SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 23 Sections.

1. Pipe joint materials.
2. Transition fittings.
3. Dielectric fittings.
4. Sleeves.
5. Mechanical sleeve seals.
6. Escutcheons.
7. Grout.
8. Fabricated metal equipment supports.
9. Installation requirements common to mechanical specification Sections.
10. Piping joint construction.
11. Cutting and patching.

B. Pipe and Pipe fitting materials are specified in piping system sections.

1.3 REFERENCES

A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

1. 2015 International Building Code
2. 2015 International Mechanical
3. 2015 International Plumbing Code
4. 2015 International Fire Protection Code
5. American Society of Mechanical Engineers (ASME)
6. American National Standards Institute (ANSI)
7. National Fire Protection Association (NFPA)
8. Underwriters Laboratories (UL)
9. American Society for Testing and Materials (ASTM)
10. American Welding Society (AWS)
11. Occupational Safety and Health Administration (OSHA)

B. DEFINITIONS:

1. Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.
2. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

3. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
4. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
5. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
6. 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.
7. The following are industry abbreviations for plastic materials:
   a. ABS: Acrylonitrile-butadiene-styrene plastic.
   b. CPVC: Chlorinated polyvinyl chloride plastic.
   c. PE: Polyethylene plastic.
   d. PVC: Polyvinyl chloride plastic.
8. The following are industry abbreviations for rubber materials:
   a. EPDM: Ethylene-propylene-diene terpolymer rubber.
   b. NBR: Acrylonitrile-butadiene rubber.

1.4 COORDINATION REQUIREMENTS

A. Coordinate layout and installation of <insert room or area descriptions> with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:

1. Vertical and horizontal runs, offsets, and transitions.
2. Clearances for access above and to the side.
3. Show dimensions and details, including connections.
4. Support locations, type of support, and weight on each support.
5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

C. Sequencing:

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

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

1.5 SUBMITTALS

A. Submit the following in accordance with the General Conditions.

B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data. Submit product data for following items:
1. Mechanical sleeve seals.
2. Transition fittings.
3. Dielectric fittings.
4. Escutcheons.

C. Shop Drawings: detailing fabrication and installation for supports and anchorage for mechanical materials and equipment.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver in shipping splits that can be moved past obstructions in the delivery path.

B. Coordinate delivery to allow movement into designated space.

C. Handle components according to manufacturer's written instructions. Use factory-installed lifting provisions.

PART 2 - PRODUCTS

2.1 PIPE JOINING MATERIALS

A. Refer to individual piping system specification Sections in Division 23 for special joining materials not listed below.

B. Solder Filler Metal: ASTM B32.
1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent), having 0.10 percent lead content.
2. Alloy Sn50: Tin (50 percent) and lead (50 percent).
3. Alloy E: Tin (approximately 95 percent) and copper (approximately 5 percent), having 0.10 percent maximum lead content.
4. Alloy HA: Tin-antimony-silver-copper-zinc, having 0.10 percent maximum lead content.
5. Alloy HB: Tin-antimony-silver-copper-nickel, having 0.10 percent maximum lead content.
6. Alloy Sb5: Tin (95 percent) and antimony (5 percent), having 0.20 percent maximum lead content.

C. Brazing Filler Metals: AWS A5.8.

1. BcuP Series: Copper-phosphorus alloys.
2. Bag1: Silver alloy.

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

E. Solvent Cements: Manufacturer's standard solvents complying with the following:

1. Acrylonitrile-Butadiene-Styrene (ABS): ASTM D2235.
2. Chlorinated Poly (Vinyl Chloride) (CPVC): ASTM F493.
3. Poly (Vinyl Chloride) (PVC): ASTM D2564.
4. PVC to ABS Transition: Made to requirements of ASTM D3138, color other than orange.

2.2 TRANSITION FITTINGS

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

1. Manufacturers:
   a. Eslon Thermoplastics.
   b. Or equal

B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:
   a. Thompson Plastics, Inc.
   b. Or equal.

C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Manufacturers:
   a. NIBCO INC.
   b. Or equal.

D. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers:
   a. Cascade Waterworks Mfg. Co.
   b. Fernco, Inc.
   c. Mission Rubber Company.
   d. Plastic Oddities, Inc.
   e. Or equal.

2.3 DIELECTRIC FITTINGS

A. Manufacturers:

1. Capitol Manufacturing Co.
2. Central Plastics Company.
3. Eclipse, Inc.
4. Epco Sales, Inc.
5. Hart Industries
6. International, Inc.
7. Watts Industries, Inc.
8. Water Products Div.
9. Zurn Industries, Inc.
10. Wilkins Div.
11. Or equal

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. Performance/Design Criteria:

1. Insulating Material: Suitable for system fluid, pressure, and temperature.
2. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

D. Materials and Construction:

1. 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.
   a. Manufacturers:
      1) Capitol Manufacturing Co.
      2) Central Plastics Company.
      3) Epco Sales, Inc.
      4) Watts Industries, Inc.; Water Products Div.
      5) Or equal.
2. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   a. Manufacturers:
      1) Advance Products & Systems, Inc.
      2) Calpico, Inc.
      3) Central Plastics Company.
      4) Pipeline Seal and Insulator, Inc.
      5) Or equal.
   b. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
3. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
   a. Manufacturers:
      1) Calpico, Inc.
      2) Lochinvar Corp.
      3) Or equal.

4. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
   a. Manufacturers:
      1) Perfection Corp.
      2) Precision Plumbing Products, Inc.
      3) Sioux Chief Manufacturing Co., Inc.
      4) Victaulic Co. of America.
      5) Or equal.

2.4 SLEEVES

A. Materials and Construction:

1. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.
3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.
5. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
6. PVC Pipe: ASTM D1785, Schedule 40.
7. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.5 MECHANICAL SLEEVE SEALS

A. Manufacturers:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Or equal

B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

C. Materials and Construction:

1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. Materials and Construction:

1. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
2. One-Piece, Cast-Brass Type: With set screw.
   a. Finish: Polished chrome-plated.
3. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated.
4. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
5. Split-Plate, Stamped-Steel Type: With exposed-rivet hinge, set screw or spring clips, and chrome-plated finish.
6. One-Piece, Floor-Plate Type: Cast-iron floor plate.
7. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.7 GROUT

A. Description: ASTM C1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

B. Materials and Construction:

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.8 FABRICATED METAL SUPPORTS

A. Structural Steel Shapes: ASTM A36.

2.9 SHOP FINISHES

A. Finish: ANSI 61 light gray paint.

B. With the exception of those parts and components customarily furnished unpainted, prepare and coat all metal surfaces with rust inhibitive shop paint. Shop paint shall be fully compatible with the field paint specified.

C. Protect machined surfaces against damage and corrosion by other means.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

B. Examine roughing-in of systems to verify the following:
   1. Systems are within the limitations established by the manufacturer.
   2. Each utility pipe and conduit is in the correct location.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.

D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

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

3.2 INSTALLATION

A. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

B. Mechanical installations
   1. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
      a. Coordinate mechanical systems, equipment, and materials installation with other building components.
      b. Verify all dimensions by field measurements.
      c. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
      d. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
      e. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
      f. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
      g. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
      h. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Owner's Representative.
      i. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
      j. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
      k. Install access panel or doors where units are concealed behind finished surfaces.

l. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

C. Piping installation

1. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 23 specify piping installation requirements unique to the piping system.
2. General Locations and Arrangements: Drawings (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, except where deviations to layout are approved on coordination drawings.
3. Install piping at indicated slope.
4. Install components having pressure rating equal to or greater than system operating pressure.
5. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
6. Install piping free of sags and bends.
7. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, except where indicated.
8. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
9. Install piping to allow application of insulation plus 3-inch clearance around insulation.
10. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
11. Install fittings for changes in direction and branch connections.
12. Install couplings according to manufacturer's printed instructions.
13. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings in finished areas.
14. Verify final equipment locations for roughing in. Refer to equipment specifications in other Sections for roughing-in requirements.
15. Angle (wye) type strainers shall be provided with shutoff valve and cap on blowdown connection.
16. Where mains are reduced, provide eccentric reducing fittings installed with flat side on the bottom.
17. Horizontal piping shall not be installed less than 6 inches above finished floor (along walls), less than 7 ft-6 inches above finished floor (other areas), or in front of windows.
18. Piping shall be offset, relocated, or changed to clear ducts, beams, conduits and other obstacles.
19. Piping systems shall be free of noise and vibration under normal operating conditions.
20. Install piping to permit valve servicing.
21. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
    c. Insulated Piping: One-piece, stamped-steel type with spring clips.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
g. Bare Piping in Unfinished Service Spaces: Non escutcheon.
h. Bare Piping in Equipment Rooms: No escutcheon.
i. Bare Piping at Floor Penetrations in Equipment Rooms: No escutcheon.

D. Sleeves

1. Install sleeves for pipes passing through concrete and masonry walls, fire-rated partitions, concrete floor and roof slabs, and where indicated.
   a. Cut sleeves to length for mounting flush with both surfaces.
      1) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 4 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring where specified.
   b. Build sleeves into new walls and slabs as work progresses.
   c. Install large enough sleeves to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      1) Steel Pipe Sleeves: For pipes smaller than 6 inches.
      2) Steel Sheet-Metal Sleeves: For pipes 6 inches and larger that penetrate gypsum-board partitions.
      3) Cast Iron Sleeve Fittings: For floors having membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
   d. Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.
   e. Except for below-grade wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants specified in Division 7 Section “Joint Sealants.”
   f. Above Grade, Exterior Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.
      1) Install steel pipe for sleeves smaller than 6 inches.
      2) Install cast-iron wall pipes for sleeves 6 inches and larger.
      3) Assemble and install mechanical seals according to manufacturer’s printed instructions.
   g. Below Grade, Exterior Wall, Pipe Penetrations: Install cast-iron wall pipes for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.
   h. Below Grade, Exterior Wall, Pipe Penetrations: Install ductile-iron wall penetration system sleeves according to manufacturer’s printed installation instructions.
   i. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping sealant material. Firestopping materials are specified in Division 7 Section Penetration Firestopping.
2. Sleeves are not required for core-drilled holes.

E. Piping joint construction

1. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
5. 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.
6. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. 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.
7. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   a. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. ABS Piping: Join according to ASTM D2235 and ASTM D2661 Appendices.
   c. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
   d. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
   e. PVC Nonpressure Piping: Join according to ASTM D2855.
   f. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D3138 Appendix
10. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.
11. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.
12. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.
   a. Plain-End Pipe and Fittings: Use butt fusion.
   b. Plain-End Pipe and Socket Fittings: Use socket fusion.
13. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

F. Piping connections

1. Piping Connections: Except as otherwise indicated, make piping connections as specified below.

a. Install unions in piping 2 inches and smaller adjacent to each valve and at final connection to each piece of equipment having a threaded pipe connection.
b. Install flanges in piping 2-1/2 inches and larger adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
c. Dry Piping Systems (Gas, Compressed Air, and Vacuum): Install dielectric unions and flanges to connect piping materials of dissimilar metals.
d. Wet Piping Systems (Water and Steam): Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.
    1) Where copper tube is joined to steel pipe, a section of brass pipe or a brass valve may be substituted for a dielectric fitting.

G. Equipment installation – common requirements
1. Install equipment to provide the maximum possible headroom where mounting heights are not indicated.
2. Install equipment according to submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Owner's Representative.
3. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.
4. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
5. Install equipment giving right-of-way to piping systems installed at a required slope.

H. Painting and finishing
1. Refer to The Section Painting for field painting requirements.
2. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

I. Fabrication and erection of metal equipment supports and anchorage
1. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical equipment.
2. Field Welding: Comply with AWS D1.1 "Structural Welding Code – Steel."

J. Cutting and patching
1. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
2. Repair cut surfaces to match adjacent surfaces.

K. Grouting
1. Install nonmetallic nonshrink grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.
2. Clean surfaces that will come into contact with grout.
3. Provide forms for placement of grout, as required.
    a. Avoid air entrapment when placing grout.

b. Place grout to completely fill equipment bases.

4. Place grout on concrete bases to provide a smooth bearing surface for equipment.
5. Place grout around anchors.
6. Cure placed grout according to manufacturer's printed instructions.

3.3 PAINTING

A. Perform field painting in accordance with the Section "Painting."

3.4 IDENTIFICATION

A. Identify piping, valves, equipment as specified in Section "Identification of HVAC Piping and Equipment."

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.6 PROTECTION

A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC 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 hangers, supports, and restraints for HVAC systems including piping, ductwork, and equipment as shown on the Contract Drawings.

1.3 REFERENCES

A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

B. American Society of Mechanical Engineers (ASME):

1. ASME B31.1 – Power Piping Code
2. ASME B31.9 – Building Services Piping
3. ASME Boiler and Pressure Vessel Code

C. Manufacturers Standardization Society (MSS):

1. MSS SP-58 Materials and Design of Pipe Supports
2. MSS SP-69 Selection and Application of Pipe Supports
3. MSS SP-89 Fabrication and Installation of Pipe Supports

D. American Society for Testing and Materials (ASTM):

1. ASTM A36 – Specification for Carbon Structural Steel
2. ASTM A167 – Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
3. ASTM A480 – Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
4. ASTM A653 – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.
5. ASTM A924 – Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot Dip Process.
6. ASTM B209 – Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
7. ASTM C1107 – Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

E. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA):

1. SMACNA "HVAC Duct Construction Standards."

1.4 COORDINATION REQUIREMENTS

A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical. Show the following:

1. Vertical and horizontal runs, offsets, and transitions.
2. Clearances for access above and to the side.
3. Show dimensions and details, including connections.
4. Support locations, type of support, and weight on each support.
5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.5 SUBMITTALS

A. Submit the following in accordance with the General Conditions.

B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

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

D. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, and seismic restraint by a qualified professional engineer.

1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

1.6 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

PART 2 - PRODUCTS

2.1 GENERAL

A. All components of like size and type shall be the product of the same manufacturer for purposes of parts interchangeability.

2.2 CROSS MEMBERS

A. Structural steel shapes, ASTM A36.

2.3 UPPER HANGER ATTACHMENTS

A. Standard-Duty Beam Clamps (for piping): Malleable iron jaw, steel tie-rod, nuts, and washer. Underwriters Laboratories (UL) listed, Factory Mutual approved

B. Heavy-Duty Beam Clamps (for large pipe and equipment): Forged steel

C. Welded Structural Attachments: Carbon steel

D. Brace Fitting: Malleable iron bracket and pipe end, hex-head cap screw and nut

E. Wall Brackets: Factory-fabricated carbon steel bracket with knee brace

F. Concrete Inserts [or new upper deck construction only:
   1. Malleable iron inserts, threaded for rod.
   2. Carbon steel inserts with lateral adjustment capability

G. Concrete Attachments [for existing concrete upper decks]: carbon steel plate with factory-drilled and anchor holes and factory-welded rod attachments

2.4 FASTENERS

A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

2.5 RODS

A. Rods: Carbon steel, ASTM A36, continuous thread or end thread.

2.6 DUCTWORK HANGERS

A. Sheet metal Straps:
   1. Galvanized steel: ASTM A 527, lock-forming quality; and ASTM A525, coating designation G-90.
   2. Aluminum: ASTM B209, alloy MLA with H-14 temper.
   3. Stainless steel: ASTM A167, Type 302, 304, or 316; and ASTM A480, finish no. 1 or no. 4.
   4. Material shall match ductwork.
   5. Fasteners and supports for FRP ductwork shall be Stainless Steel.

B. Fasteners:
   1. Sheet metal screws: same material as duct.
   2. Bolts and nuts: steel or galvanized steel, hex-head.

C. Fabricate ductwork hangers in accordance with SMACNA “HVAC Duct Construction Standards.”

PART 3 - EXECUTION

3.1 GENERAL

A. Hang, support, and restrain mechanical work from structural work. Do not hang, support, or restrain mechanical work from electrical work or from other mechanical work. Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

3.2 EQUIPMENT HANGERS

A. Provide vibration isolating hangers for equipment with motors.

B. Support air terminal units independent of ductwork.

C. Support slot diffusers independent of suspended ceiling grid.

3.3 RODS

A. Pipe and duct hanger rods shall be full size to match hangers.

B. Trapeze and equipment hanger rods shall be sized for maximum load with a safety factor of five.

C. Provide two nuts at each end of rods for positioning rod and hanger and locking each in place.

3.4 UPPER HANGER ATTACHMENTS

A. General

1. Upper hanger attachments shall be made to structural steel wherever possible.
2. Powder-driven drive pins shall not be used.
3. Expansion nails shall not be used.
4. Powder-driven fasteners shall not be used in precast concrete.
5. Loads in excess of 250 pounds shall not be supported from a single welded or powder-driven stud.

B. Steel Frame Construction

1. Provide intermediate structural steel members where required by ductwork support spacing. Select members based on a minimum safety factor of five.
2. Secure upper hanger attachments to steel bar joists within 6 inches of panel points, or provide intermediate strut to transfer load to top chord of joist.
3. Holes shall not be drilled in structural steel members.
4. Friction clamps shall not be used.

3.5 EXAMINATION

A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

B. Examine roughing-in of systems to verify the following:

1. Systems are within the limitations established by the manufacturer.
2. Each utility pipe and conduit is in the correct location.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.

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

3.6 PROTECTION

A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC 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 as shown on the Contract Drawings.
   1. Duct Identification.
   2. Equipment Identification.

1.3 REFERENCES

A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

B. American National Standards Institute (ANSI)
   1. ANSI A13.1 - Scheme for the Identification of Piping Systems.

1.4 COORDINATION REQUIREMENTS

A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

1.5 SUBMITTALS

A. Submit the following in accordance with the General Conditions.

B. Product Data: Catalog cuts and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

C. Submit, for review, samples of symbols and abbreviations, letter size, color for coding, and a complete list of legend wording proposed for mechanical identification. Do not order or purchase identification materials until samples have been reviewed.
Quality Control Submittals
   1. Submit manufacturer's installation instructions.

D. Contract Closeout Submittals
   1. Submit final valve service identification chart(s), framed as specified below.

1.6 QUALITY ASSURANCE

A. Identifying labels and markings for piping shall conform to ANSI A13.1 for legend, color, visibility, and size of legend and letters.

B. Qualifications

1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.7 SEQUENCING AND SCHEDULING

A. Complete all testing, insulation, and finish painting prior to executing the Work of this Section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials and Construction:

1. Duct and Equipment Identification Letters & Numbers:

a. Type: Stick-on type, made of all purpose polyester, single character letters and numbers, specifically designed for outdoor use.
b. Color: Black letters on bright yellow background.
c. Size: Letters and numbers shall be 1 inch or 3 inches in height, as specified.

2.2 MANUFACTURERS

A. The following manufacturers are named to establish a standard of quality necessary for the Project:

1. Seton Identification Company, Branford, Connecticut.
2. Brady Corporation, Milwaukee, Wisconsin.
3. Or equal

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

B. Examine roughing-in of systems to verify the following:

1. Systems are within the limitations established by the manufacturer.
2. Each utility pipe and conduit is in the correct location.

C. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

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

3.2 DUCT IDENTIFICATION

A. General:

1. Ductwork shall be identified as to type of air being conveyed and, where specified, the air handling unit to which it is connected by use of stick-on letters and numbers.
2. Identify bare or insulated interior ductwork (outdoor ductwork does not require labeling) in the following locations:

a. Mechanical Equipment Rooms.
b. Penthouses.
c. Ductwork penetrating the roof (below the roof).

B. Location and Content of Identification:

1. Locate identification at ductwork connections to equipment and at ductwork roof penetrations.
2. Assemble letters to identify air within the duct as one of the following:

a. "SUPPLY AIR"
b. "RETURN AIR"
c. "EXHAUST AIR"
d. "OUTSIDE AIR"
e. "FUME EXHAUST"

3. In addition, at roof penetrations, include the equipment identification number to which or from which the penetrating duct is connected. For example:
4. "EXHAUST AIR" or "SUPPLY AIR"
5. "TO EF-12A" "FROM ACU-301"
6. Horizontal ductwork shall have lettering on opposite sides, along centerline of the duct at each point of identification. Where view of vertical sides is obstructed, apply lettering to be visible from bottom and/or top of duct.
7. Vertical ductwork shall have lettering applied on the two most visible sides, oriented to read from the bottom upward, along the centerline of the duct.

C. Size of Lettering:

1. 12 inch or less duct or insulation dimension (or diameter) to which the lettering is applied: 1 inch high lettering.
2. Greater than 12 inch duct or insulation dimension (or diameter) to which the lettering is applied: 3 inch high lettering.

D. Installation:

1. Prepare surface to which lettering is applied and install lettering in accordance with the manufacturer's instructions.
2. Apply lettering in a straight line along the axis of the duct. Lettering edges should touch, but not overlap.

3.3 EQUIPMENT IDENTIFICATION

A. General:

1. Identify mechanical equipment, bare or insulated, in the following locations, by use of stick-on letters and numbers:

a. Mechanical Equipment Rooms.
b. Suspended ceiling plenums.
c. Roof mounted equipment.

B. Location and Content of Identification:

1. Equipment shall be identified with a minimum of two sets of lettering. Center identification lettering, vertically and horizontally, on opposite vertical sides of the equipment.
2. Vertical sides selected shall have the longest dimension (i.e., label sides of equipment and not the ends), unless view is obstructed to those sides. If view is obstructed to sides of equipment, locate identification lettering on the two most visible vertical sides and/or ends.
3. Equipment identification numbers and letters shall match the designation found in the equipment schedules on the Contract Drawings.

C. Size of Lettering:

1. Use the largest lettering size (3 inch or 1 inch height) that will easily fit the available surface space.
2. Use only one lettering height on any given piece of equipment (i.e., do not mix lettering sizes).

D. Installation:

1. Prepare surface to which lettering is applied and install lettering in accordance with the manufacturer's instructions.
2. Apply lettering in a straight line along the axis of the equipment. Lettering edges should touch, but not over-lap.

3.4 CLEANING

A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.5 PROTECTION

A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:

1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
2. Adjusting total HVAC systems to provide indicated quantities.
3. Measuring electrical performance of HVAC equipment.
4. Setting quantitative performance of HVAC equipment.
5. Verifying that automatic control devices are functioning properly.
6. Reporting results of the activities and procedures specified in this Section.

1.3 REFERENCES

A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

1. Associated Air Balance Council (AABC).
2. Air Movement and Control Association (AMCA).
3. Cooling Tower Institute (CTI).
4. National Environmental Balancing Bureau (NEBB).
5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1.4 PROJECT CONDITIONS

A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting, and balancing period. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

B. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

1.5 COORDINATION REQUIREMENTS

A. Coordinate with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

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

C. Notice: Provide 7 days advance notice to Owner's Representative for each test. Include scheduled test dates and times.

D. Witness and signoff by Owner's Representative is required.

E. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.6 SUBMITTALS

A. Submit the following in accordance with the General Conditions.

B. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.

C. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3 of this Section.

D. Strategies and Procedures Plan: Within 60 days from the Contractor's Notice to Proceed, submit 2 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 "Preparation" Article below. Include a complete set of report forms intended for use on this Project.

E. Certified Testing, Adjusting, and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

F. Sample Report Forms: Submit 2 sets of sample testing, adjusting, and balancing report forms.

G. Warranty: Submit 2 copies of special warranty specified in the "Warranty" Article below.

H. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

1.7 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.

B. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, HVAC controls Installer, and other support personnel. Provide 7 days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
   a. Submittal distribution requirements.
   b. Contract Documents examination report.

c. Testing, adjusting, and balancing plan.
d. Work schedule and Project site access requirements.
e. Coordination and cooperation of trades and subcontractors.
f. Coordination of documentation and communication flow.

C. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

D. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing" or use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards or as described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

1.8 WARRANTY

A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. National Project Performance Guarantee: Provide a guarantee on AABC'S "National Standards" forms stating that AABC will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents.

C. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified Agent has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

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

K. Test: A procedure to determine quantitative performance of a system or equipment.

L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

3.2 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine project record documents described in Division 1 Section "Project Record Documents."

D. Examine Engineer's 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 equipment performance data, including fan and pump curves. 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. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

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

J. Examine strainers for clean screens and proper perforations.

K. Examine open-piping-system pumps to ensure absence of entrained air in the suction piping.

L. Examine equipment for installation and for properly operating safety interlocks and controls.

M. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices operate by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
5. Sensors are located to sense only the intended conditions.
6. Sequence of operation for control modes is according to the Contract Documents.
7. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
8. Interlocked systems are operating.

N. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures. Report the status of each component listed in the examination in paragraph M above.

O. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

P. Examine roughing-in systems to verify the following:
   1. Systems are within the limitations established by the manufacturer.
   2. Each utility pipe and conduit is in the correct location.

Q. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

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

3.3 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness 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. Isolating and balancing valves are open and control valves are operational.

3.4 GENERAL TESTING AND BALANCING PROCEDURES

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards and this Section or perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.5 CONSTANT-VOLUME AIR SYSTEMS – BALANCING PROCEDURES

A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems. Additional procedures are required for process exhaust-air systems. These additional procedures are specified in other articles in this Section.

B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.
   1. Measure fan static pressures to determine actual static pressure as follows:
      a. Measure outlet static pressure as far downstream from the fan as practicable 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 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.

2. Measure static pressure across each air-handling unit component.
a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers under final balanced conditions.

4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.

5. Adjust fan speed higher or lower than design with the approval of the Engineer. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

6. 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 no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.

C. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
a. Where sufficient space in submains 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. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.

D. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.

E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.

1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts or as indicated on the Contract Documents.

3.6 AIR HANDLING UNITS

A. Record drawing, design and field test static pressure, in order of physical arrangement, for each applicable system component; i.e., louver, filter, preheat coil, cooling coil, etc., and the most remote terminal unit. With controls functioning properly and proper water

flow rates, test and record air dry bulb and wet bulb temperature of entering outside air, return air, mixed air, supply air, and air entering and leaving each coil for each air handling unit. Where feasible, measure air dry bulb and wet bulb temperatures with the mechanically aspirated psychrometer. All filters shall be clean and in place before starting fans. All air filters shall be artificially loaded, by partial blanking or other means, to produce air pressure drop midway between clean and dirty. Controls and dampers shall be set for normal full air flow testing and balancing.

3.7 MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating if high-efficiency motor.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

3.8 TEMPERATURE TESTING

A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.9 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Verify free travel and proper operation of control devices such as damper and valve operators.

F. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.

G. Confirm interaction of electrically operated switch transducers.

H. Confirm interaction of interlock and lockout systems.

I. Record voltages of power supply and controller output. Determine if the system operates on a grounded or nongrounded power supply.

J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.10 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans: Plus 5 to plus 10 percent.
   2. Air Outlets and Inlets: 0 to minus 10 percent.
   3. Heating-Water Flow Rate: 0 to minus 10 percent.
   4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.11 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, 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: As Work progresses, prepare 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.

3.12 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed by the certified testing and balancing agent.
   1. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to the 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, but do not include approved Shop Drawings and Product Data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of testing, adjusting, and balancing Agent.
   3. Project name.
   4. Project location.

5. Engineer's name and address.
6. Contractor's name and address.
7. Report date.
8. Signature of testing, adjusting, and balancing Agent who certifies the report.
9. Summary of contents, including the following:
    a. Design versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
10. Nomenclature sheets for each item of equipment.
11. Data for terminal units, including manufacturer, type size, and fittings.
12. Notes to explain why certain final data in the body of reports vary from design values.
13. Test conditions for fans and pump performance forms, including the following:
    a. Settings for outside-, 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.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:

1. Quantities of outside, 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.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches (mm), and bore.
    i. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
    j. Number of belts, make, and size.
    k. Number of filters, type, and size.
2. Motor Data: Include the following:
    a. Make and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.

e. Sheave make, size in inches (mm), and bore.
f. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).

3. Test Data: Include design and actual values for the following:
a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Filter static-pressure differential in inches wg (Pa).
f. Preheat coil static-pressure differential in inches wg (Pa).
g. Cooling coil static-pressure differential in inches wg (Pa).
h. Heating coil static-pressure differential in inches wg (Pa).
i. Outside airflow in cfm (L/s).
j. Return airflow in cfm (L/s).
k. Outside-air damper position.
l. Return-air damper position.

G. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data: Include the following:
a. System and air-handling unit number.
b. Location and zone.
c. Traverse air temperature in deg F (deg C).
d. Duct static pressure in inches wg (Pa).
e. Duct size in inches (mm).
f. Duct area in sq. ft. (sq. m).
g. Design airflow rate in cfm (L/s).
h. Design velocity in fpm (m/s).
i. Actual airflow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig (Pa).

H. Instrument Calibration Reports: For instrument calibration, include the following:

1. Report Data: Include the following:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.13 ADDITIONAL TESTS

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

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

3.14 PAINTING

A. Perform field painting in accordance with the Section “Painting”.

3.15 CLEANING

A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior “white glove clean”, removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.16 PROTECTION

A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 07 00
HVAC INSULATION

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 mechanical insulation as shown on the Contract Drawings.
   1. Semi-rigid and flexible duct and plenum; insulating cements; factory- or field-applied jackets; accessories and attachments; and sealing compounds.
   2. Blanket and board; insulating cements; factory- or field-applied jackets; accessories and attachments; and sealing compounds.

1.3 REFERENCES

A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
   1. American Society for Testing and Materials (ASTM)
   2. Military Specifications (MIL), as applicably noted.
   3. International Energy Conservation Code.

1.4 COORDINATION REQUIREMENTS

A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

B. Coordinate clearance requirements with duct, equipment and piping Installer(s) for insulation applications.

C. Coordinate size and location of supports, hangers, and insulation shields specified in the Section “Hangers and Supports for HVAC Piping and Equipment.”

D. Coordinate installation and testing of electric heat tracing.

1.5 SUBMITTALS

A. Submit the following in accordance with the General Conditions.

B. Product Data: “Catalog cuts” and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

C. Shop Drawings:
   1. Show fabrication and installation details for the following:
      a. Duct
         1) Removable insulation sections at access panels.
         2) Application of field-applied jackets.
         3) Applications at linkages for control devices.
         4) Duct lining.

D. Certificates:

1. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.6 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

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

1.7 SCHEDULING

A. Schedule insulation application after testing duct systems and piping systems. Insulation application may begin on segments of piping and ducts that have satisfactory test results.

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:

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

1. Mineral-Fiber Insulation:
   a. CertainTeed Manson.
   b. Knauf FiberGlass GmbH.
   c. Owens-Corning Fiberglas Corp.
   d. Johns Manville Corp.
2. Flexible Elastomeric Thermal Insulation:
   a. Armstrong World Industries, Inc.
   b. Rubatex Corp.
   c. Aerocel.
3. Closed-Cell Phenolic-Foam Insulation:
   a. Kooltherm Insulation Products, Ltd.
   b. Kingspan Corp.

2.2 INSULATION MATERIALS

A. Duct / Equipment

1. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film. Jacket to have self-sealing lap as applicable for application.
2. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.
   a. Adhesive: As recommended by insulation material manufacturer.
   b. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.
3. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
   a. Adhesive: As recommended by insulation material manufacturer.
   b. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

B. Piping/Equipment

1. Closed-Cell Phenolic-Foam Insulation: Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1 reformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.

2. Install piping insulation in accordance with manufacturer's instructions.

3. Install field-applied jacket for above grade.

2.3 FIELD-APPLIED JACKETS

A. Duct / Equipment

1. General: ASTM C 921, Type 1, unless otherwise indicated.
2. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
3. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
   a. Adhesive: As recommended by insulation material manufacturer.
   b. PVC Jacket Color: White [or gray].

2.4 ACCESSORIES AND ATTACHMENTS

A. General

1. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz/yd2.
   a. Tape Width: 4 inches.
2. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
   a. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
   b. Galvanized Steel: 0.005 inch thick.
   c. Aluminum: 0.007 inch thick.
   d. Brass: 0.010 inch thick.
   e. Nickel-Copper Alloy: 0.005 inch thick.
3. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

B. Duct / Equipment

1. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.
   a. Welded Pin Holding Capacity: 100 lb for direct pull perpendicular to the attached surface.
2. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.
   a. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface.
3. Self-Adhesive Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

2.5 VAPOR RETARDERS

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

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

C. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

D. Examine roughing-in of systems to verify the following:

1. Systems are within the limitations established by the manufacturer.
2. Each utility pipe and conduit is in the correct location.

E. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.

F. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

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

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct, equipment and piping system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

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

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

F. Keep insulation materials dry during storage, application and finishing.

G. Apply duct, equipment and pipe insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

H. Apply insulation with the least number of joints practical.

I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

1. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.

1. Apply insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

L. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.
4. Circumferential Joints: Cover with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
5. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
   a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.

M. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

N. Install vapor-retarder mastic on equipment, ducts and plenums scheduled to receive vapor retarders.

1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.
3. Equipment with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.

O. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.

1. Seal penetrations with vapor-retarder mastic.
2. Apply insulation for exterior applications tightly joined to interior insulation ends.
3. Seal insulation to roof flashing with vapor-retarder mastic.
4. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.

P. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.

Q. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.

R. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.

1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

S. Insulate the following indoor equipment:
   1. Heating hot-water air separators.

T. Omit equipment insulation from the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.4 MINERAL-FIBER INSULATION APPLICATION: DUCTWORK

A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, 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 anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
      c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not overcompress insulation during installation.
   4. Impale insulation over anchors and attach speed washers.
   5. 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.
   6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
   7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.
   8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
   9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
   10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

B. Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, 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. Space anchor pins as follows:
   a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
   c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
4. 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.
5. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply 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 the insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION: DUCTWORK

A. Apply insulation to ducts and plenums as follows:

1. Follow the manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the duct and plenum surface.

3.6 FIELD-APPLIED JACKET APPLICATION: DUCTWORK

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.

1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of jacket manufacturer's recommended adhesive.
3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

3.7 FINISHES: DUCTWORK – EXPOSED

A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Section "Painting."

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.

3.8 DUCT SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in Table 1 at the end of this Section.

B. Materials and thicknesses for systems listed below are specified in Table 1 at the end of this Section.

C. Insulate the following plenums and duct systems:

1. Gas unit heater combustion air ductwork.
2. Gas unit heater gas-vent pipes within 8 ft above finished floor.

D. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner.
3. Flexible connectors.
4. Vibration-control devices.
5. Testing agency labels and stamps.
6. Nameplates and data plates.
7. Access panels and doors in air-distribution systems.

3.9 FINISHES: EQUIPMENT

A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Division 9 Section "Painting."

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.

3.10 EQUIPMENT APPLICATIONS

A. Insulation materials and thicknesses are specified in Table 2 at the end of this Section.

3.11 INSTALLATION

A. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

TABLE 1 – DUCT INSULATION MATERIALS

Notes indicated in ( ) are at end of Table 1

SERVICE	INSULATION MATERIAL	THICKNESS	NOTES
Outdoor air ducts and plenums, connections, and mixing boxes installed indoors	Rigid mineral fiber	2 inches	Provide neat fit at intake plenum Maintain vapor retarder.
Ducts located outdoors and weatherproofed	Flexible Elastomeric foam	2 inches	(2)

Note 1: Return air ducts within air conditioned spaces, or above lay-in ceilings of air conditioned spaces, or in return air plenums are not to be insulated.

Note 2: Fasten mechanically and with recommended adhesive. Make watertight and airtight, cover seams and joints and 100% of duct. Finish weatherproof with aluminum jacket or two 1/8-inch coats of "Miracle" CO-130 mastic, as made by Miracle Adhesive Corp., troweled smooth with a layer of "Duramesh" glass fabric between coatings.

3.12 PAINTING

A. Perform field painting in accordance with the Section "Painting".

3.13 IDENTIFICATION

A. Identify as specified in Section "Identification of HVAC Piping and Equipment".

3.14 CLEANING

A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.15 PROTECTION

A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 09 13
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes:
   1. Instrumentation devices for HVACs
   2. Control devices for HVACs

B. Coordinate Work of this Section with Electrical Work.

1.3 COORDINATION REQUIREMENTS

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

B. Coordinate equipment from other divisions including “Intrusion Detection,” “Lighting Controls,” “Motor-Control Centers,” “Panelboards,” and “Fire Alarm” to achieve compatibility with equipment that interfaces with those systems.

C. Coordinate supply of conditioned electrical circuits for control units and operator workstation.

D. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

1.4 SUBMITTALS

A. Submit the following in accordance with the General Conditions.

B. In addition to those submittals identified in the General Conditions, the following items shall also be submitted:
   1. Manufacturer’s certification that all materials furnished are in compliance with the applicable requirements of the referenced Standards and this specification.

C. Product Data: “Catalog cuts” and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
   1. Include manufacturer’s technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
      a. Each control device labeled with setting or adjustable range of control.

D. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   a. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
   b. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
   c. Written description of sequence of operation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide a complete and functional system to operate in accordance with the sequence of operations and control schemes shown on the drawings and described in the specifications.

2.2 ELECTRIC CONTROL DEVICES

A. Line-Voltage, On-Off Temperature controller: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with adjustable differential and sensing bulb holder. Set point range shall be 0-100°F. Differential range shall be 3-10°F. Switching shall be SPDT and motor rates for the connected load. Controller shall be model T675A1508 as manufactured by Honeywell, or equal.

B. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual on-off-auto selector switch.

1. Equip thermostats, which control electric heating loads directly, with off position on dial wired to break ungrounded conductors.
2. Dead Band: Maximum 2 deg F.

C. Room thermostat accessories include the following:

1. Insulating Bases: For thermostats located on exterior walls.

D. Cooling Tower system control panel shall be packaged programmable system consisting of a temperature sensor, programmable unit with LCD screen and button inputs and both analog and digital outputs to suit the sequence of operation. Model T775 as manufactured by Honeywell, or equal.

E. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq ft of coil surface.

F. Electronic Damper and Valve Actuators: Direct-coupled type designed for minimum 100,000 full-stroke cycles at rated torque. Belimo or equal.

1. Valves: Size for torque required for valve close-off at maximum pump differential pressure (regardless of water loop system pressures).

2. Dampers: Size for running torque calculated as follows:
   a. Parallel-Blade Damper with Edge Seals: 7 inch-lbs/sq ft of damper.
   b. Opposed-Blade Damper with Edge Seals: 5 inch-lbs/sq ft of damper.
   c. Parallel-Blade Damper without Edge Seals: 4 inch-lbs/sq ft damper.
   d. Opposed-Blade Damper without Edge Seals: 3 inch-lbs/sq ft of damper.
   e. Dampers with 2 to 3 inches wg of Pressure Drop or Face Velocities of 1000 to 2500 FPM: Multiply the minimum full-stroke cycles above by 1.5.
3. Coupling: V-bolt and V-shaped, toothed cradle.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
6. Power Requirements (Two-Position Spring Return): 120V ac.
7. Power Requirements (Modulating): Maximum 15 VA at 24-V ac.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: 22 deg F to 122ºF.
10. Run Time: 200 seconds open, 40 seconds closed.

G. Smoke Detector

1. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Division 23. All wiring for air duct detectors shall be provided under the Section Fire Alarm Systems.

H. Air flow switch

1. Service: Air and non-combustible gas flow.
2. Vane: Stainless Steel.
3. Temperature Limit: 180°F (82°C).
4. Switch Type: SPDT.
5. Electrical Rating: 125 VAC: 9.8 amp full load 58.8 amp locked rotor. 250 VAC: 4.9 amp full load 29.4 amp locked rotor. Pilot Rating: 470 VA at 125, 250 VAC. Resistive: 15 amp at 125, 250, or 480 VAC.
6. Electrical Connections: Screw type terminal.
7. Conduit Connection: 7/8" conduit hole.
8. Mounting Orientation: Horizontal duct flow.
9. Set Point Adjustment: Screw type.
10. Unit shall be Model 530 as manufactured by Dwyer Instruments, or equal.

I. Explosion Proof Room Thermostat

1. Room Thermostat shall control the on and off of the hot water heating system based on room air temperature. Unit shall be suitable for Class I, Division I, Group D locations. Provide a 3 degree differential, single stage SPST line voltage snap-action switch, external, coiled sensing element and adjustable setpoint knob. Unit shall be model WR80-EP as manufactured by Chromalox, or equal.

J. Firestat

1. Ruskin TS150 or approved equal.
2. Provide equipment rated for the classification in areas served.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control units and operator workstation.

B. Verify that duct-, pipe-, and equipment-mounted devices and wiring are installed before proceeding with installation.

C. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

D. Examine roughing-in of Instrumentation and Control Devices for HVAC systems to verify the following:

1. Instrumentation and Control Devices for HVAC systems are within the limitations established by the manufacturer.
2. Each utility pipe and conduit is in the correct location.

E. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.

F. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

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

3.2 INSTALLATION

A. Install equipment level and plumb.

B. Verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate all 60 inches above the floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

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

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

E. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

3.3 PAINTING

A. Perform field painting in accordance with the Section "Painting".

3.4 IDENTIFICATION

A. Identify as specified in the Section "Identification of HVAC piping and Equipment."

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior “white glove clean”, removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.6 PROTECTION

A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 31 00
HVAC DUCTS AND CASINGS

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 ductwork systems as shown on the Contract Drawings.

1.3 REFERENCES

A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

1. American Society for Testing and Materials (ASTM)
2. Underwriters Laboratories (UL)
3. National Fire Protection Association (NFPA)
4. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).

1.4 COORDINATION REQUIREMENTS

A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:

1. Vertical and horizontal runs, offsets, and transitions.
2. Clearances for access above and to the side.
3. Show dimensions and details, including connections.
4. Support locations, type of support, and weight on each support.
5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.5 SUBMITTALS

A. Submit the following in accordance with the General Conditions.

B. In addition to those submittals identified in the General Conditions, the following shall be submitted:

1. Layout drawings of the equipment, ductwork, hangers, supports and accessories. Coordinate layout drawings with architectural, structural, electrical, plumbing,

and mechanical work. Drawings shall list ductwork material, thickness (gauge), seam types, seam dimensions, and seal class for each size or size range of duct.

2. Method of attachment of duct hangers to building construction.

C. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

1.6 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Ductwork

1. Galvanized Steel: ASTM A527 lock forming quality - galvanizing: ASTM A525 coating designation G-90.
2. Aluminum: ASTM B-209, Alloy 3003, Temper H-14.

B. Duct Hangers

1. Strap Hangers: Same material as ducts.
2. Rod Type Hangers: Mild low carbon steel, unless otherwise specified; fully threaded or threaded each end, with 2 removable nuts each end for positioning and locking rod in place. Unless stainless steel, galvanized or cadmium plated; shop coat with metal primer.

C. Miscellaneous Fasteners and Upper Hanger Attachments

1. Sheet Metal Screws, Machine Bolts and Nuts: Same material as duct, unless otherwise specified.
2. Concrete Inserts: Steel or malleable iron, galvanized; continuously slotted or individual inserts.
3. Welding Studs: Erico Fastening Systems, capacitor discharge, low carbon steel, copper flashed.
4. Structural (carbon) Steel Shapes and Steel Plates: ASTM A36, shop primed.
5. Machine Bolt Expansion Anchors:
   a. Non-caulking single unit type: FS FF-S-325, Group II, Type 2, Class 2, Style 1.
   b. Non-caulking double unit type: FS FF-S-325, Group II, Type 2, Class 2, Style 2.
   c. Self-drilling type: FS FF-S-325, Group III, Types 1 and 2.

2.2 RECTANGULAR DUCTWORK

A. Low Pressure Ductwork

1. Low pressure ductwork shall be defined as all duct with velocities less than 2500 FPM and static pressures of 0 to 2 inches (positive or negative). Low pressure ductwork shall conform to the 2-inch duct pressure class as classified by

SMACNA. Low pressure ductwork shall include all transitions, plenums and, for variable air volume systems, the portion of supply ductwork between the VAV boxes and the diffusers.

B. Elbows

1. All square corner elbows and all short radius elbows where the center line radius is less than 1-1/2 times duct width shall be fitted with directional flow air-turning vanes on supply, return, intake and exhaust systems.

2.3 DUCT SEALANT

A. Low and medium pressure supply, exhaust and outdoor air duct systems shall be provided with Class A seals as defined in the SMACNA duct construction standards and as noted herein. All joints and connections shall be sealed with Duro-Dyne S-2 Hi-Pressure Sealer (an oil resistant polymer solution) or equal. Apply sealer to clean duct surface. For medium pressure classes 2 inches through 10 inches w.g., apply a 2-inch wide strip of polyvinyl-treated open weave fiberglass membrane over the wet sealer, then apply another coat of sealer over the membrane, as per manufacturer's recommendation. In addition, Contractor shall apply a coat of sealant to all male connectors of round ducts with medium pressure classification.

B. Low pressure return systems only need to meet Class C sealing requirements.

C. Ductmate' connections do not have to be sealed if installed per manufacturer's recommendations (see Part 3 – Execution).

2.4 FLEXIBLE DUCT

A. Insulated flexible duct shall be a factory-fabricated assembly consisting of an inner sleeve, insulation and an outer moisture barrier. The inner sleeve shall be constructed of a continuous vinyl-coated spring steel wire helix bonded to a continuous layer of vinyl-coated fiberglass mesh. A thick insulating blanket of fiberglass, providing a thermal conductance (C Factor) of 0.23 BTU/hr/ft2/deg F at 75 deg F, shall encase the inner sleeve and be sheathed with an outer moisture barrier of a reinforced metalized Mylar/neoprene laminate of low permeability with integral attaching devices (grommets) for a suspension system as listed by Underwriters' Laboratories, Inc. The flexible duct shall be rated for a maximum working velocity of 2500 FPM and a maximum working pressure of 6 inches w.g. positive and 2 inches w.g. negative, and shall be listed by Underwriters' Laboratories, Inc. under its UL-181 Standard as a Class 1 air duct and shall comply with NFPA Standard No. 90A. The flexible duct shall be Thermaflex MK-E as manufactured by Flexible Tubing Division, or similar by Automation Industries, Inc., United McGill, Flexaust Co., or approved substitution.

PART 3 - EXECUTION

3.1 GENERAL

A. Duct sizes shown on drawings are in terms of width by depth. Duct sizes are inside clear dimensions.

B. Provide flexible connectors at connections to fans, air handling equipment, and fume hoods.

C. Exhaust duct branch connections shall be made at 45 degrees.

D. Maintain duct cross-sectional area at offsets.

E. Ductwork shall not be penetrated by obstructions such as pipe or conduit.

3.2 INSTALLATION

A. Install interior ductwork as high as possible and parallel to walls.

B. Ductwork shall not be installed in front of doors or windows. Ductwork shall not block access to equipment

C. Install products in accordance with the manufacturer's instructions.

D. Check locations of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and light arrangement.

E. Install duct mounted diffusers and registers with air-tight connection.

F. Provide volume dampers on duct take-off to diffusers, registers, and grilles.

G. Paint ductwork visible behind air outlets and inlets with matte black.

3.3 EXTERIOR FINISH

A. Attach sponge rubber padding to exterior corners of horizontal ductwork less than 7 feet 0 inches above finished floor.

3.4 CLEANING

A. Clean dust, dirt, debris, and scrap metal from inside ductwork prior to start-up.

3.5 EXAMINATION

A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

B. Examine roughing-in of systems to verify the following:

1. Systems are within the limitations established by the manufacturer.
2. Each utility pipe and conduit is in the correct location.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.

D. Verify that ground connections are in place and that installation of grounding described in Electrical Sections is complete.

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

3.6 INSTALLATION

A. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

3.7 IDENTIFICATION

A. Identify as specified in Section "Identification for HVAC Piping and Equipment".

3.8 CLEANING

A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.9 PROTECTION

A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

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 Ductwork Accessories as shown on the Contract Drawings.

1.3 REFERENCES

A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein: Examples:

1. Underwriters Laboratories (UL).
2. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).
3. International Energy Conservation Code.
4. International Mechanical Code.

1.4 COORDINATION REQUIREMENTS

A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:

1. Vertical and horizontal runs, offsets, and transitions.
2. Clearances for access above and to the side.
3. Show dimensions and details, including connections.
4. Support locations, type of support, and weight on each support.
5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.5 SUBMITTALS

A. In addition to those submittals identified in the General Conditions, the following shall be submitted:

1. Layout drawings of the equipment, duct work, hangers, supports and accessories. Coordinate layout drawings with architectural, structural, electrical, plumbing, and mechanical work. Drawings shall specify duct work material, pressure

classifications, thickness (gauge), seam types, seam dimensions, and seal class for each size or size range of duct.
2. Details of intermediate structural steel members required to span main structural steel for the support of duct work.
3. Method of attachment of duct hangers to building construction.
4. Installation details for each type of fire damper used.

B. Submit the following in accordance with the General Conditions.

C. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

1.6 QUALITY ASSURANCE

A. Qualifications
1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

PART 2 - PRODUCTS

2.1 FILTERS AND HOUSINGS

A. Air filters shall MERV 8, Camfill Farr 30/30, or equal.

B. Housing shall provide for slide in access to filter with gasketed hinged access door. Material of construction shall match the ductwork system.

2.2 FIRE DAMPERS

A. Fire dampers shall be interlocking-blade, curtain-type, and 165 deg F fusible link. Dampers shall be suitable for mounting in either a vertical or horizontal position as shown on the Contract Drawings.

B. Fire dampers shall be rated for 1-1/2 hours as shown on the Contract Drawings. Rating shall be in accordance with UL 555, and each damper shall be UL-listed.

C. Style B fire dampers shall be used on ducts smaller than or equal to 12-inch x 12-inch or 12-inch diameter. Style B fire dampers shall be rated for 1-1/2 hours.

D. Style A fire dampers shall be used on ducts greater than 12-inch x 12-inch or 12-inch diameter. Style A fire dampers shall be rated for 1-1/2 hours.

E. Interior Fire Dampers
1. Style WC fire dampers shall be rated for 1-1/2 hours.

F. Manufacturers:
1. Ruskin
2. NCA Manufacturing
3. Equal

2.3 VOLUME DAMPER

A. Rectangular volume dampers shall be galvanized steel or aluminum to match duct, manual operator, locking quadrant, opposed action blades.

B. Round volume dampers shall be galvanized steel or aluminum to match duct, manual operator, locking quadrant, single blade.

C. Manufacturers:

1. Ruskin
2. NCA Manufacturing
3. Equal

2.4 CONTROL DAMPERS

A. Material shall match duct.

B. Galvanized Steel

1. Rectangular control dampers shall be 14-gauge galvanized steel, air foil section, opposed action blades and suitable for use with an electric actuator. Damper shall be provided with head, sill, blade, and jamb seals. AMCA Standard 500 tested leakage rate of 48-inch x 48-inch damper shall be less than 5.6 cfm per sq ft at 4 inches w.g. Static pressure drop shall be less than 0.03-inch water-column at free area velocity of 1000 fpm. .
2. Round control dampers shall be galvanized steel, single blade, pressure-sensitive blade seal and suitable for use with an electric actuator. Maximum leakage rate shall be 4 cfm per sq ft at 4 inches w.g
3. Electric actuator shall be provided by damper manufacturer. Actuator operating cycle and voltage shall be 60hertz, 120 volts.

C. Aluminum

1. Rectangular control dampers shall be aluminum air foil section, opposed action blades and suitable for use with an electric actuator. Damper shall be provided with head, sill, blade, and jamb seals. AMCA Standard 500 tested leakage rate of 48-inch x 48-inch damper shall be less than 5.6 cfm per sq ft at 4 inches w.g. Static pressure drop shall be less than 0.03-inch water-column at free area velocity of 1000 fpm. Ruskin CD50, NCA Manufacturing Model ACD-56, or equal.
2. Electric actuator shall be provided by damper manufacturer. Actuator operating cycle and voltage shall be 60hertz, 120 volts.

2.5 BACKDRAFT DAMPERS

A. Gravity-operated dampers shall be galvanized steel or aluminum to match duct with blade seals and adjustable weighted operator. Operator shall open with system pressure.

2.6 FLEXIBLE CONNECTORS

A. Flexible duct connector shall be fiberglass fabric coated with neoprene. Weight: 30 oz/sq yd. Thickness: 0.024 inches.

2.7 ACCESS DOORS

A. Access doors shall be galvanized steel or aluminum to match duct with insulated, double wall construction.

B. Provide butt or piano type hinges and SMACNA Lock Type 1 sash locks.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide flexible connectors at connections to fans, air handling equipment, and fume hoods.

B. Provide access doors at inlet side of coils, intake plenums, and fire dampers.

3.2 EXAMINATION

A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

B. Examine roughing-in of systems to verify the following:
   1. Systems are within the limitations established by the manufacturer.
   2. Each utility pipe and conduit is in the correct location.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.

D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

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

3.3 INSTALLATION

A. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

3.4 IDENTIFICATION

A. Identify as specified in Section "Identification for HVAC Piping and Equipment."

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.6 PROTECTION

A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 34 00
HVAC FANS

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 Fans and associated equipment as shown on the Contract Drawings.

1.3 REFERENCES

A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

1. Air Moving and Conditioning Association (AMCA).
2. American Society of Testing Materials (ASTM).
3. National Electrical manufacturers Association (NEMA).

1.4 COORDINATION REQUIREMENTS

A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:

1. Vertical and horizontal runs, offsets, and transitions.
2. Clearances for access above and to the side.
3. Show dimensions and details, including connections.
4. Support locations, type of support, and weight on each support.
5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.5 SUBMITTALS

A. Submit the following in accordance with the General Conditions.

B. Product Data: “Catalog cuts” and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

C. Shop Drawings:

1. Fan curves with operating point clearly marked.
2. Sound data.

3. Motor orientation.

D. Closeout Submittals

1. Operation and Maintenance Data.

1.6 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

A. Coordinate delivery to allow movement into designated space.

PART 2 - PRODUCTS

2.1 SQUARE IN-LINE CENTRIFUGAL FAN

A. Manufacturers:

1. Loren Cook
2. Greenheck
3. Or equal

B. Description: In-line centrifugal fans shall be the sizes and capacities as shown on the drawings. Fans shall be belt or direct driven as scheduled.

C. Materials and Construction:

1. Fan Housing
   a. Fan housing shall be of a square design, constructed of minimum 18 galvanized steel with inlet and discharge collars. Provide one access door and mounting feet.
2. Fan Wheels
   a. Fan wheels shall be backward inclined, centrifugal type of aluminum construction. Wheel and shaft shall be statically and dynamically balanced at the factory, in accordance with AMCA standard 204-96.
3. Shafts
   a. Fan shafts shall be ground and polished steel sized so that the first critical speed is at least 25% over the maximum operating speed. Pillow block bearings shall be factory-tested and designed for air handling applications with a minimum (L50) life in excess of 200,000 hours.
4. Motors
   a. Motors for belt drive shall be premium efficiency type and shall be matched to the fan load hp as indicated. Provide a UL-listed disconnect switch, factory-mounted and -wired to the motor.
   b. Motors for direct drive non-hazardous (non-explosion proof) shall be electrically commutated motors with integral speed adjusters accessible by screw driver.
   c. Motors for hazardous explosion proof areas shall be XP rated for Class I, Division 1, group D.

5. Drives
   a. Drives shall be sized for 150% of driven horse power. Machined cast iron pulleys shall be factory-set to the required RPM and shall be field adjustable for final system balancing.
6. Disconnect Switch
   a. Provide factory-mounted and -wired, NEMA 1 disconnect switch.
   b. Provide factory-mounted and -wired, NEMA 7 disconnect switch for hazardous explosion proof areas.
7. Inlet/Discharge Guard
   a. Provide 1/2-inch by 1/2-inch galvanized welded wire on a galvanized frame. Frame shall be removable for service and inspection.
8. Motor Cover/Belt Guard
   a. Provide galvanized steel constructed, combination motor cover and belt guard.
9. Motor Cover/Belt Guard
   a. Protective Coating
   b. All steel fan components shall be coated with an electrostatically applied, baked polyester powder coating.
10. Insulated Fan Housing
    a. Provide fan housing with internal insulation lining as scheduled.
11. Hanging Vibration Isolators
    a. Provide hanging vibration isolators when fan is supported from structure above. Vibration isolators shall be neoprene hanging isolators.
12. Backdraft Damper
    a. Provide gravity backdraft damper as scheduled.

2.2 ROOF EXHAUST FAN

A. Manufacturers:
   1. Loren Cook
   2. Greenheck
   3. Or equal

B. Materials and Construction:
   1. Construction
      a. Spun aluminum centrifugal aluminum wheel with non-overloading characteristics. Units shall have the motor mounted in a weather-tight compartment separate from the exhaust stream.
   2. Motor
      a. Motors as scheduled.
   3. Disconnect
      a. Provide factory-mounted and wired as scheduled.
   4. Dampers
      a. Provide as scheduled.
   5. Roof Curb Cap Adapter
      a. Provide roof curb cap adapter prefabricated aluminum with insulation to match the dimension of the existing roof curb. Field verify existing roof curb dimensions.

2.3 WALL EXHAUST FAN

A. Manufacturers:
   1. Loren Cook
   2. Greenheck model SP-L80
   3. Or equal

B. Materials and Construction:
   1. Construction
      a. Corrosion resistant galvanized steel scroll and housing, white designer non-yellowing grille, oval metal outlet duct collar with integral plastic backdraft damper, single inlet forward curved wheel.
   2. Motor
      a. Motors as scheduled.
   3. Disconnect
      a. Provide factory-mounted and wired as scheduled.
   4. Dampers
      a. Provide damper as scheduled.

2.4 FRP CENTRIFUGAL BLOWER

A. Manufacturers:
   1. New York Blower
   2. Or equal.

B. Description: FRP centrifugal blowers shall be of the size and capacities as shown on the Contract Drawings. The fan assembly shall be dynamically balanced and completely assembled at the factory prior to shipping.
   1. Unit shall be model FRP Radial Fume Exhauster, Size 200 arrangement 10 as manufactured by New York Blower, or equal.

C. Materials and Construction:
   1. Fan Wheel shall be cast in a one-piece mold with a resin-glass mixture featuring premium-quality, corrosion-resistant vinyl ester resin. Solid FRP wheels are oven-cured to provide optimum strength and corrosion resistance. Radial-blade design provides stable, pulsation-free performance over the entire pressure range from wideopen to closed-off.
   2. Standard shaft shall be ASTM A-108 steel, grade C-1040/1045. Inside the fan housing the shaft is covered with an FRP sleeve that is bonded to the wheel backplate and extends through the housing side, protecting the shaft from corrosive attack.
   3. Housing is made of premium-quality, corrosion resistant polyester resin. The interior is extremely smooth, due to fabrication on male molds.
   4. Flanged inlet and outlet for easy in-duct connection; supplied without holes as standard.
   5. Fans shall be rotatable to any of six discharge positions.
   6. Welded-steel base shall be constructed of heavy-gauge components for structural strength and durability.
   7. Arrangement 10 base with self-contained motor platform.
   8. Close-fitting, Teflon® shaft-hole closure.

9. Neoprene gasketing at all bolted FRP joints.
10. Fan exterior shall be coated with gray epoxy enamel.
11. Dynamically balanced before and after final assembly at the specified running speed.
12. Meet ASTM D 4167 Standard Specification for Fiber-Reinforced Plastic Fans and Blowers when fan is purchased with surface veil.
13. Motor
    a. Motors shall be explosion proof matched to the fan load, and shall be mounted out of the air stream. Provide adjustable drives.
14. Weather Cover
    a. The weather cover shall be epoxy-coated steel and cover the shaft and drive assemblies.
15. Vibration Isolation
    a. Provide vibration isolation pads for horizontal floor mounting.
16. Drain Connection
    a. Connection shall be threaded FRP drain with 1-inch female PVC pipe plug, at the lowest point in the housing.
17. Electrical Grounding
    a. Air stream surfaces shall be coated with a carbon coating with grounding straps to the motor frame.
18. Inspection Port
    a. Opening for visual inspection of fan wheel. Gasketed and held in place with stainless steel bolts.
19. Corrosion Protection of Steel/Finish Coating
    a. All steel fan surfaces are to be thoroughly cleaned prior to painting using a combination of washing and hand/power tool cleaning per SSPC-SP1, SSPC-SP2 and SSPC-SP3 standards.
    b. All steel fan surfaces are to receive, as a minimum, cleaning per SSPC-SP6 standards). After cleaning, all fan exterior surfaces are to receive a coat of manufacturer's standard primer followed by one coat of epoxy enamel finish to a thickness of 2-3 mils d.f.t. Surfaces of bolted components shall be coated and allowed to dry prior to final assembly. All fasteners external to the gas stream shall be plated for extra corrosion protection.
20. Flanged Inlet
    a. Shall be pre-drilled solid fiberglass flange.
21. Flanged Outlet
    a. Shall be pre-drilled solid fiberglass flange.
22. Inlet Box
    a. Provide FRP inlet box for rain protection.
23. Belt Guard
    a. Totally enclosed belt guard shall be provided for each fan.
24. Surface Veil
    a. Fan shall be provided with surface veil provided.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

B. Examine roughing-in of systems to verify the following:

1. Systems are within the limitations established by the manufacturer.
2. Each utility pipe and conduit is in the correct location.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.

D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

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

3.2 INSTALLATION

A. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

B. Roof fans and intake hoods shall be installed with a rubber gasket between the unit's base and the roof curb. The curb cap shall be securely mounted to the roof curb.

C. Vibration Isolators for fans shall be internally isolated by the manufacturer.

D. Roof Curbs: Top of curb shall set level. Provide sloping roof curb or shims as required.

3.3 MANUFACTURER'S FIELD SERVICES

A. Engage a factory-authorized service representative to perform the following inspections, checks, and supervision of testing:

1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with the manufacturer's installation recommendations and requirements.
2. Set field-adjustable settings to the values recommended by the equipment manufacturer.
3. Confirm vibration is within allowable limits.

3.4 PAINTING

A. Perform field painting in accordance with the Section "Painting."

3.5 IDENTIFICATION

A. Identify as specified in the Section "Identification for HVAC Piping and Equipment".

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.7 PROTECTION

A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

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 air outlets and inlets and louvers as shown on the Contract Drawings.

1.3 REFERENCES

A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
   1. National Fire Protection Association (NFPA)
   2. Underwriters Laboratories (UL)
      a. Fire Resistance Directory

1.4 COORDINATION REQUIREMENTS

A. Coordinate layout and installation of Air Outlets and Inlets with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

1.5 SUBMITTALS

A. Submit the following in accordance with the General Conditions.

B. Product Data: “Catalog cuts” and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

C. Shop Drawings: Shop drawings shall indicate assembly, noise criteria, flow criteria, pressure drop, unit dimensions, required clearances, construction details, and field connection details.

D. Manufacturer Instructions: Submit manufacturer's installation instructions.

1.6 QUALITY ASSURANCE

A. Qualifications
   1. Manufacturer’s Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

A. Store Air inlets and Outlets in clean dry indoor rooms with electric heating to maintain the storeroom between 5 and 40 deg. C. Comply with manufacturer's additional written instructions for storing and periodic inspection and testing.

B. Handle Air Outlets and Inlets components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 WARRANTY

A. Provide parts and labor warranty in accordance with the General Conditions.

PART 2 - PRODUCTS

2.1 TRANSFER GRILLE (TG-1)

A. Manufacturers: Titus Model 300FL, or equal by Anemostat or Krueger.

B. Description:

1. Double Deflection. Front blades shall be horizontal with individually adjustable tapered blades spaced 3/4 inch apart. Rear blades shall be individually adjustable tapered blades spaced 3/4 inch apart.
2. All necessary appurtenances shall be provided to allow for mounting.
3. Register blades shall have a 1-3/8 inch margin frame with countersunk screw mounting.
4. Unless otherwise indicated, register blades and frame shall have factory-applied white finish.
5. All supply registers shall be constructed with radius end caps and foam gaskets for a tight seal to the duct diameter.

2.2 SUPPLY REGISTER (SR-1)

A. Manufacturers: Titus Model 300FL/300RL, or equal by Anemostat or Krueger.

B. Supply register shall be aluminum or steel to match the ductwork of the respective system.

C. Description:

1. Double Deflection. Front blades shall be horizontal with individually adjustable tapered blades spaced 3/4 inch apart. Rear blades shall be individually adjustable tapered blades spaced 3/4 inch apart.
2. Register shall have integral; face adjustable, opposed blade damper constructed of heavy duty extruded aluminum.
3. All necessary appurtenances shall be provided to allow for mounting.
4. Register blades shall have a 1-3/8 inch margin frame with countersunk screw mounting.
5. Unless otherwise indicated, register blades and frame shall have factory-applied white finish.
6. All supply registers shall be constructed with radius end caps and foam gaskets for a tight seal to the duct diameter.

2.3 RETURN REGISTER (RR-1)

A. Heavy extruded aluminum frame shall have countersunk screw mounting. Unless otherwise indicated, register blades and frame shall have factory-applied white finish.

B. Register shall be suitable for 24"x24" ceiling mounting as shown on the Contract Drawings. All necessary appurtenances shall be provided to allow for mounting.

C. Actual sizes and airflows from individual registers shall be as indicated on plans.

D. Register shall have integral, face adjustable, opposed blade damper constructed of 20-gauge galvanized steel.

E. Manufacturers: Titus Model 50F, or equal by Anemostat or Krueger.

2.4 EXHAUST REGISTER (ER-1)

A. Return register shall be aluminum or steel to match the ductwork of the respective system.

B. ½ inch spacing of angled blades.

C. Heavy extruded frame shall have countersunk screw mounting. Unless otherwise indicated, register blades and frame shall have factory-applied white finish.

D. All necessary appurtenances shall be provided to allow for mounting.

E. Actual sizes and airflows from individual registers shall be as indicated on plans.

F. Register shall have integral, face adjustable, opposed blade damper constructed of 20-gauge galvanized steel.

G. Manufacturers: Titus Model 355FL/355RL, or equal by Anemostat or Krueger.

2.5 EXHAUST GRILLE (EG-1)

A. Return grille shall be aluminum or steel to match the ductwork of the respective system.

B. ½ inch spacing of angled blades.

C. Heavy extruded frame shall have countersunk screw mounting. Unless otherwise indicated, register blades and frame shall have factory-applied white finish.

D. All necessary appurtenances shall be provided to allow for mounting.

E. Actual sizes and airflows from individual registers shall be as indicated on plans.

F. Register shall have integral, face adjustable, opposed blade damper constructed of 20-gauge galvanized steel.

G. Manufacturers: Titus Model 355FL/355RL, or equal by Anemostat or Krueger.

2.6 LOUVERS

A. Extruded aluminum stationary louvers with drainable blades.

B. Performance Ratings: AMCA licensed.

1. Frame:
   a. Material: Extruded aluminum, Alloy 6063-T5.
   b. Wall Thickness: 0.081 inch (2.1 mm), nominal.
   c. Depth: 6 inches (152 mm).
   d. Downspouts and caulking surfaces.
2. Blades:
   a. Style: Drainable.
   b. Material: Extruded aluminum, Alloy 6063-T5.
   c. Wall Thickness: 0.081 inch (2.1 mm), nominal.
   d. Angle: 37.5 degrees.
   e. Centers: 5-29/32 inches (150 mm), nominal.
3. Bird Screen:
   a. Material: Aluminum, 1/2 inch mesh x 0.063 inch, intercrimp.
   b. Frame: Removable, rewireable.
4. Gutters: Drain gutter in head frame and each blade.
5. Downspouts: Downspouts in jambs to drain water from louver for minimum water cascade from blade to blade.
6. Vertical Supports: Hidden vertical supports to allow continuous line appearance up to 120 inches (3,048 mm).
7. Sill: Steeply angled integral sill eliminating areas of standing or trapped moisture where mold or mildew may thrive and effect indoor air quality.
8. Assembly: Factory assembled louver components. All welded construction.

C. Design Load: Incorporate structural supports required to withstand wind load of 20 pounds per square foot.

D. Extended Sills: Extruded aluminum, Alloy 6063-T5. Minimum nominal wall thickness 0.060 inch (1.5 mm).

E. Non Visible Mullions: Manufacturer's standard horizontal or vertical mullions for architectural accent as indicated on drawings.

F. Kynar 500 Fluoropolymer Coating:

G. Conform to AAMA 605.2.

H. Apply coating following cleaning and pretreatment.

I. Cleaning: AA-C12C42R1X.

J. Dry louvers before final finish application.

K. Total Dry Film Thickness: Approximately 1.2 mils, when baked at 450 degrees F for 10 minutes.

L. Submit full color range for Architect's color selection

M. Louver shall be AMCA rated model ELF6375DX as manufactured by Ruskin, or equal by Construction Specialties or Greenheck.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide supply and return air registers with 45° entries that are 4 inches long. Install registers with duct extensions such that no part of the register protrudes into the 45° entry.

3.2 EXAMINATION

A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

B. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.

C. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

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

3.3 INSTALLATION

A. Install products in accordance with the manufacturer's instructions.

B. Check locations of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and light arrangement.

C. Install duct mounted diffusers and registers with air-tight connection.

D. Provide volume dampers on duct take-off to diffusers, registers, and grilles.

E. Paint ductwork visible behind air outlets and inlets with matte black.

F. Install Air Inlets and Outlets as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

G. Provide testing adjusting and balancing in accordance with the Section "Testing, Adjusting and Balancing for HVAC."

3.4 CLEANING

A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish.

3.5 PROTECTION

A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 73 13
HEAT RECOVERY UNIT

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 Central Station Air Handling Units as shown on the Contract Drawings for heat recovery unit HRU-101.

1.3 REFERENCES

A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

1. American Society for Testing and Materials (ASTM)
2. American National Standards Institute (ANSI)
3. National Fire Protection Association (NFPA).
4. International Energy Conservation Construction Code.
5. International Mechanical Code.
6. Underwriters Laboratories (UL).

1.4 COORDINATION REQUIREMENTS

A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:

1. Vertical and horizontal runs, offsets, and transitions.
2. Clearances for access above and to the side.
3. Show dimensions and details, including connections.
4. Support locations, type of support, and weight on each support.
5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.5 SUBMITTALS

A. In addition to those submittals identified in the General Conditions, the following shall also be submitted:

1. Provide fan curves with specified operating point clearly plotted.

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

B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

1. Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, and gauges and finishes of materials.
2. Submit product data of filter media, filter performance data, filter assembly, and filter frames.

C. Shop Drawings:

1. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.

D. Manufacturer Instructions:

1. Submit manufacturer's installation instructions.
2. Submit control panel installation and operating instructions.

E. Closeout Submittals

1. Operation and Maintenance Data.
2. Warranty Documentation.

1.6 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver in shipping splits that can be moved past obstructions in the delivery path.

B. Coordinate delivery to allow movement into designated space.

C. Handle components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 WARRANTY

A. Provide parts and labor warranty in accordance with the General Conditions.

PART 2 - PRODUCTS

2.1 HRU-101 HEAT RECOVERY UNIT

A. MANUFACTURERS

1. The following manufacturers are named to establish a standard of quality necessary for the Project: Innovent, Concepts and Designs Incorporated, Isolation Air Systems, Inc.
2. The design basis for the unit is Innovent Model ERU-OU-PL-10000-EH-460, or approved equal by listed manufacturer.

B. General: Construct unit as specified herein. Single wall construction is unacceptable and will be rejected. Frame and panel construction must be used with no individual panel exceeding 36" width. All panels on the unit must be fully removable without the use of cutting tools. All internal components must be removable without dismantling the structural framing of the unit. Unit shall be suitable for outdoor installation as detailed on the plan drawings.

C. Base: Construct base of minimum 10 ga. welded structural steel with cross supports and integral lifting lugs. Bolted bases are unacceptable. Coat base exterior with 2 part epoxy primer and urethane modified enamel top coat. Welded lifting lugs are provided.

D. Framing: Frame is constructed of structural tube members designed to support flush-mounted double-wall panels. Vertical framing members must be easily removable, without the use of specialty tools or torches, for replacement of large internal components. Welded framing is not acceptable unless all internal components can be easily removed without cutting any welds. A closed-cell polyvinyl foam gasket with a thickness of 3/16" or greater must be applied between all framing members and panels.

E. Flooring: Floor shall be 2" thick double-wall, foam injected panel construction, with a minimum of 18 gauge galvanized steel walk on surface, and 22 gauge galvanized steel underside of paneled floor. Floor panels shall be foam injected for optimal support strength. Maximum deflection of the floor shall be L/500 (L=span in inches), and the maximum point load on the floor shall be 800 lbs (over 1 square foot). Floor shall be of a fastener free design, bonded to the unit base with an industrial adhesive, with all seams finished with an adhesive sealant providing a water tight floor system. Use of tack welding, caulk or screws penetrating the entire floor panel anywhere in the floor is unacceptable. The floor shall have a smooth and flat walk-on surface. A minimum 1" lip must be provided around all floor penetrations. Walk-on grating must be provided over all accessible floor mounted duct connections.

F. Panels: Unit shall have non-load bearing, fully-removable, heavy gauge 2" double-wall panels.

G. Exterior Materials: Exterior skin shall be galvanized G60 steel or galvanealed steel for painted equipment. Unpainted galvanized exterior unacceptable if unit casing or framework is welded.

H. A textured polyester paint (gray color) shall be provided. Coating shall be salt spray tested per ASTM B117 for a minimum of 2,500 hours and have no blistering or red rust on the face when the testing is completed.

I. Interior Materials: Interior skin shall be galvanized G90 steel

J. Thermal break construction: The entire casing, excluding doors, must be built such that no member on the exterior of the unit, excluding fasteners, has through metal contact with any member on the interior of the unit, excluding fasteners.

K. Casing Ratings: Maximum casing panel deflection shall not exceed L/250 at the design total static pressure (where L is the longest panel span on the unit). Casing shall meet a SMACNA duct leakage class (DLC) rating of 5.0 or better. The panel insertion loss, per octave band, shall not be less than the following:

L.	Frequency (Hz): 8000	100	125	250	500	1000	2000	4000
M.	Insertion loss (dB): 60	24	16	30	32	33	34	63

N. Insulation: All interior walls, floor, and ceiling shall be double wall and insulated with polyurethane injected foam insulation having a minimum R-13 thermal value. No insulation shall be exposed to the air stream. Fiberglass or non-injected foam insulation is not acceptable and will be rejected.

O. Access Doors: Provide double wall doors with the same insulation and inner/outer wall material as the rest of the air handler. Doors shall be full height (up to 72") with industrial stainless-steel hinges. Bi-directional compression latches with integral roller cam and hex-screw locking assembly must be provided. An EPDM type gasket must be provided in accordance with ASTM D 2000. Supply and exhaust air streams shall not be covered by a single door. Access panels in lieu of access door are unacceptable. Rain gutters are provided over all access doors that are not the full height of the unit casing. All doors that open with pressure shall be provided with a pressure relief safety latch. Provide doors for access to any area requiring routine maintenance.

P. Weather hoods (for outdoor units): Provide weather hoods with expanded aluminum bird screens over all exposed inlets and outlets. Hoods may ship loose for installation in the field.

Q. Roof (for outdoor units): Provide roof with standing seam construction which allows removal of individual sections for inspection purposes without removal of the entire roof. A double wall foam injected panel must be provided below the roof liner creating 3 layers of metal between the conditioned air tunnel and ambient air. Pitch roof with sufficient slope to ensure water drainage. Units over 137" wide require double sloped roof designs. Roof overhang to be provided around complete perimeter of the unit. No penetrations can be made to the roof.

R. BLOWER/MOTOR –

1. Supply & Exhaust blowers: AF or BI blade direct drive plenum fans shall be provided. Fans shall be certified to bear the AMCA seal for air and sound performance. Fan motors must be selected to run at 90 Hz maximum at design conditions. Any fan/motor combination selected to run at a higher frequency will be rejected due to decreased motor life. This unit was selected with two supply and two exhaust blowers.

2. Provide the following scheduled equipment:

SUPPLY FAN											SUPPLY
QTY	CFM	CLASS	SIZE (mm)	TYPE	TSP ("WC)	BHP	MHP	RPM	MOTOR RPM	VFD Hz	MOTOR TYPE
2	5000	N/A	450	Plenum	2.21	2.8	5.0	2074	1800	71.1	TEFC
TOTAL:	10000	-	-	-	2.21	5.6	10.0	-	-	-	-
TSP CALCULATION											
SA ESP ("WC)	0.75	Outside Filter Clean PD ("WC)	0.24	Plate Heat Exchanger ("WC)	0.44	-	-				
Casing Loss ("WC)	0.30	Outside Filter Loading PD ("WC)	0.38	Electric Heater ("WC)	0.10	TSP:	2.21	"WC			

EXHAUST FAN											EXHAUST
QTY	CFM	CLASS	SIZE (mm)	TYPE	TSP ("WC)	BHP	MHP	RPM	MOTOR RPM	VFD Hz	MOTOR TYPE
2	5000	N/A	450	Plenum	2.11	2.7	5.0	2059	1800	70.6	TEFC
TOTAL:	10000	-	-	-	2.11	5.4	10.0	-	-	-	-
TSP CALCULATION											
RA ESP ("WC)	0.75	Return Filter Clean PD ("WC)	0.24	Plate Heat Exchanger ("WC)	0.44						
Casing Loss ("WC)	0.30	Return Filter Loading PD ("WC)	0.38	TSP:	2.11	"WC					

3. Motors shall be 3 phase TEFC with a NEMA frame, cast iron construction and a 1.15 service factor. Motor brake horsepower shall not exceed scheduled values. Fan brake horsepower shall not exceed 90% of motor horsepower. All motors shall be premium

efficiency with class F insulation. Shaft grounding will be provided on all VFD controlled motors 10 HP and larger.

4. Isolation: Blower and motor shall be mounted on a unitary base with 1" housed seismic rated spring isolators.

S. Accessories:

1. Variable frequency drives: Provide variable speed drive for supply and exhaust fans. VFDs shall be factory provided and installed or provided by others and factory installed on the exterior of the unit or inside the unit behind an access door.

1. Electric heat of capacity, voltage and steps of control specified shall be provided as an integral part of the unit. Field installed segments shall not be acceptable. The electric heater and control panel shall be a U.L. listed electric duct heater.

ELECTRIC HEATER				NONAIRSTREAM
CFM	ENTERING DB (°F)	LEAVING DB (°F)	PD	kW
2325	6.2	81.0	0.10	55

2. All heaters will be supplied with internal wiring of controls, contactors, etc. including 120-volt, 60 hertz control circuit transformer, automatic reset thermal cut-out and fuses per N.E.C. and U.L. (on heaters exceeding 48 amps).

3. Provide a low temperature limit switch freezestat to shut off unit in the event that the supply air temperature falls to a minimum where the potential to freeze the building exists. Initially set freezestat set point to 40°F.

T. PLATE HEAT EXCHANGER

1. Provide Plate Heat Exchanger in accordance with the following scheduled capabilities:

PLATE HEAT EXCHANGER								SUPPLY & RETURN
	OUTSIDE AIR DATA				RETURN AIR DATA			
MODE	CFM	EAT (DB/WB)(°F)	LAT (DB/WB)(°F)	PD	CFM	EAT (DB/RH)(°F/%)	LAT (DB/RH)(°F/%)	PD
Cooling	2325	89.9/73.9	80.5/71.2	0.44	2325	75.0/55.0	84.3/40.7	0.44
Heating	2325	-20.0/-20.6	32.0/22.0	0.37	2325	60.0/34.9	17.2/100.0	0.40
MODEL: H-1-30A-750					DEFROST MODE SUPPLY LAT (°F): 6.2			

The plate heat exchanger shall be integral to the unit. Provide cross-flow aluminum plates, corrosion resistance, with no cross-leakage.

U. ECONOMIZER

1. Provide 100% economizer operation via bypass around the Plate Heat Exchanger section of the energy recovery unit.

V. CONTROLS

1. The control panel shall be factory provided, field installed remote from the unit.

2. The factory provided controls shall include heater stage control and the following operator interface:

a. Fan start and stop

b. Heater lockout (summer/winter switch)

c. Discharge air temperature set point adjustment

d. On and off indicator light. Provide unit status.

e. Heater on indicator light. Provide heater status.

f. Dirty filter indicator light. Provide dirty filter dp switch.

g. Freezestat indicator light. Provide freezestat.

h. Flow switch. Provide airflow switch rated for 2500 CFM to 10000 CFM, for remote field mounting.

3. The control panel and controls shall be Factory Mutual and CSA Approved for use in a NEMA 4x Control Panel.

W. FILTERS

1. The unit shall be provided with integral side-access filter rack holding 2" thick MERV 7 pleated pre-filters sized for maximum 500 fpm face velocity. Filter pressure drop shall be monitored via SPST differential pressure switch and provide remote indication of dirty filter condition.

2. Provide Outside air filtration:

OUTSIDE FILTER									OUTSIDE
CFM	TYPE	DEPTH (in)	FACE VEL. (FPM)	MERV	QTY	WIDTH (in)	HEIGHT (in)	CLEAN PD	TOTAL PD
10000	Pleated	2	500	8	6	24	20	0.24	0.62

3. Provide Return air filtration

RETURN FILTER									RETURN
CFM	TYPE	DEPTH (in)	FACE VEL. (FPM)	MERV	QTY	WIDTH (in)	HEIGHT (in)	CLEAN PD	TOTAL PD
10000	Pleated	2	500	8	6	24	20	0.24	0.62

X. LOW LEAK DAMPERS

1. The unit shall be provided with integral two-position motorized inlet damper with blade edge and jamb seals.

Y. FACTORY START-UP

1. A factory employed technician shall be present for unit start-up and specific calibration of control components.

Z. SINGLE POINT CONNECTION

1. Unit shall be equipped with a single point electrical connection consisting of a disconnect branch fusing as required by standards referenced below, motor starters, control panels, lights, transformers, and wiring to all motors. The panels and all associated components shall be U.L. listed. All wiring shall comply with N.E.C. The panel shall contain a single point power connection, single-speed fan motor contactor(s) with overload device(s), three-phase ambient compensated overload heater elements, two primary control fuses, one secondary control line size fuse, terminal strip and on/off auto switch. In addition, the motor control panel shall contain a transformer for lights, receptacles and control devices.

2. Provide the following electrical characteristics:

ELECTRICAL INFORMATION					UNIT POWER
COMPONENT	VOLTS	PHASE	FREQ. (Hz)	MOP	MCA
Electrical Enclosure	460	3	60	125	114.8
AMP SUMMARY					
Electric Heater	69.0	Exhaust Fan	6.7 x 2	--	--
Supply Fan	6.7 x 2	--	--	Total:	95.8

AA. UNIT MOUNTED DISCONNECT

1. Each unit shall be equipped with a unit mounted nonfused disconnect. The disconnect shall be in a separate NEMA 4x enclosure.

BB. Accessories

1. Outside air temperature sensor shall be furnished with the unit for field installation.
2. Supply air temperature sensor shall be factory provided, installed with unit.
3. Unit shall be provided with a factory installed return air smoke detector.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify that proper power supply is available.

3.2 EXAMINATION

A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

B. Examine roughing-in systems to verify the following:
   1. Systems are within the limitations established by the manufacturer.
   2. Each utility pipe and conduit is in the correct location.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.

D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

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

3.3 INSTALLATION

A. Install in accordance with manufacturer's printed instructions and in accordance with ARI 435.

B. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

3.4 SPARE EQUIPMENT

A. Provide one (1) additional set of pleated media filters. Furnish one (1) additional complete set of fan motor drive belts.

3.5 MANUFACTURER'S FIELD SERVICES

A. Engage a factory-authorized service representative to perform the following inspections, checks, and supervision of testing:
   1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with the manufacturer's installation recommendations and requirements.
   2. Set field-adjustable settings to the values recommended by the equipment manufacturer.

3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and components.
4. Supervise tests performed by independent testing firms. Witness initial energization and perform or supervise startup services.
5. Prepare written report to record the following:
   a. Inspections and checks carried out on site.
   b. Test procedures used.
   c. Test results that comply with requirements.
   d. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.6 DEMONSTRATION AND TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the equipment.
   1. Train Owner's maintenance personnel for a minimum of 4 hours on procedures and schedules for energizing and de-energizing, troubleshooting, servicing, and maintaining equipment and schedules.
   2. Review data in Operation and Maintenance manuals.
   3. Schedule training with Owner, with at least 10 days advance notice.

3.7 PAINTING

A. Perform field painting in accordance with the Section “Painting”.

3.8 IDENTIFICATION

A. Identify as specified in the Section “Identification for HVAC Piping and Equipment.”

3.9 CLEANING

A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior “white glove clean”, removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.10 PROTECTION

A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 82 00
ELECTRIC TERMINAL UNITS

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 Electric Terminal Units as shown on the Contract Drawings.

B. Equipment includes:

1. Electric Unit Heaters (EUH)
2. Cabinet Unit Heaters (CUH)
3. Electric Ductwork Heating Coils (EDH)

C. Certain features of Electric Terminal Units shall be as scheduled on the Contract Drawings.

1.3 REFERENCES

A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

1. American Society for Testing and Materials (ASTM)
2. American National Standards Institute (ANSI)
3. American Society of Mechanical Engineers (ASME)
4. National Fire Protection Association (NFPA)
5. International Fire Code
6. International Building Code
7. International Energy Conservation Code
8. Underwriters Laboratories (UL)
9. National Electrical Code (NEC).

1.4 SUBMITTALS

A. Submit the following in accordance with the General Conditions.

B. Product Data: “Catalog cuts” and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

1.5 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer’s Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.6 WARRANTY

A. Two year warranty against defects in materials and workmanship from date of Owner's Representative's acceptance.

B. Provide parts and labor warranty in accordance with the General Conditions.

PART 2 - PRODUCTS

2.1 ELECTRIC UNIT HEATERS (EUH)

A. Standard Unit Heaters

1. Electric unit heaters shall consist of heating element, fan, motor, controls, and cabinet.
2. Heating element shall be metal sheath type with built-in overheat protection.
3. Fan shall be direct-drive axial-flow type. Fan shall be factory balanced.
4. Controls shall be factory mounted and wired, and shall include magnetic contactors, control power transformer.
5. Unit manufacturer shall provide pre-wired integral thermostat as scheduled.
6. Cabinet shall be heavy-gauge steel with adjustable discharge louvers and rear protective grille.
7. The heater shall be provided with the appropriate wall -mounting kit designed to bear the weight of the heater assembly.
8. Provide the following:
   a. 24-volt relay, [with] [without] transformer
   b. 120-Volt control circuit
   c. Fusing (under 48 amps)
   d. Diffuser cones for vertically mounted heaters
   e. Built-in disconnect switch (100 amps maximum).
   f. Provide phenolic coating on all units' coils, except in the Electrical Room.
9. Indeeco Model UCI or equal by Chromalox or Trane.

B. Explosion Proof Unit Heaters

1. Electric explosion-proof unit heaters shall have the KW rating, voltage and phase specified in the schedule. They shall be forced fan type, Factory Mutual and CSA approved for:
   a. Class I, Divisions 1 and 2, Group D; Ignition Temperature Code No. T3C, 320 deg F (Standard construction).
2. Unit heaters shall have dual automatic reset thermal cutouts for redundant over-temperature protection, controlling magnetic contractor and 24-volt control circuit transformer housed in a NEMA 7, cast aluminum enclosure.
3. The heat exchanger shall be liquid-to-air design, utilizing a copper tube core with integral aluminum fins. Nontoxic, inhibited, propylene glycol heat transfer fluid shall be used that provides freeze protect freeze protection down to –49 deg F. Pressure relief valve setting to be 70 psig.
4. Heat exchanger and aluminum fan blade shall be enclosed in an industrial grade, corrosion resistant cabinet fabricated from powder coated, 14 gauge steel. Adjustable outlet louvers to have minimum opening safety stops.

5. Fan motor shall include permanently lubricated ball bearings and built-in thermal overload protection. Motor to operate at line voltage and be prewired to the control enclosure to eliminate the need for separate field wiring to the motor.
6. The heater shall be provided with the appropriate wall -mounting kit designed to bear the weight of the heater assembly.
7. Dirty duty, corrosion-resistant construction with epoxy-coated chem-duty motor; iridite-plated heat exchanger; epoxy-coated fan blade; NEMA 4X, 7, 9 terminal box, conduit and fittings; stainless steel hardware.
8. Provide the following controls built-in and factory-prewired.
   a. Adjustable built-in thermostat.
   b. Disconnect switch with external handle.
   c. Manual reset thermal cutout for triple over-temperature protection.
   d. "Heater On" pilot light to indicate when heating elements are energized.
   e. "Warning" pilot light to indicate when thermal cutouts have tripped and heater needs to be serviced.
   f. Manual reset thermal cutout with backup contactor.
   g. 120-volt control circuit for special external thermostat circuit.
   h. "Heater On" pilot light to indicate when heating elements are energized.
9. Provide phenolic coating on coils.
10. Indeeco Ultra Safe or equal by Chromalox or Trane.

2.2 CABINET UNIT HEATERS (CUH)

A. Each heater shall include chassis, coil, fanboard, fanwheel, housing, motor, and insulation. Chassis shall be galvanized steel wrap-around structural frame with all edges flanged. Insulation shall be faced, heavy density glass fiber. Heaters shall be as manufactured by Indeeco or approved equivalent as manufactured by Trane or Chromalox. Units shall be of type, capacity and configuration as shown in the schedule.

B. Cabinets

1. Cabinet shall be 16 gauge steel, cleaned, bonderized, phosphatized, and flow-coated with baked-on primer. A baked on enamel final finish shall be provided from a selection of seven (min.) decorator colors. Cabinets shall be semi-recessed, wall mounted type with architectural type bar grilles.

C. Coils

1. Electric coils shall be Nichrome elements with an open wire design.

D. Fans

1. Fan wheels centrifugal, forward-curved, double width of steel or aluminum. Fan housing of formed sheet metal.

E. Motors

1. Motors shall have integral thermal overload protection and start at 78% rated voltage. Motors shall operate satisfactorily at 90% of rated voltage on all speed settings and at 10% over voltage without undue magnetic noise. Temperature rise by winding resistance method shall not exceed 60C shaded pole motors and 50C for PSC motors on high speed. Motors shall be factory run tested assembled in unit prior to shipping. Motor cords shall be quickly detachable at junction box by locking prong connector on vertical cabinet and wall hung units.

F. Filters

1. Removable from horizontal units by pivoting hinged bottom panel. Filters shall be 1 inch woven glass 30% efficiency throwaway type filters. Contractor shall purchase one spare set of filters for replacement of factory shipped filters upon completion of start-up.

G. Provide the following:

1. Smooth finish back-mounting plate, when back of the heater is visible.
2. Recess trim for non-surface mounted units.
3. Sub-base for floor-mounted units.
4. Manual reset for backup thermal protection.
5. Fusing (under 48 amps).
6. On / Auto fan switch; tamperproof and adjustable through the grille with a screwdriver.
7. 24-volt relays instead of a switch or thermostat.
8. Provide phenolic coating on coils.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

B. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.

C. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

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

3.2 INSTALLATION

A. Equipment shall be installed, supported, cleaned, tested, and adjusted in accordance with manufacturer's recommendations and instructions.

B. Install equipment as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

3.3 IDENTIFICATION

A. Identify equipment as specified in Section "Identification for HVAC Piping and Equipment."

B. Emergency Operating Instructions: Frame and mount under clear acrylic plastic for wall mounting.

C. Operating Instructions: Frame printed operating instructions. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchgear.

3.4 PROTECTION

A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION