - c. Stiffen damper blades for stability.
  - d. Galvanized-steel, 0.064 inch thick.
6. Blade Axles: Galvanized steel.
7. Tie Bars and Brackets: Galvanized steel.

#### B. Standard, Aluminum, Manual Volume Dampers:

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

- a. Air Balance Inc.; a division of Mestek, Inc.
  - b. McGill AirFlow LLC.
  - c. Nailor Industries Inc.
  - d. Ruskin Company.
2. Standard leakage rating, with linkage outside airstream.
  3. Suitable for horizontal or vertical applications.
  4. Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
  5. Blades:
    - a. Multiple or single blade.
    - b. Parallel- or opposed-blade design.
    - c. Stiffen damper blades for stability.
    - d. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
    - e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
  6. Blade Axles: Galvanized steel.
  7. Tie Bars and Brackets: Aluminum.
- C. Jackshaft:
1. Size: 1-inch diameter.
  2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
  3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- D. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
  2. Include center hole to suit damper operating-rod size.
  3. Include elevated platform for insulated duct mounting.

## 2.4 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
  2. Nailor Industries Inc.
  3. Ruskin Company.
  4. Young Regulator Company.
- B. Frames:
1. Angle shaped.
  2. Galvanized-steel channels, 0.064 inch thick.
  3. Mitered and welded corners.
- C. Blades:
1. Multiple blade with maximum blade width of 8 inches.
  2. Opposed-blade design.



3. Galvanized steel.
4. 0.064 inch thick.
5. Blade Edging: Closed-cell neoprene edging.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

D. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

## 2.5 FIRE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. Ruskin Company.

B. Type: Dynamic Out of Airstream; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 and 3 hours (as required for wall rating).

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

K. Heat-Responsive Device: Electric resettable link and switch package, factory installed, 165 deg F rated.

## 2.6 SMOKE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.

2. Greenheck Fan Corporation.
  3. Nailor Industries Inc.
  4. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Smoke Detector: Integral, factory wired for single-point connection.
- D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- F. Leakage: Class I / Class II (as required for assembly).
- G. Rated pressure and velocity to exceed design airflow conditions.
- H. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.
- I. Damper Motors: two-position action.
- J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
  3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
  4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
  5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
  6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
  7. Electrical Connection: 115 V, single phase, 60 Hz.
- K. Accessories:
1. Auxiliary switches for signaling, fan control, or position indication.
  2. Momentary test switch, Test and reset switches, damper remote mounted.
- 2.7 FLANGE CONNECTORS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.

2. Nexus PDQ; Division of Shilco Holdings Inc.
  3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

## 2.8 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
  2. Duro Dyne Inc.
  3. METALAIRE, Inc.
  4. SEMCO Incorporated.
  5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- E. Vane Construction: Single and Double wall.
- F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

## 2.9 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
  2. Greenheck Fan Corporation.
  3. McGill AirFlow LLC.
  4. Nailor Industries Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:
  - a. Double wall, rectangular.
  - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
  - c. Vision panel.
  - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
  - e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
  - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
  - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
  - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
  - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 10-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.10 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Ductmate Industries, Inc.
  2. Flame Gard, Inc.
  3. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
- D. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

## 2.11 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
  2. Duro Dyne Inc.
  3. Ventfabrics, Inc.
  4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd..
  2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd..
  2. Minimum Tensile Strength: 500 lbf/inch in the warp and 440 lbf/inch in the filling.
  3. Service Temperature: Minus 50 to plus 250 deg F.
- G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
  2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
  7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

## 2.12 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flexmaster U.S.A., Inc.
  2. McGill AirFlow LLC.
  3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

- B. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
  - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 10 to plus 160 deg F.
  
- C. Noninsulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.
  - 1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 20 to plus 175 deg F.
  
- D. Noninsulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire.
  - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 20 to plus 210 deg F.
  
- E. Noninsulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire.
  - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 20 to plus 210 deg F.
  
- F. Noninsulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil.
  - 1. Pressure Rating: 8-inch wg positive or negative.
  - 2. Maximum Air Velocity: 5000 fpm.
  - 3. Temperature Range: Minus 100 to plus 435 deg F.
  
- G. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
  - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 10 to plus 160 deg F.
  - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.
  
- H. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
  - 1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 20 to plus 175 deg F.
  - 4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1-2004.
  
- I. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
  - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 20 to plus 210 deg F.
  - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.

- J. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
  - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 20 to plus 210 deg F.
  - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.
  
- K. Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil; fibrous-glass insulation; polyethylene vapor-barrier film.
  - 1. Pressure Rating: 8-inch wg positive or negative.
  - 2. Maximum Air Velocity: 5000 fpm.
  - 3. Temperature Range: Minus 20 to plus 250 deg F.
  - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.
  
- L. Flexible Duct Connectors:
  - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
  - 2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

## 2.13 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
  
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
  
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
  
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
  
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  - 1. Install steel volume dampers in steel ducts.
  - 2. Install aluminum volume dampers in aluminum ducts.

- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. On both sides of duct coils.
  - 2. Upstream from duct filters.
  - 3. At outdoor-air intakes and mixed-air plenums.
  - 4. At drain pans and seals.
  - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
  - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  - 7. At each change in direction and at maximum 50-foot spacing.
  - 8. Upstream from turning vanes.
  - 9. Control devices requiring inspection.
  - 10. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
  - 1. One-Hand or Inspection Access: 12 by 12 inches.
  - 2. Two-Hand Access: 12 by 12 inches.
  - 3. Head and Hand Access: 18 by 12 inches.
  - 4. Head and Shoulders Access: 21 by 14 inches.
  - 5. Body Access: 30 by 30 inches.
  - 6. Body plus Ladder Access: 42 by 30 inches.
- K. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- N. Connect terminal units to supply ducts with maximum 6-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- O. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- P. Connect flexible ducts to metal ducts with draw bands.
- Q. Install duct test holes where required for testing and balancing purposes.
- R. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.



3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00

## SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Diffusers, registers and grilles – All Type.

B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

#### 1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified.

### PART 2 - PRODUCTS

#### 2.1 DIFFUSERS, REGISTERS AND GRILLES

A. Provide diffusers, registers and grilles for supply, return and exhaust outlets, of size, type, construction and design shown on Drawings.

B. Acceptable manufacturers:

1. Krueger
2. Metalaire
3. Price Industries
4. Titus
5. Tuttle & Bailey.

B. Equipment shall be tested and rated per ASHRAE 91-70.

C. Equipment shall handle air quantities at operating velocities:

1. With maximum diffusion within space supplied or exhausted.
2. Without objectionable air movement as determined by Architect.
3. With sound pressure level not to exceed NC 25.

- D. Supply, return and exhaust outlets shall have opposed blade volume dampers operable from front (unless otherwise noted).
- E. Supply registers shall have two sets of directional control blades.
- F. Diffusers within same room or area shall be of same type and style to provide Architectural uniformity.
- G. Diffusers, registers and grilles shall be furnished with gaskets and installed with faces set level and plumb, tightly against mounting surface.
- H. Diffusers, registers and grilles shall be aluminum construction and painted with white enamel. Finish shall receive final approval from the Architect prior to ordering.
- I. Provide all necessary equipment for complete installation, including: lined plenum boxes, frame types, etc.. as called for on the drawings.
- I. Coordinate diffusers, registers and grilles with ceiling and wall construction. Refer to Architectural Drawings for exact lengths and for framing and mitering arrangements that may differ from those shown on HVAC Drawings.

## 2.2 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

### 3.2 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

## SECTION 26 05 00 - BASIC ELECTRICAL MATERIALS AND METHODS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Work that applies to all sections of DIVISION 26
  - 2. Temporary electrical wiring
  - 3. Supporting devices for electrical components
  - 4. Removals (demolition) and relocations

#### 1.2 RELATED DOCUMENTS

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all **BASIC ELECTRICAL MATERIALS AND METHODS** work indicated on the drawings, herein specified or both.

#### 1.3 RELATED WORK SPECIFIED UNDER OTHER SECTIONS: (Read these DIVISIONS carefully. For purposes of bidding, assume that all work of the DIVISION referenced is to be performed under that DIVISION unless specifically indicated therein to be performed under the ELECTRICAL DIVISION.)

- A. Temporary wiring for building construction - see DIVISION 1.
- B. Cutting and patching - see DIVISION 17
- C. Access panels - see DIVISION 8.
- D. Painting of all backboards (on all sides and edges before mounting); painting of panels (trims and doors - 2 coats before mounting); painting of exposed electrical raceways, boxes and fittings - see DIVISION 9.
- E. Furnishing of magnetic starters for HVAC equipment - see DIVISION 23.
- F. Temperature controls, temperature control wiring, interlock wiring, and boiler control wiring (except as indicated on the electrical drawings) - see DIVISION 23.

#### 1.4 DEFINITIONS

- A. Provide: Furnish and install.
- B. Wiring: Wire, raceways, boxes and fittings.

#### 1.5 SUBMITTALS

- A. Product Data: For each product indicated

- B. Shop Drawings: Wiring and connection diagrams
- C. Manufacturers: Where the drawings or specifications list specific brands or catalog numbers, only these products may be used unless the words: "or approved equal" or "but are not limited to" are included.
- D. Limitations of approval: The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Engineer's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation, in a separate cover letter on Contractor's letterhead, at the time of submittal and the Engineer has given written approval to the specific deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Engineer's approval thereof.
- E. Contractor's responsibility: It is the responsibility of the Contractor to check all dimensions and details on shop drawings, before submission to the Engineer, reject same if necessary and only forward to the Engineer shop drawings which he is reasonably certain fulfill the requirements of the contract documents and the work. The approval of shop drawings by the Engineer shall be general only in character and not mean dimensions on drawings have been checked, and will in no way relieve the Contractor of the responsibility for proper fitting and construction of the work, nor from the necessity of furnishing materials or doing the work required by the drawings and/or specifications, which may not be indicated on the shop drawings when approved. All shop drawings shall be checked by the Contractor, and must bear the Contractor's stamp of approval; drawings submitted without this stamp of approval will not be considered.
- F. Samples: Provide all samples requested by the Engineer.
- G. Tests: Test the complete installation to prove it free from shorts, grounds, opens and faulty connections. Make any corrections necessary before acceptance.
  - 1. Test each function of each system including each device.
- H. Fault Current/Coordination Study: Provide a "Fault Current" and "Coordination Study" for the electrical distribution equipment for this project.
- I. Certification: Upon request, provide "Certification" (by a recognized testing agency or a Professional Engineer registered in the state where the project is located) that submitted items of equipment are suitable for their intended use.
- J. Record of Addenda and Change Orders: To avoid overlooking addenda and change order modifications, mark all changes on all copies of drawings and specifications, in a manor acceptable to the Engineer. One method of accomplishing this is to make copies and tape them on the back of the preceding page (tape all edges). Also, circle the changed area and note: see addenda #1, etc. If whole pages or sheets change, either remove the superseded document or put a bold "X" through it.
- K. Record Drawings: Owner's record drawings shall be updated as the project progresses. Maintain documents in a safe, dry location. Indicate clearly and accurately any changes necessitated by field conditions and dimension all raceways built into or under concrete slabs or buried under ground. Contractor to prepare as-built drawings in CAD format at contractor's expense. Contract drawings in CAD format to be furnished to contractor at no cost to contractor. Contractor to provide two compact discs and two hard copies of final as-built drawings.

- L. Operating Instructions and Manuals: Provide the Owner or his representative with complete operating instructions by qualified personnel of all electrical systems. Provide three (3) bound sets (indexed and bound in three sturdy three-ring binders) of operating and maintenance instructions of all electrical systems employed and all shop drawings.
- M. Manuals: Provide one (1) extra bound set of all shop drawings. Bind in a sturdy 3-ring binder.
- N. Letter of Confirmation: Include in the above manuals a letter confirming that the following items have been completed. Provide written receipt signed by the Owner or his representative indicating that the first 3 items listed below have been received.
  - 1. Keys have been provided for all locked electrical equipment.
  - 2. The provisions of the "Operating Instructions and Manuals" paragraph of these specifications have been met.
  - 3. Spare fuses have been provided.
  - 4. Identification is complete and in accordance with these specifications.
  - 5. As-built electrical drawings have been completed and submitted.
  - 6. All tests are complete and in accordance with these specifications.
  - 7. All required shop drawings have been submitted and approved.
  - 8. The entire installation has been accepted by all authorities.

#### 1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Do all wiring and provide all equipment in accordance with the prevailing issue of the National Electrical Code, State Building Code, State Fire Code, OSHA and any additional local rules or requirements.
- C. Obtain and pay for all necessary permits, certificates, etc. Present satisfactory proof of final inspection and approval by all inspection authorities.
- D. Consider the following Industry Standards as minimum requirements for all materials, equipment and systems where such standards are established for materials in question:
  - 1. National Board of Fire Underwriters
  - 2. National Electrical Manufacturers Association
  - 3. National Fire Protection Association
  - 4. Institute of Electrical and Electronic Engineers
  - 5. Local Electric Utility Company
  - 6. Local Telephone Company
  - 7. A nationally recognized testing laboratory (UL, ETL, etc.)
  - 8. Factory Mutual
  - 9. Americans with Disabilities Act
- E. Where applicable, this installation shall comply with the following NECA (National Electrical Contractors Association) "National Electrical Installation Standards." Except, if there is a conflict between this specification and these standards, the requirements of this specification shall prevail.
  - 1. NECA 1-2000 Standard Practices for Good Workmanship in Electrical Contracting

2. NECA 101-2001 Standard for Installing Steel Conduit (Rigid, EMT)
3. NECA/IESNA 500-1998 Recommended Practice for Installing Indoor Commercial Lighting Systems

#### 1.7 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings for electrical supports, raceways, and cable with general construction work.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment that requires positioning before closing in the building.
- C. Coordinate electrical service connections to components furnished by utility companies.

#### 1.8 SCHEDULING AND SHUTDOWNS:

- A. All work must be scheduled to allow the least interference with the normal operation of the existing facility. Schedule must be arranged to meet the approval of the Owner. All shutdowns of services (power, fire alarm, telephone, etc.) must be approved in writing by the Owner.
- B. All "shutdowns" must be done at other than normal working hours without additional compensation.
- C. All building services (power, fire alarm, telephone, lighting, emergency lighting, exit signs, etc.) must remain in operation during full period of construction. Provide temporary or permanent wiring (if required) to accomplish this.
- D. When an existing fire alarm system is modified or replaced with new, all existing devices must remain in operation until replaced with new devices that are fully tested, approved and operational. All non-functioning equipment shall be so labeled until it is removed or put into service.

#### 1.9 TEMPORARY ELECTRICAL WIRING: (Extended from existing building)

- A. Provide temporary electrical wiring of power and lighting for construction.
- B. Extend service from the electrical system of the existing building. However, if it is necessary to disrupt the existing service, provide new temporary service or generator. Do not overtax the service or distribution system. Provide a portable generator, if necessary.
- C. The Owner to pay the cost of energy consumed.
- D. Provide all required connections, panels, circuit breakers, feeders, branch circuit wiring, transformers, lighting fixtures, lamps, receptacles, switches, etc. for a complete and operating temporary electrical system.
- E. Provide a minimum of 5 footcandles of temporary general illumination throughout the floor area of the building, including all corridors and stairways.
- F. Existing lighting may be used where it is sufficient and remains energized.

- G. Provide feeders of sufficient capacity for the requirements of the work, sufficient number of outlets conveniently located so that extension cords not exceeding 100 feet will reach all work requiring artificial light or power.
  - H. All receptacles must be GFCI protected and the entire installation must comply with all applicable OSHA requirements.
  - I. At the end of the day's work, disconnect all lights and power, other than the minimum required security illumination.
  - J. Provide replacement light bulbs and maintenance of the temporary wiring system, as required, throughout the period of construction.
  - K. Conform to all codes and regulations.
  - L. Completely remove temporary wiring system upon completion of construction.
- 1.10 CHANGE ORDERS/PROPOSAL REQUESTS:
- A. During the course of construction, changes in the work may occur. When a significant change is to be made, a Proposal Request will be issued.
  - B. Provide a complete cost breakdown when responding to each Proposal Request.
  - C. Each item of work to be priced separately.
  - D. Each line item to be broken down including quantities and listing separately labor and material.
  - E. Both credits and extras shall be separately and clearly quantified.
  - F. Allowances for overhead and profit shall be as listed in the supplementary conditions.
  - G. If you become aware of a field condition, code requirement, error, or omission that you feel should result in a change to the work, please contact the Engineer for discussion. The Engineer may be able to clarify the situation and avoid unnecessary paperwork.
  - H. It is recognized that the Owner benefits when the construction process is a cooperative effort instead of an adversarial relationship. Reasonable give-and-take allows the construction process to move smoothly. Your efforts in this regard will be appreciated by all parties.
- 1.11 PACKAGED PRICES:
- A. It is in the facility owner's interest, that all bidders receive the best possible quotes on all materials during bidding so that any savings can result in a lower bid price. It is the policy of this Engineer not to specify brands that will result in "packaged" prices. Therefore, manufacturers' representatives are hereby notified that "packaged prices" are prohibited on this project. Upon request, suppliers are to provide bidders with complete material breakdown including each lighting fixture, system, component of system, each piece of equipment, etc. In keeping with this policy, Contractors are hereby cautioned not to anticipate deep discounts after the contract is awarded.



#### 1.12 INSPECTIONS/SITE OBSERVATIONS

- A. The authority having jurisdiction (usually the Municipal Electrical Inspector) shall be notified at periodic intervals that an inspection is requested. Inspections shall be requested at points of progress, meeting the approval of the inspector.
- B. Do not cover the work before the Engineer has had a chance to observe it in completed form. The electrical foreman shall request a meeting with the Engineer within 10 days after the start of electrical construction to assure that there is agreement on the scope of work and to answer questions.
- C. The electrical foreman shall provide assistance to the Engineer during site observations:
  - 1. Describe the progress of the electrical work in detail.
  - 2. Accompany the Engineer on his tour of the site, upon request.
  - 3. Provide use of a suitable ladder, scaffolding or bucket truck to observe the work, upon request.
  - 4. Remove ceiling tiles, panel trims, junction box covers, etc. for observation of the work, upon request.
  - 5. Provide use of project drawings, specifications and shop drawings.

#### 1.13 GUARANTEES/WARRANTIES:

- A. See other portions of the Project Manual for details on Guarantees and Warranties. However, minimum shall be one year from date of acceptance by the Engineer.
- B. The Owner reserves the right to make appropriate modifications or extensions of systems and equipment furnished under this contract during the guarantee/warranty period without "voiding" or modifying the guarantee/warranty of equipment and wiring installed under this contract. If manufacturer voids guarantee, it shall not relieve this contractor of his responsibilities for guarantee/warranty period.

#### 1.14 MISCELLANEOUS

- A. Provide all systems complete. Drawings and Specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both.
- B. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for a sound, secure and complete installation.
- C. All wiring and connections to be done with associated circuit de-energized.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS - General:

- A. All materials and equipment to be new unless specifically stated otherwise.

- B. Materials and equipment shall be suitable for their intended use and for the environment in which they are installed. For example, equipment located outside shall be weatherproof and constructed of materials that will not rust. This includes brackets, screws, etc.
- C. Coordinate all dimensions to make sure that boxes, raceways, equipment, fixtures, etc., fit properly in the finished construction. If special provisions, such as shallow boxes, are required, they shall be provided at no increase in contract price, regardless of catalog numbers listed in contract documents or on shop drawings.
- D. As it is not practical to enumerate in these specifications (or show on the drawings) all details of fittings and accessory equipment required for proper operation of the various electrical systems herein described, it is understood that they will be supplied without extra compensation. Provide all fittings, terminations, relays, components of panels and equipment, etc., needed for the best performance possible at the present state-of-the-art.

## 2.2 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs. Strength rating to suit structural loading.
- D. Slotted Channel Fittings and Accessories: Recommended by the manufacturer for use with the type and size of channel with which used.
  - 1. Materials: Same as channels and angles, except metal items may be stainless steel.
- E. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- F. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- G. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- H. Expansion Anchors: Carbon-steel wedge or sleeve type.
- I. Toggle Bolts: All-steel springhead type.

## 2.3 ELECTRICAL IDENTIFICATION

- A. Identification Device Colors: Use those prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Colored Adhesive Marking Tape for Wires and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick (25 mm wide by 0.08 mm thick).

- C. Tape Markers for Conductors: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- D. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

### PART 3 - EXECUTION

#### 3.1 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

#### 3.2 LAYOUTS

- A. The electrical system layouts indicated are generally diagrammatic and locations of outlets and equipment are approximate only; govern exact routing of wiring and locations of outlets and equipment by structural conditions and obstructions. This is not to be construed to permit redesigning systems. Interconnect as shown.
- B. Locate all equipment requiring maintenance and operation so that it will be readily accessible. The right is reserved to make any reasonable change in location of outlets and equipment prior to roughing-in without involving additional expense. This may involve slightly longer wiring runs, longer stems, additional mounting provisions, etc. Allow for this in your bid because additional compensation will not be provided. Items not specifically located on the plans shall (for the purposes of bidding) be assumed to be in the farthest, most difficult location. Exact location to be as directed in the field.

#### 3.3 ELECTRICAL SERVICE: (Existing)

- A. Existing electrical service shall remain.
  - 1. Service voltage is 120/208 volts, three phase, four wire.
- B. Conform to all requirements of the local electrical utility company, municipality and state.

#### 3.4 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials, slotted channel system components.
- B. Dry Locations: Steel materials.

- C. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four with, 200-lb (90-kg) minimum design load for each support element.

### 3.5 SUPPORT INSTALLATION

- A. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- B. Size supports for multiple raceway or cable runs so capacity can be increased by a 25 percent minimum in the future.
- C. Support individual horizontal single raceways with separate, malleable-iron pipe hangers or clamps except use spring-steel fasteners for 1-1/2-inch (38-mm) and smaller single raceways above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- D. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- E. Secure electrical items and their supports to building structure, using the following methods unless other fastening methods are indicated:
  - 1. Wood: Wood screws or screw-type nails.
  - 2. Gypsum Board: Toggle bolts. Seal around sleeves with joint compound, both sides of wall.
  - 3. Masonry: Toggle bolts on hollow block and expansion bolts on solid block. Seal around sleeves with mortar, both sides of wall.
  - 4. New Concrete: Concrete inserts with machine screws and bolts.
  - 5. Existing Concrete: Expansion bolts.
  - 6. Structural Steel: Welded threaded studs or Spring-tension clamps.
    - a. Comply with AWS D1.1 for field welding.
  - 7. Fasteners for Damp, Wet, or Weather-Exposed Locations: Stainless steel.
  - 8. Light Steel: Sheet-metal screws.
  - 9. Fasteners: Select so load applied to each fastener does not exceed 25 percent of its proof-test load.
  - 10. Light Steel Framing: sheet metal screws.

### 3.6 IDENTIFICATION MATERIALS AND DEVICES

- A. Provide typewritten directories, not smaller than 5" x 7", mounted under clear plastic affixed to the inside surface of all door-in-trim panels. Information shall include circuit numbers, type of load served and location of load served. For example: #1 Receptacles in rooms 5 & 6.
- B. Label the exterior of switchgear, distribution panels, power and lighting panels, cabinets, each switch of fuse switch panels, each disconnect switch (including those furnished under other sections) with engraved-plastic labels. Provide name of equipment (and use where appropriate). Also, identify each circuit, if a directory is not included. For example: Panel A "Lighting and Power." Provide nameplates called for elsewhere similar to above, unless otherwise noted. Provide a nameplate at each new pilot light. Identification shall include existing panels and equipment modified under this contract and additional existing items, as indicated.

- C. At each pull box, junction box and outlet box, each circuit contained therein shall be identified by panel designation and circuit number. This shall be accomplished by attaching hand written cardboard labels with string to each set of wires or by other agreed upon methods. In addition, where boxes are concealed, covers shall be marked with the same information using magic marker or other agreed upon means.
- D. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- E. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.
- F. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box.

3.7 COLOR CODE:

- A. Secondary service, feeders, and branch circuit conductors shall be color-coded as follows:

Phase	208/120 Volts
A	Black
B	Red
C	Blue
Neutral	White
Ground	Green
Isolated Ground	Green w/trace ID

- B. Permanently post at each panel.

3.8 SEQUENCE AND BALANCE:

- A. Maintain correct phase sequence of all feeders and circuits by establishing phase identification and maintaining correct relationship throughout the system. Provide line balance within 10% of normal loads.

3.9 FIRESTOPPING

- A. Apply firestopping to cable and raceway sleeves and other penetrations of fire-rated floor and wall assemblies to restore original undisturbed fire-resistance ratings of assemblies.
- B. Penetrations through exterior surfaces shall be made watertight.
- C. Floor boxes, fed from floor below, shall be fire-rated, poke-through type with UL labeled fire rating to match floor rating.

3.10 WORK INTERFERING WITH EXISTING WIRING:

- A. Make any necessary re-circuiting, extensions of existing circuits and relocations required to properly re-energize remaining existing devices or equipment that may be interfered with by new construction or removals.

3.11 REMOVALS (DEMOLITION) AND RELOCATIONS:

- A. Coordinate with DIVISION 2 section "Selective Demolition."
- B. Do all removal work in a neat and orderly manner so as not to endanger lives nor cause damage. Removal work to include all associated hangers, couplings, supports, raceway and wiring, etc., and shall be complete in every way.
- C. Remove and dispose of, off-site in a legal manner, all raceways and wire indicated to be removed.
- D. Carefully remove and store on-site, where directed by the Owner, all electrical equipment indicated to be REMOVED. After the Owner has examined this equipment, remove and dispose of, off-site in a legal manner, all of this equipment that the Owner does not want. All remaining equipment shall remain the property of the Owner. Relocate the remaining equipment to a permanent storage location on site where directed by the Owner.
- E. The electrical removal (demolition) drawings show the general extent of removals. However it is impractical to show every item; some of which may be concealed. Therefore, assume that you will be required to perform an additional 10% of removal work, without additional compensation. Items not shown to be removed or to remain shall remain or be removed, as directed.
- F. Prior to removing any electrical equipment, properly de-energize all associated wiring. Remove wires from terminals of supply switches or circuit breakers. Properly tape supply and load end conductors of all wiring remaining and not re-used. Properly tag both ends.
- G. Provide outlet boxes, knock-out seals, receptacle cover plates, etc. to leave remaining installation in finished condition.
- H. Take special care in removing equipment indicated to be RELOCATED and properly and thoroughly clean and lubricate this equipment. Renew fuses and overload elements in starters and switches being relocated, if required to properly serve the new installation.
- I. Adjust outlet and junction boxes as required to suit new finished surfaces.
- J. When necessary to perform your work, carefully remove ceiling tiles and properly re-install them. Make sure that hands are clean and take special care to avoid damage. If tiles become damaged, provide new tiles to exactly match existing. If existing tiles have yellowed with age, it may be necessary to relocate existing undamaged tiles from utility spaces (closets, etc.) and install new tiles in their place.
- K. For relocation of lighting fixtures, see sections entitled "Interior Lighting" and "Exterior Lighting."
- L. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

- M. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- N. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- O. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.12 CORE DRILLING:

- A. All holes through masonry surfaces must be "core drilled". This trade (specification section) is responsible for its respective core drilling, if any.
- B. Do not endanger any work by drilling or altering work or any part of it.
- C. Do not drill or alter work of another Contractor without written consent of the Engineer.
- D. Prior to drilling which affects structural safety of project, or work of another Contractor, submit written notice to the Engineer, requesting consent to proceed with cutting.
- E. Perform all work of core drilling to perfectly match the quality as specified throughout these specifications.

3.13 CLEANING, PAINTING AND REFINISHING:

- A. Paint all new plywood backboards on all sides and edges before mounting, under DIVISION 9.
- B. Thoroughly clean all new electrical equipment, devices and enclosures upon completion of all work.
- C. Refinish any new electrical equipment whose finish is damaged or rusted, as determined by the Engineer.

END OF SECTION 26 05 00

## SECTION 26 05 19 - CONDUCTORS AND CABLES (copper only)

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

#### 1.2 RELATED DOCUMENTS:

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all **CONDUCTORS AND CABLES (copper only)** work indicated on the drawings, herein specified or both.
- B. The applicable portions of section 260500 BASIC ELECTRICAL MATERIALS AND METHODS are hereby make a part of this section. It is important that you read that section carefully because it expands upon the requirements herein.

#### 1.3 QUALITY ASSURANCE

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

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

#### 2.2 CONDUCTORS AND CABLES

- A. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- B. Conductor Material: Copper complying with NEMA WC 5 solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.
- C. Conductor Insulation Types: Type THHN-THWN or XHHW complying with NEMA WC 5.



- D. Multiconductor Cable: Metal-clad cable, Type MC, Nonmetallic-sheathed cable, Type NM with ground wire.

### 2.3 CONNECTORS AND SPLICES

- A. Description: Spring type factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated. Push in type are not acceptable.

## PART 3 - EXECUTION

### 3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Metal-clad cable, Type MC.
- B. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
- C. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.
- D. Fire Alarm Circuits: see FIRE ALARM SECTION.

### 3.2 INSTALLATION

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Section "Basic Electrical Materials and Methods."
- F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."
- G. Identify and color-code conductors and cables according to Division 26 Section "Basic Electrical Materials and Methods."
- H. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.
- I. Where the number of current-carrying conductors in a raceway or cable exceeds three, the allowable ampacity shall be reduced per NEC table based on no diversity. Consider neutrals to be current carrying conductors.

- J. When branch circuits are combined using a common neutral, oversize the neutral to accommodate possible harmonic currents. On 20 amp (#12) branch circuits, use a #10 neutral.

### 3.3 CONNECTIONS

- A. Make all final connections required for a complete and fully operational facility.
- B. Wiring connections to equipment shall include connections to all accessories. For example, if a fan has an associated damper, the wiring must be extended from the fan to the damper at no additional charge. Another example is interconnection of equipment. Some items of equipment consist of several pieces, which must be interconnected before connecting to the circuit. No additional compensation will be paid for interconnections.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486 B.
- D. Avoid splices and taps, where feasible. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- E. Locations of junction boxes, stub-ups and disconnects are diagrammatic. At the time of design, the exact brand of equipment is usually not known. Therefore, the exact locations of connections are not known. For the purposes of bidding assume the worst, farthest locations. During construction, coordinate connections with final approved shop drawings and coordinate with other trades. Conform to manufactures written installation instructions. Provide working space in compliance with code.

### 3.4 FIELD QUALITY CONTROL

- A. All cables installed under this contract are to be protected from damage prior to installation, during installation and after installation. Store cable in a dry area protected from physical damage. Before installing cable, raceway to be clear, dry and free from burs or sharp edges. When cables pass through metal partitions provide permanently installed insulating bushings. This applies to all cables installed under this contract (systems, communications, etc.). Insulated bushings are to be installed prior to pulling in of cable. Cables to be installed back from edge of studs as required by Code.

END OF SECTION 26 05 19

## SECTION 26 05 33 - RACEWAYS AND BOXES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. See Division 7 Section "Through-Penetration Firestop Systems" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
- C. See Division 26 Section "Basic Electrical Materials and Methods" for supports, anchors, and identification products.
- D. See Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

#### 1.2 RELATED DOCUMENTS:

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all **RACEWAYS AND BOXES** work indicated on the drawings, herein specified or both.
- B. The applicable portions of section 260500 BASIC ELECTRICAL MATERIALS AND METHODS are hereby make a part of this section. It is important that you read that section carefully because it expands upon the requirements herein.

#### 1.3 SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details of custom enclosures and cabinets.

#### 1.4 QUALITY ASSURANCE

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

### PART 2 - PRODUCTS

#### 2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.

- B. EMT and Fittings: ANSI C80.3.
  - 1. Fittings: Set-screw or compression, steel. (Die-casts are not acceptable).
- C. FMC: Zinc-coated steel.
- D. LFMC: Flexible steel conduit with PVC jacket.
- E. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

## 2.2 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
- C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- D. Floor Boxes: Except, as otherwise indicated on the drawings, provide the following: Cast metal, fully adjustable, rectangular, flush with cast brass hinged receptacle cover plates. Floor boxes in concrete floors to have provisions for leveling after floor has set.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

## 2.3 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

- A. Outdoors:
  - 1. Exposed: Rigid steel. (Note: All raceways to be concealed unless otherwise indicated.)
  - 2. Concealed: Rigid steel.
  - 3. Underground, Single Run: RNC.
  - 4. Underground, Grouped: RNC.
  - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  - 6. Boxes and Enclosures: NEMA 250.

- B. Indoors:
  - 1. Exposed: EMT. (Note: all raceways to be concealed unless otherwise indicated).
  - 2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
  - 3. Damp or Wet Locations: Rigid steel conduit.
  - 4. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
    - a. Damp or Wet Locations: NEMA 250, Type 4.
- C. Minimum Raceway Size: 1/2-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.

### 3.2 INSTALLATION

- A. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Division 26 Section "Basic Electrical Materials and Methods."
- D. Install temporary closures to prevent foreign matter from entering raceways.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above finished slab.
- F. Make bends and offsets so ID is not reduced. Keep legs of bends in same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
  - 1. Install concealed raceways with a minimum of bends in shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.
  - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
  - 2. Space raceways laterally to prevent voids in concrete.
  - 3. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
  - 4. Change from nonmetallic tubing to rigid steel conduit before rising above floor.
  - 5. Do not run raceways in "topping" of precast concrete.
- I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.

1. Run parallel or banked raceways together on common supports.
  2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- J. Join raceways with fittings designed and approved for that purpose and make joints tight.
1. Use insulating bushings to protect conductors.
- K. Tighten set screws of threadless fittings with suitable tools.
- L. Terminations:
1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
  2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  2. Where otherwise required by NFPA 70.
- N. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- O. Flexible Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor in flexible conduit and in LFMC.
- P. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- Q. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
- R. Provide a minimum of 2-inch spacing between raceways underground or in concrete.
- S. Expansion fittings shall be provided in all raceways, if and where required.
- 3.3 PROTECTION
- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

## SECTION 26 24 19 – HVAC ELECTRICAL REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes:

1. Electrical work relating to the work of Division 23 "MECHANICAL".
2. Power Monitors: To disconnect power to motors, in the event of abnormal power conditions.

#### 1.2 RELATED DOCUMENTS:

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all **HVAC ELECTRICAL REQUIREMENTS** work indicated on the drawings, herein specified or both.
- B. The applicable portions of section 260500 BASIC ELECTRICAL MATERIALS AND METHODS are hereby make a part of this section. It is important that you read that section carefully because it expands upon the requirements herein.

#### 1.3 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Wiring and connection diagrams.

#### 1.4 QUALITY ASSURANCE

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

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

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



## 2.2 HVAC & PLUMBING

- A. Provide all wire, conduit, boxes and fittings for all HVAC and plumbing equipment and final connections. Conform to Division 16, Section "Conductors and Cables".
- B. Examine DIVISION 23 carefully for any work specified as performed under this Section and coordinate.
- C. Provide all disconnects according to Division 26, Section "Enclosed Switches and Circuit Breakers".
- D. Provide nameplates on all disconnects according to Division 26, Section "Basic Materials and Methods".
- E. Automatic starters to be furnished under DIVISION 23 and installed and wired (both sides) under this Section. Some starters may be variable frequency drive (VFD) type and may have built-in disconnects. Provide wiring on both sides. Some VFD's are large and heavy. Provide adequate mounting support and proper working space.
- F. Provide a manual starter (thermal toggle switch) at each motor not furnished with an automatic starter. Manual starters to consist of a manual operated toggle switch equipped with a melting alloy type thermal overload relay. Starters must be inoperative if thermal unit is removed. Mount at motor location.
- G. Temperature controls are provided under DIVISION 23. Temperature control wiring, interlock wiring, and boiler control wiring are provided under DIVISION 23, except as shown on the electrical drawings or indicated differently herein.
- H. Provide "Fire-O-Matic" detector, remote shut-off, and associated wiring for each boiler/furnace/water heater.
- I. Install and wire to electric heating units furnished under DIVISION 23.
- J. Provide power wiring to all control transformers and temperature control panels.
- K. Control valves and transformers for all heating units are furnished and installed under DIVISION 23.
- L. Do not use electrical drawings for location of feeds to mechanical equipment. In general, use mechanical drawings for bidding purposes and final approved mechanical shop drawings for actual installation. However, report any discrepancies to mechanical and electrical engineer for final determination, prior to installation.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install according to NEMA standards.
- B. Mount plumb and rigid without distortion of box.
- C. Provide supports and nameplates, according to Division 26 section "Basic Electrical Materials and Methods".

- D. Provide wiring according to Division 26, Section "Conductors and Cables".
- E. Provide raceways according to Division 26, Section "Raceways and Boxes".

END OF SECTION 26 24 19

## SECTION 26 27 26 - WIRING DEVICES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes the following:

1. Single and duplex receptacles, ground-fault circuit interrupters, and integral surge suppression units.
2. Snap switches and dimmer switches.
3. Device wall plates.
4. Floor service outlets, poke-through assemblies, service poles, and multi-outlet assemblies.
5. **Emergency lighting relays.**

#### 1.2 RELATED DOCUMENTS:

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all **WIRING DEVICES** work indicated on the drawings, herein specified or both.
- B. The applicable portions of section 260500 BASIC ELECTRICAL MATERIALS AND METHODS are hereby make a part of this section. It is important that you read that section carefully because it expands upon the requirements herein.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: Upon request.

#### 1.4 QUALITY ASSURANCE

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

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

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

1. Wiring Devices:

- a. General Electric Company: Wiring Device Division
- b. Bryant Electric, Inc./Hubbell Subsidiary.
- c. Hubbell Incorporated; Wiring Device-Kellems.
- d. Leviton Mfg. Company Inc.
- e. Pass & Seymour/Legrand; Wiring Devices Div.

2.2 RECEPTACLES

- A. Provide 20 amp., commercial specification grade, grounded, duplex receptacles. Color as selected by Architect. Provide additional receptacles to suit the particular equipment served. Catalog numbers are for General Electric Company.

20A/125V	Duplex Receptacle	GE #GCR-20
20A/125V	Single Receptacle	GE #4102
30A/125V/250V	4 Wire Receptacle	GE #1439-3
50A/125V/250V	4 Wire Receptacle	GE #4181-3
20A/125V	Duplex Receptacle	GE #5362-IG (Isolated Ground)
20A/125V	Single Receptacle	GE #4102-IG (Isolated Ground)
20A/125V	GFI Dup. Rec.	GE #GFR 5342

- 1. Provide other special duty receptacles as indicated on the drawings.
- 2. Receptacles mounted outdoors or in other wet or damp locations shall be GFI type and installed in weatherproof enclosures with key lock cover, the integrity of which is not affected when the receptacle is in use (attachment plug cap inserted).

2.3 SWITCHES

- A. Provide 20 amp, toggle type, "Federal Specification Grade" lighting switches. Color as selected by Architect. Catalog numbers are for General Electric Company.

Single pole	GE #5951	Three-way	GE #5953
Double pole	GE #5952	Four-way	GE #5954

2.4 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Provide smooth (unribbed) high-impact thermoplastic (nylon, PVC, Lexan or polycarbonate) switch and receptacle cover plates. Color as selected by Architect.
  - 3. Receptacles mounted outdoors or in other wet or damp locations shall be installed in weatherproof enclosures with key lock cover, the integrity of which is not affected when the receptacle is in use (attachment plug cap inserted).

2.5 EMERGENCY LIGHTING RELAYS

- A. Provide relays in emergency lighting circuits to cause emergency lights to automatically light whenever the emergency transfer switch goes to the emergency position, regardless of the position of the local switch.

- B. Provide SPDT transfer relays in NEMA #1 enclosure above accessible suspended ceiling or flush mounted adjacent to lighting panel. Provide one relay for each switch. Provide holding coils rated for continuous operation with 24 ampere contacts. Wire as indicated on the drawings or as directed.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install devices and assemblies level, plumb, and square with building lines.
- B. Install wall dimmers to achieve indicated rating after derating for ganging.
- C. Install unshared neutral conductors on line and load side of dimmers.
- D. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.
- E. Remove wall plates and protect devices and assemblies during painting.
- F. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings. However, obtain approval of adjustments from Architect/Engineer prior to installation.

#### 3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Basic Electrical Materials and Methods."
  - 1. Receptacles: Engrave each receptacle plate with panel designation and circuit number. (Brother P-Touch Labeling System is acceptable, in lieu of engraving.)
  - 2. Outlet boxes: Provide cardboard tags, tied to each wire inside all outlet boxes (receptacles, switches, motors, etc). Include panel designation and circuit number.

#### 3.3 CONNECTIONS

- A. Connect wiring according to Division 26 Section "Conductors and Cables."

#### 3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections:
  - 1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
  - 2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 26 27 26

## SECTION 26 28 13 - FUSES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Cartridge fuses rated 600 V and less.

#### 1.2 RELATED DOCUMENTS:

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all **FUSES** work indicated on the drawings, herein specified or both.
- B. The applicable portions of section 260500 BASIC ELECTRICAL MATERIALS AND METHODS are hereby make a part of this section. It is important that you read that section carefully because it expands upon the requirements herein.

#### 1.3 SUBMITTALS

- A. Product Data: For each fuse type indicated.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NEMA FU 1.
- C. Comply with NFPA 70.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Cooper Bussman, Inc.
  - 2. Tracor, Inc.; Littlefuse, Inc. Subsidiary.
  - 3. Gould

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.3 SPARE FUSE CABINET

- A. Cabinet: suitably identified, wall-mounted, lockable, compartmented steel cabinet, sized to hold spare fuses specified.
- B. Mount where directed.

PART 3 - EXECUTION

3.1 FUSE APPLICATIONS

- A. Provide all main, switchboard, and distribution panel fuses Class L, Class J, or Class RK1 current limiting time delay type. At other locations, provide Class J or Class RK1 dual-element, time-delay type fuses. "One-time", "renewable" and RK5 type fuses are not acceptable.
- B. Provide one spare set (3) of each size and type used. Where fuse sizes are not indicated, size per N.E.C.

<b>FUSE CLASS</b>	<b>LITTLEFUSE</b>	<b>BUSSMANN</b>	<b>GOULD</b>
L	KLPC	KRPC	A4BQ
J	JTD	LPJ	AJT
RK-1	LLSRK/LLNRK	LPSRK/LPNRK	A6D/A2D

3.2 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 26 28 13

## SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
  - 1. Fusible switches.
  - 2. Molded-case circuit breakers.
  - 3. Enclosures.

#### 1.2 RELATED DOCUMENTS:

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all **ENCLOSED SWITCHES AND CIRCUIT BREAKERS** work indicated on the drawings, herein specified or both.
- B. The applicable portions of section 260500 BASIC ELECTRICAL MATERIALS AND METHODS are hereby make a part of this section. It is important that you read that section carefully because it expands upon the requirements herein.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.

#### 1.4 QUALITY ASSURANCE

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

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.



## 2.2 FUSIBLE SWITCHES

- A. Manufacturers:
1. Square D/Group Schneider.
  2. General Electric Co.; Electrical Distribution & Control Division.
  3. Siemens Energy & Automation, Inc.
  4. Eaton Corporation; Cutler-Hammer Products.
- B. All fusible switches: shall be rated for the application voltage specified and have a UL listed short circuit rating to match the fuse installed. Provide heavy duty switches. General duty switches are unacceptable.
- C. Fusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Fusible switches, 800 amps and above: NEMA bolted pressure contact switches made by firmly bolting the switchblades to the stationary contact terminals and to the hinge terminals and meet UL 977.
- E. Double Throw Switches: Provide double throw (manual transfer switches) where shown. All double throw switches shall have switchblades, which are fully visible in the "OFF" position when the switch door is open. All current carrying parts shall be plated to resist corrosion and promote cool operation. Lugs shall be UL listed for 75° C, aluminum and copper conductors. The operating handle shall be an integral part of the box, not the cover. Provisions for padlocking the switch in the "OFF" position shall be provided. The handle position shall indicate whether the switch is "ON" or "OFF". Provide fusible type, unless otherwise indicated.
- F. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors. (Provide when neutral is available at switch).

## 2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers:
1. Square D/Group SchneiderEaton Corporation; Cutler-Hammer Products.
  2. General Electric Co.; Electrical Distribution & Control Division.
  3. Siemens Energy & Automation, Inc.
- B. Interrupting Capacity: Unless otherwise indicated, a "series-combination" system of interrupting capacity rating shall not be used.
- C. Switching Duty: All single pole circuit breakers to be rated SWD.
- D. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents. All main breakers to be 100% rated.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger. Adjust as prescribed in 3.2.
  2. Current-Limiting Circuit Breakers: Where needed.
  3. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity for personnel protection and 30-mA trip for equipment protection.
- E. Molded-Case Circuit-Breaker Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
  2. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.
  3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
  4. Ground-Fault Protection: With adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator. Provide ground-fault protection when indicated or where required by code.
  5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage. Provide shunt trip when indicated.
- F. Electronic trip-unit circuit breakers: where indicated or required, 100% rated, with RMS sensing, field-replaceable rating plug, trip indication (showing which adjustment caused trip) and the following field-adjustable settings, with interrupting capacity to meet available fault current.
1. Instantaneous trip
  2. Long-time pickup
  3. Short-time pickup
  4. Long-time delay
  5. Short-time delay
  6. Ground fault (if required)

## 2.4 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
1. Outdoor Locations: NEMA 250, Type 3R.
  2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
  3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Seismic Controls for Electrical Work."

- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Most manufactures of bolted pressure switches make for line entering top and load exiting bottom. Verify shop drawings before running conduits.
- F. Do not mount switches or circuit breakers upside down or side ways.
- G. Identify field-installed conductors, interconnecting wiring, and components; provide labels and warning signs as specified in Division 16 Section "Basic Electrical Materials and Methods."

### 3.2 CIRCUIT BREAKER ADJUSTMENTS

- A. Thermal-magnetic circuit breakers:
  - 1. Test circuit and correct deficiencies
  - 2. Set magnetic trip at minimum.
  - 3. Turn associated loads "on".
  - 4. Turn breaker on/off a minimum of six (6) times.
  - 5. If nuisance tripping occurs, set "up" one notch and repeat test.
  - 6. Repeat steps 4 and 5 until nuisance tripping no longer occurs.

### 3.3 FIELD QUALITY CONTROL

- A. Prepare for acceptance testing as follows:
  - 1. Inspect mechanical and electrical connections.
  - 2. Verify switch and relay type and labeling verification.
  - 3. Verify rating of installed fuses.
- B. Perform the following field tests and inspections.
  - 1. Perform visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION 26 28 16

## SECTION 26 51 00 - INTERIOR LIGHTING

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures with lamps and ballasts.
2. Lighting fixtures mounted on exterior building surfaces with lamps and ballasts.
3. Accessories, plaster rings, fasteners, etc.
4. Lamps in equipment (regardless of which specification Division that the equipment is supplied under). This includes lamps in fan/light combinations, heat lamps, lamps in medicine cabinets, etc.

#### 1.2 RELATED DOCUMENTS:

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all **INTERIOR LIGHTING** work indicated on the drawings, herein specified or both.
- B. The applicable portions of section 260500 BASIC ELECTRICAL MATERIALS AND METHODS are hereby make a part of this section. It is important that you read that section carefully because it expands upon the requirements herein.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Include data on features, accessories, and finishes.
- B. Shop Drawings: Show details of nonstandard or custom fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
- C. Operation and maintenance data.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. FMG Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

### PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
- B. Products: subject to compliance with requirements, provide the products indicated on the drawings, (no substitutions).**

## 2.2 LIGHTING FIXTURES

- A. See schedules on drawings.

## 2.3 FLUORESCENT LAMP BALLASTS

- A. Description: Include the following features, unless otherwise indicated:
  - 1. Designed for type and quantity of lamps indicated at full light output.
  - 2. Provide Class P, self protected ballasts.
  - 3. Subject to compliance with requirements, manufacturers offering products include but are not limited to the following: Advance, Osram Sylvania, General Electric, Magnetek, Motorola or Futron.
  - 4. Ballasts must be CBM and ETL certified and meet NEC and UL requirements.
  - 5. "Packaged Prices" for lighting fixtures are prohibited. See section 260500 – Basic Electrical Materials and Methods.
- B. Electronic ballasts for linear lamps shall include the following features, unless otherwise indicated:
  - 1. Comply with NEMA C82.11.
  - 2. Ballast Type: Instant start, unless otherwise indicated.
  - 3. Sound Rating: A.
  - 4. Total harmonic distortion rating of less than 20 percent according to NEMA C82.11.
  - 5. Transient Voltage Protection: IEEE C62.41, Category A.
  - 6. Operating Frequency: 20 kHz or higher.
  - 7. Lamp Current Crest Factor: Less than 1.7.
  - 8. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.
  - 9. Low Power: Provide low power ballasts for code 30 and code 32 power company rebate features.
- C. Ballasts for compact lamps in recessed fixtures shall have the following features, unless otherwise indicated:
  - 1. Type: Electronic or electromagnetic, as indicated.
  - 2. Power Factor: 90 percent, minimum.
  - 3. Flicker: Less than 5 percent.
  - 4. Lamp Current Crest Factor: Less than 1.7.
  - 5. Electronic Ballast Operating Frequency: 20 kHz or higher.
  - 6. Lamp end-of-life detection and shutdown circuit for electronic ballasts.
  - 7. Transient Protection: Comply with IEEE C62.41 for Category A1 locations.
- D. Ballasts for compact lamps in nonrecessed fixtures shall include the following features, unless otherwise indicated:

1. Power Factor: 90 percent, minimum.
2. Ballast Coil Temperature: 65 deg C, maximum.
3. Transient Protection: Comply with IEEE C62.41 for Category A1 locations.

#### 2.4 FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Basic Electrical Materials and Methods" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture).
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, 12 gage 2.68 mm.
- E. Wires For Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).
- F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Provide Unistrut support as necessary where the structure or other trades conflict.
- C. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
  1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from fixture corners.
  2. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
  3. Provide additional support, independent of ceiling grid for all fixtures (including incandescent) by use of jack chain having breaking strength of 3 times the weight of the fixture (minimum of #12). Fixtures over one foot in length shall be supported at all four corners.
  4. See section 260548, "Seismic Controls" for additional requirements.
- D. Suspended Fixture Support: As follows:
  1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
  2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

3. Continuous Rows (stem mounted): Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Continuous Rows (cable mounted): Suspend from cable.
5. Support: Per NEC 410-16.

E. Air-Handling Fixtures: Install with dampers closed and ready for adjustment.

F. Adjust aimable fixtures to provide required light intensities. Adjust all fixtures to the satisfaction of the Engineer. Adjustments required at night shall be done at no additional charge. Provide all equipment needed including scaffolding, if required.

### 3.2 RENOVATIONS

#### A. General

1. Fixtures indicated to be "RELOCATED": Thoroughly clean inside and outside with soap and water, dry, and provide new lamps.
2. Fixtures indicated to be "REMOVED": Carefully remove and store on the site, where directed, for future use by the Owner. However, properly dispose of any fixtures that the owner does not want, off the site. De-energize wiring or connect for feed-thru.
3. If outlet feeds thru to other devices, provide blank plates. If a new non-lift-out ceiling is mounted below, provide new wiring as required to eliminate the need for a junction box.
4. If outlet dead-ends, remove outlet and wiring.

#### B. PCB Ballast Disposal

1. Lighting ballasts manufactured prior to 1979 may contain PCB's (polychlorinated biphenyls). PCB's are themselves considered a hazardous substance and must be treated as such.
2. All PCB ballasts (lighting ballasts removed which are not clearly marked "Non-PCB") must be disposed of by incineration.
3. Disposal (including removal and temporary storage) of PCB ballasts must be done in a manner, which complies with all state and federal laws and regulations. Follow the state and federal laws and regulations associated with implementing safe removal and temporary storage of PCB ballast for the period between PCB ballast removal from the lighting fixture and removal from the facility. For information, you can contact the State Departments, which are associated with regulating proper disposal of hazardous substances at the following telephone numbers:

Rhode Island Department of Environmental Management  
(Division of Hazardous Waste) 401-277-2797

IF THE LOCAL POWER COMPANY OFFERS A REBATE PROGRAM FOR BALLAST REMOVAL, YOU MUST FULLY COMPLY WITH ALL THEIR REQUIREMENTS SO THAT THE PROJECT OWNER WILL RECEIVE THE REBATE.

4. Include in your bid, the services of a Hazardous Waste Contractor licensed by the state in which the project is located, who has a minimum of 2 years of experience. This contractor must provide a complete disposal service including: furnishing proper containers and labeling, site pickup, temporary storage, transportation, and

final disposal by incineration. This contractor shall also be responsible for proper incineration of "miscellaneous PCB contaminated debris" such as gloves, rags, plastic liners, etc.

5. Prior to hiring Hazardous Waste Contractor, submit name, qualifications and a copy of their license for approval. Upon completion of work, submit a "Certificate of Destruction" from the incineration facility.
6. No leaking PCB ballasts were observed at the site. Therefore, assume for the purposes of bidding that none will be encountered. However, if any leaking ballasts or contaminated fixture parts are found, they must be handled with special care and disposed of properly. Notify the Engineer for special instruction, if leaks are found.

END OF SECTION 26 51 00



## SECTION 28 37 00 – FIRE ALARM SYSTEM MODIFICATIONS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Provide an addition and modification to the existing automatic and manual, auxiliary connected fire alarm system, according to the following specifications to be wired, connected, tested and left in first class operating condition.
- B. Replace any existing equipment and wiring that is not compatible with the equipment that you provide or the modifications that you make, without additional compensation.
- C. Modify the control panel and add additional components as necessary to provide a fully functional fire alarm system in compliance with all current codes. All control panel components must be of the same manufacturer. Also, provide modifications and equipment necessary to accomplish functions specified in other sections, such as elevator capture. Provide battery calculations demonstrating that the entire fire alarm system will have full hours of backup as required by code and authority having jurisdiction.

#### 1.2 RELATED DOCUMENTS:

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all **FIRE ALARM SYSTEM MODIFICATIONS** work indicated on the drawings, herein specified or both.
- B. The applicable portions of section 260500 BASIC ELECTRICAL MATERIALS AND METHODS are hereby make a part of this section. It is important that you read that section carefully because it expands upon the requirements herein.

#### 1.3 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Wiring and connection diagrams.
- C. Submit shop drawings and product data to and obtain written approval from the authority having jurisdiction, prior to ordering fire alarm equipment and prior to installation of wiring and modifications to equipment.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with applicable sections of NFPA 72, Life Safety Code 101 and State Fire Safety Code.

- C. Comply with additional requirements of the authority having jurisdiction.
- D. Equipment must be UL listed and FM approved and installed per UL and FM requirements.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Requirements:
  - 1. All modifications to control equipment must be with the same brand of equipment as the existing.
  - 2. All devices must be U.L. listed as compatible with the control equipment.
  - 3. As it is not practical to enumerate in these specifications all details of fittings and accessory equipment required for proper operation of the system herein described, it is understood that they will be supplied by the contractor without extra compensation. Provide all fittings, terminations, etc., needed for the best performance possible at the present state-of-the-art.

### 2.2 EQUIPMENT

- A. Provide equipment as indicated on the drawings and as required to comply with the summary of the work.

### 2.3 WIRING

- A. The electrical subcontractor shall provide in accordance with manufacturer's instructions, all wiring, conduit and outlet boxes required for installation of a complete system as described herein and as shown on the drawings.
- B. Provide all wiring in metallic raceway. Provide No. 14 gauge, THWN, solid conductors and color code as required.
- C. Make final connections between control equipment and the wiring system under direct supervision of a representative of the manufacturer.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Mounting heights to comply with ADA requirements.
- B. Provide wiring according to Division 26, Section "Conductors and Cables", subject to the limitations herein stated.
- C. Provide raceways according to Division 26, Section "Raceways and Boxes", subject to the limitations herein stated.

### 3.2 ACCEPTANCE TESTING

- A. Before this installation shall be considered complete and acceptable to the awarding authorities, a complete test on the system shall be performed as follows: The electrical contractor's job foreman, in the presence of a representative of the manufacturer and a representative of the local fire department, shall operate each alarm initiating device and verify zone annunciation, audible and visual signaling and proper operation of the master box. Each circuit shall be opened at its most remote point to check for the correctness of the supervisory circuitry. When the above test has been completed (to the satisfaction of the manufacturer's representative, the electrical contractor's job foreman, and the local fire department,) a letter witnessed and co-signed by all attesting to the completion of this testing shall be forwarded to the Engineer. Test to include both new and existing wiring and equipment.

### 3.3 QUARTERLY TESTING

- A. Periodic testing is not part of this contract.

### 3.4 SERVICE CALLS

- A. Service calls during the warrantee period are part of this contract.
- B. Service calls resulting from acts of vandalism, acts of nature, or acts, which are beyond the control of the equipment manufacturer, are excluded under the guarantee/warrantee and shall be considered a billable call.

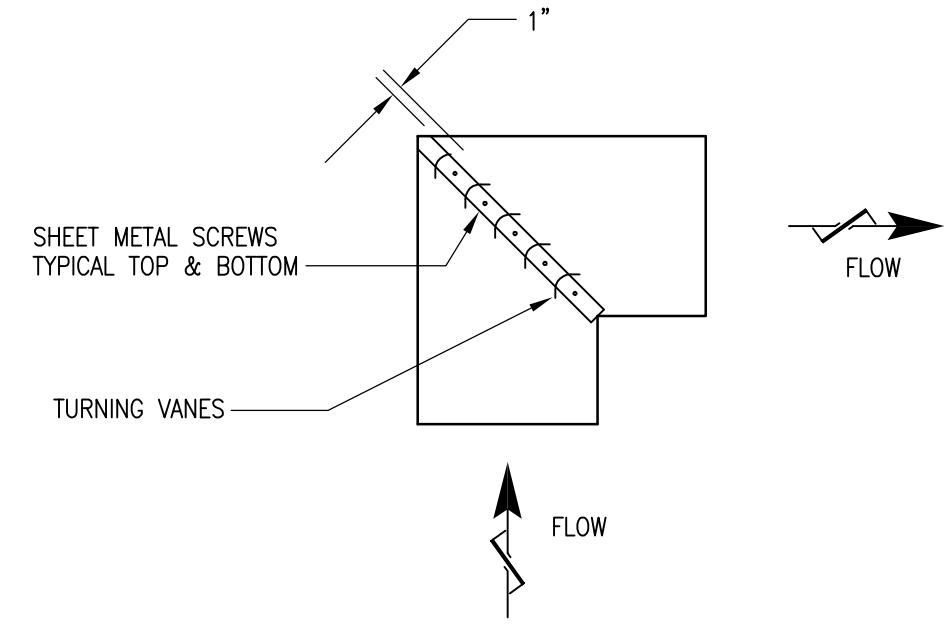
END OF SECTION 28 37 00

TAG NO.	FAN			COOLING/HEATING COIL												ELECTRICAL DATA				WEIGHT (LBS)	MANUFACTURER MODEL NUMBER	REMARKS					
	TOTAL CFM	OA CFM	ESP (IN WC)	TOTAL MBH	SENS MBH	GPM	% GLYCOL	EWT (°F)	LWT (°F)	EAT (°F)	LAT (°F)	WPD (FT)	MBH	GPM	% GLYCOL	EWT (°F)	LWT (°F)	EAT (°F)	LAT (°F)				WPD (FT)	POWER	V	PH	HZ
FCU-1	818	80	0.50	16.5	12.2	3.4	0	45	55	80/67	55/54	3.41	34.7	3.4	0	140	120	60	118.19	7.22	157 W	115	1	60	150	TRANE MODEL FCEB10	1,2,3,4,5,6
FCU-2	534	40	0.50	9.0	6.6	1.8	0	45	55	80/67	55/54	1.41	21.0	1.8	0	140	120	60	117.38	3.65	100 W	115	1	60	120	TRANE MODEL FCEB06	1,2,3,4,5,6
FCU-3	534	40	0.50	9.0	6.6	1.8	0	45	55	80/67	55/54	1.41	21.0	1.8	0	140	120	60	117.38	3.65	100 W	115	1	60	120	TRANE MODEL FCEB06	1,2,3,4,5,6
FCU-4	310	40	0.00	9.0	6.6	1.8	0	45	55	80/67	55/54	1.57	21.0	1.8	0	140	120	60	119.05	4.12	60 W	115	1	60	120	TRANE MODEL FCDB08	1,3,4,5,6
FCU-5	600	80	0.00	16.5	12.2	3.4	0	45	55	80/67	55/54	3.42	34.7	3.4	0	140	120	60	119.76	5.49	80 W	115	1	60	150	TRANE MODEL FCDB10	1,3,4,5,6

NOTES: 1. PROVIDE DISCONNECT. 2. PROVIDE HIGH STATIC MOTOR. 3. PROVIDE TAMPERPROOF SCREWS. 4. PROVIDE FLAT PLATE TYPE THERMOSTAT. 5. PROVIDE UNIT MOUNTED FAN SPEED SWITCH. 6. PROVIDE TAMPER PROOF ACCESS PANEL PROVIDED BY MECHANICAL CONTRACTOR & INSTALLED BY GENERAL CONTRACTOR FOR ALL VALVE ACCESS.

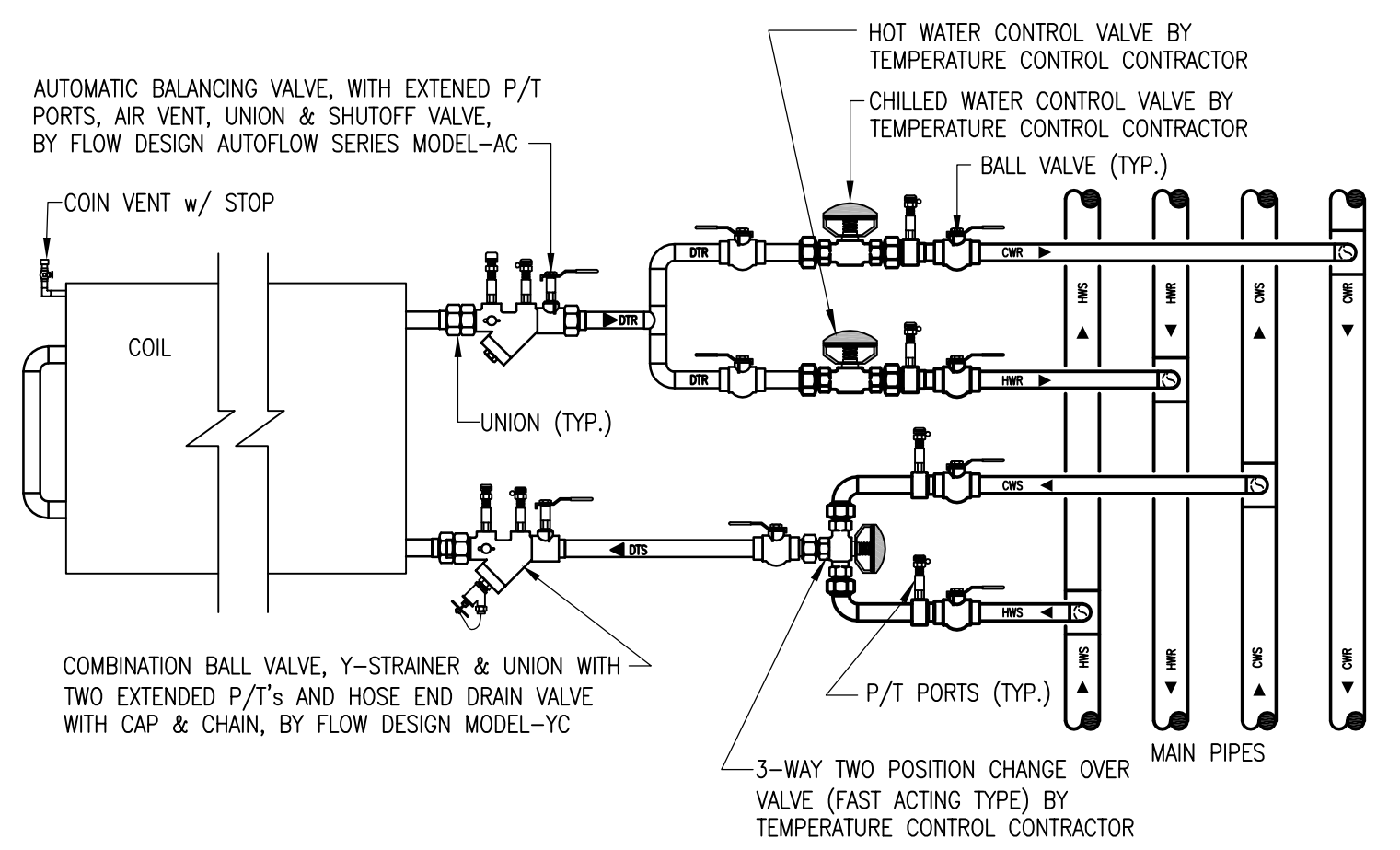
TAG NO.	FAN TYPE	CFM	SONES	ESP (IN WC)	SPEED (RPM)		DRIVE	ELECTRICAL DATA				MANUFACTURER MODEL NUMBER	REMARKS
					FAN	MOTOR		POWER	V	PH	HZ		
EF-1	INLINE	450	8.2	0.5	1539	1550	DIRECT	1/8 HP	115	1	60	GREENHECK MODEL SQ-95-D	1,2,3,4

NOTES: 1. PROVIDE DISCONNECT. 2. PROVIDE VIBRATION ISOLATORS. 3. PROVIDE BACKDRAFT DAMPER. 4. PROVIDE SPEED CONTROLLER.



SQUARE THROAT / ROUND HEEL ELBOWS ARE NOT ALLOWED - NO EXCEPTIONS

TYPICAL SQUARE ELBOW  
NTS



TYPICAL FAN COIL UNIT DETAIL (COMBINATION HEAT / COOL COIL)  
NTS

**AUTOMATIC TEMPERATURE CONTROLS - SEQUENCE OF OPERATIONS COMBINATION HEATING AND COOLING COIL**

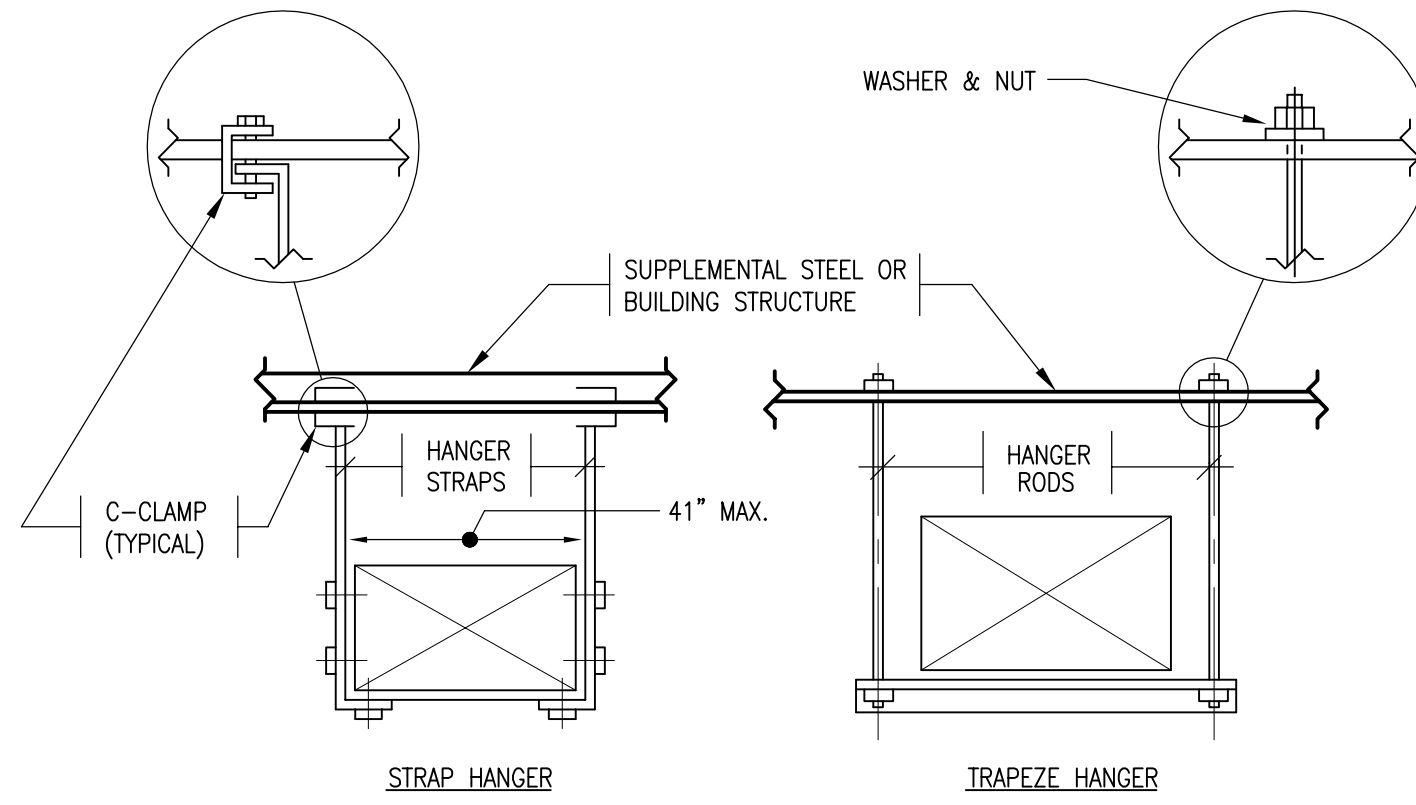
**HEATING:** THE TWO POSITION 3-WAY CHANGE OVER VALVE SHALL OPEN TO THE HOT WATER SUPPLY LOOP. ON A CALL FOR HEAT SENSE BY THE SPACE SENSOR THE HEATING WATER 2-WAY CONTROL VALVE SHALL OPEN TO MAINTAIN SPACE TEMPERATURE SETPOINT OF 72F (ADJ.). AND CLOSE ONCE ITS SATISFIED.

**COOLING MODE:** THE TWO POSITION 3-WAY CHANGE OVER VALVE SHALL OPEN TO THE CHILLED WATER SUPPLY LOOP. ON A CALL FOR COOLING AS SENSED BY THE SPACE SENSOR, THE CHILLED WATER 2-WAY CONTROL VALVE SHALL OPEN TO MAINTAIN SPACE TEMPERATURE OF 72F (ADJ.) AND CLOSE ONCE ITS SATISFIED.

VALVE SHALL FAIL OPEN TO THE HEATING POSITION

THE FMCS SHALL MONITOR AND CONTROL THE FOLLOWING:  
SPACE TEMPERATURE  
HEATING CHILLED WATER CONTROL VALVES POSITION (% OPEN)  
DIVERTING VALVE POSITION (OPEN / CLOSED)  
FAN STATUS (ON / OFF)

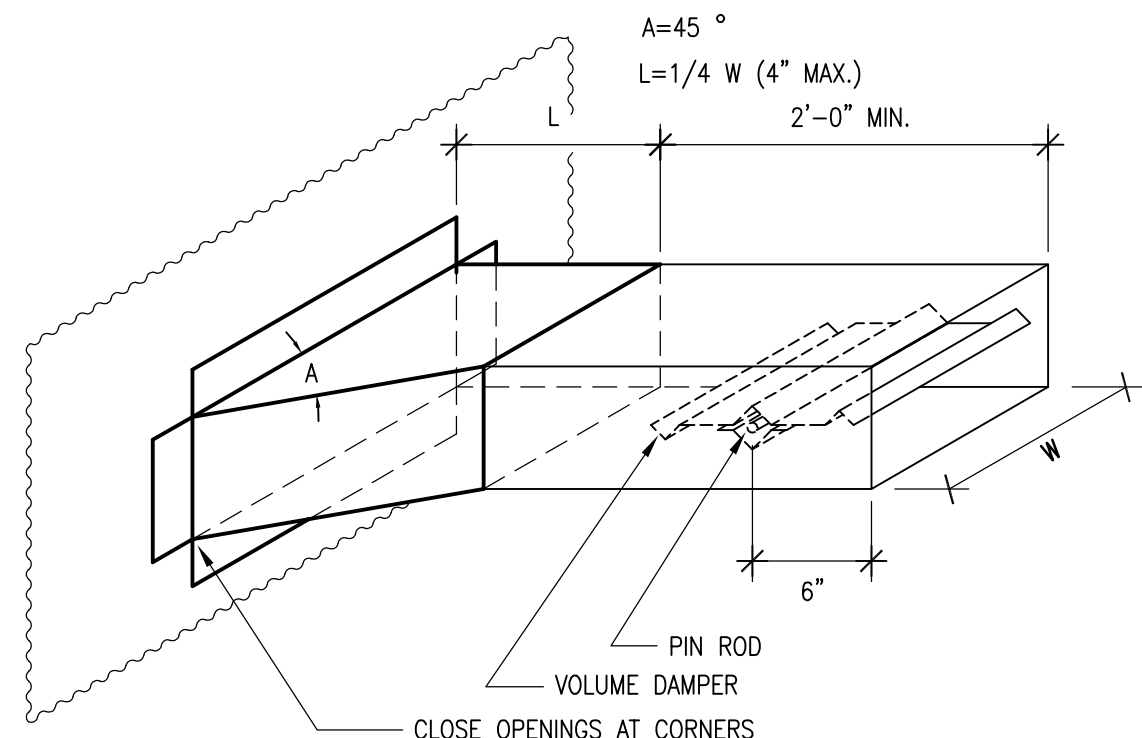
THE EXISTING BUILDING MANAGEMENT SYSTEM AT MURRAY COURTHOUSE IS BY ANDOVER CONTROLS. CONTACT  
STEVEN BEVERAGE  
IN CONTROL  
1-401-734-9250  
SBEVERAGE@INCONTROL.COM  
HTTP://INCONTROL.COM



NOTES:  
1. NO POP RIVETS SHALL BE USED, SELF-TAPPING SHEETMETAL SCREWS ONLY.

DUCTWORK HANGER DETAIL  
NTS

DIFFUSER / REGISTER / GRILLE SCHEDULE			
<b>SUPPLY DIFFUSERS</b>			
S-00	MARK		
000	CFM		
0x0	SIZE		
SYMBOL	THROW	MODEL	MARK
	4-WAY	PRICE - MSPG	S-4W
	3-WAY	STEEL	S-3W
	2-WAY OPPOSED	W/ MAXIMUM SECURITY	S-2O
	2-WAY CORNER	PERFORATED FACE PLATE	S-2C
	1-WAY		S-1W
<b>RETURN / EXHAUST / TRANSFER GRILLES</b>			
R-00	MARK		
000	CFM		
0x0	SIZE		
SYMBOL	THROW	MODEL	MARK
	N/A	PRICE - MSPG	R/E/T-1
		STEEL	
		W/ MAXIMUM SECURITY	
		PERFORATED FACE PLATE	

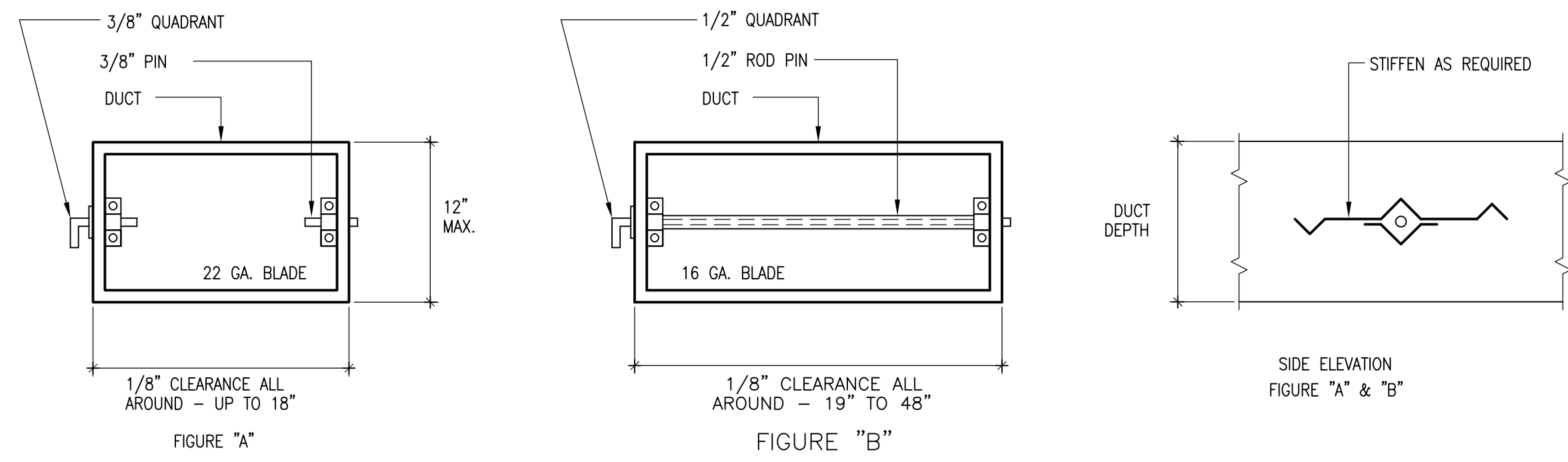


45° ENTRY BRANCH CONNECTION  
NTS

DUCT CONSTRUCTION DETAIL													
DIMENSION OF LONGEST SIDE - INCHES	SHEET METAL GAGE (ALL FOUR SIDES)	MINIMUM REINFORCING ANGLE SIZE & MAXIMUM LONGITUDINAL SPACING BETWEEN TRANSVERSE JOINTS &/OR INTERMEDIATE REINFORCING	MIN. "H" DIM. IN.										
			DRIVE SLIP	PLAIN "S" SLIP	HEMMED "S" SLIP	ALTERNATE BAR SLIP	REINFORCED BAR SLIP	BAR SLIP	ANGLE SLIP	STAND. SEAM	ANGLE REINFORCED STAND. SEAM	POCKET LOCK	ANGLE REINFORCED POCKET LOCK
			RECOM-MENDED GAGE	RECOM-MENDED GAGE	RECOM-MENDED GAGE	RECOM-MENDED GAGE	RECOM-MENDED GAGE	RECOM-MENDED GAGE	REINFORCED ANGLE SIZE	REINFORCED ANGLE SIZE	RECOM-MENDED GAGE	REINFORCED ANGLE SIZE	
UP THRU 12	26	NONE REQ.	1	26	26	24	24	24	24	NOT REQ.	NOT REQ.	24	NOT REQ.
13 - 18	24	NONE REQ.	1	24	24	24	24	24	24	NOT REQ.	NOT REQ.	24	NOT REQ.
19 - 30	24	1X1X $\frac{1}{8}$ @60"	1	-	24	24	24	24	24	NOT REQ.	NOT REQ.	24	NOT REQ.
31 - 42	22	1X1X $\frac{1}{8}$ @60"	1	-	-	22	22	22	22	NOT REQ.	NOT REQ.	22	NOT REQ.
43 - 54	22	1 $\frac{1}{2}$ X1 $\frac{1}{2}$ X $\frac{1}{8}$ @60"	1 $\frac{1}{2}$	-	-	22	22	22	1 $\frac{1}{2}$ X1 $\frac{1}{2}$ X $\frac{1}{8}$	NOT REQ.	22	22	NOT REQ.
55 - 60	20	1 $\frac{1}{2}$ X1 $\frac{1}{2}$ X $\frac{1}{8}$ @60"	1 $\frac{1}{2}$	-	-	-	22	22	1 $\frac{1}{2}$ X1 $\frac{1}{2}$ X $\frac{1}{8}$	NOT REQ.	22	22	NOT REQ.
61 - 84	20	1 $\frac{1}{2}$ X1 $\frac{1}{2}$ X $\frac{1}{8}$ @30"	1 $\frac{1}{2}$	-	-	-	22	22	1 $\frac{1}{2}$ X1 $\frac{1}{2}$ X $\frac{1}{8}$	1 $\frac{1}{2}$ X1 $\frac{1}{2}$ X $\frac{1}{8}$	22	1 $\frac{1}{2}$ X1 $\frac{1}{2}$ X $\frac{1}{8}$	

TRANSVERSE REINFORCING SIZE IS DETERMINED BY DIMENSION OF SIDE TO WHICH ANGLE IS APPLIED

DUCT CONSTRUCTION DETAIL  
NTS



VOLUME DAMPERS  
NTS

CELLBLOCK RENOVATIONS  
FLORENCE MURRAY  
COURT COMPLEX



45 WASHINGTON SQUARE  
NEWPORT, RI 02840

Edward Rowse  
ARCHITECTS

115 Cedar Street (401) 331-9200  
Providence, RI 02903-1082 Fax (401) 331-9270  
Massachusetts Office (508) 252-5446  
e-mail: rowse@rowsearch.com

OWNERSHIP AND USE OF DOCUMENTS, DRAWINGS AND SPECIFICATIONS AS INSTRUMENTS OF PROFESSIONAL SERVICE, ARE, AND SHALL REMAIN, THE PROPERTY OF THE ARCHITECT. THESE DOCUMENTS ARE NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECTS OR PURPOSES, OR BY ANY OTHER PARTIES THAN THOSE PROPERLY AUTHORIZED BY CONTRACT WITHOUT THE EXPRESS AUTHORIZATION OF THE ARCHITECT.



GENERAL NOTES

- EXISTING CONDITIONS WERE OBTAINED FROM DRAWINGS AND DATA PROVIDED BY THE OWNER AND AIE FIELD SURVEY. NO WARRANTY OF ACTUAL CONDITIONS IS INTENDED BY ARCHITECT OR OWNER. CONTRACTOR TO VERIFY ALL CONDITIONS PRIOR TO BID AND START OF CONSTRUCTION.
- DRAWINGS DO NOT INCLUDE NECESSARY COMPONENTS FOR CONSTRUCTION SAFETY.
- CONTRACTOR SHALL VISIT SITE, PRIOR TO BID, AND CAREFULLY INVESTIGATE, AND EXAMINE THE AREA OF WORK SO AS TO SATISFY HIMSELF AS TO THE NATURE AND LOCATION OF THE WORK. CONTRACTOR TO NOTE THE CHARACTER, QUALITY, QUANTITIES OF MATERIALS REQUIRED, AND DIFFICULTIES TO BE ENCOUNTERED. ALSO, THE KIND, AND EXTENT OF EQUIPMENT AND FACILITIES NEEDED FOR PERFORMANCE OF THE WORK, AND OTHER ITEMS WHICH MAY, IN ANY WAY, AFFECT THE WORK OR CONTRACTOR'S PERFORMANCE.
- THE BUILDING WILL BE OCCUPIED DURING ALL OF THE CONSTRUCTION PROCESS. THE CONSTRUCTION SCHEDULE SHALL BE DEVELOPED WITH THE UNDERSTANDING THAT THE BUILDING IS OCCUPIED AND THAT IT CAN NEITHER BE CLOSED, NOR CAN THE OWNER'S OPERATIONS STOP. THE CONTRACTOR SHALL PERFORM THE WORK OF THIS CONTRACT IN A MANNER THAT CAUSES NO DISRUPTION TO THE CONTINUOUS OCCUPATION OF THE BUILDING AND SITE FOR THEIR INTENDED PURPOSE.
- NO EXITS SHALL BE CLOSED WITHOUT THE WRITTEN PERMISSION OF THE OWNER.

Date: JANUARY 28, 2013  
Drawn by: KC Proj. Mgr.: RCN

No.	Date	Description
1	FEBRUARY 20, 2013	ADDENDUM # 1

SCHEDULES & DETAILS  
(MECHANICAL)

M2.0