

## SECTION 230001

### HEATING, VENTILATING AND AIR CONDITIONING

#### GENERAL

##### 1.00 RELATED DOCUMENTS

- A. Include General Conditions, Supplementary General Conditions, applicable parts of Division 1, and condition of the Contract as part of this Section.
- B. Examine all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.
- C. Coordinate work with that of all other trades affecting, or affected by the work of this Section. Co-operate with such trades to assure steady progress of all work under the Contract.

##### 1.01 SCOPE OF WORK

- A The work under this Section shall include the furnishing of all materials, labor, equipment and supplies and the performance of all operations to provide complete working systems, in general, to include the following items:
  - 1. Piping and Fittings (all types)
  - 2. Pipe Hangers and Supports
  - 3. Sleeves
  - 4. Unit Heaters (Hot Water)
  - 5. Ductwork and Supply outlets
  - 6. Insulation
  - 7. Core drilling, cutting and channeling for HVAC equipment for holes five (5) inches and less in diameter.
  - 8. Fire stopping of penetrations made by/for this contractor.
  - 9. Furnish and maintain safe and adequate conditions, all staging and scaffolding that is required for the work of this section.
  - 10. Hoisting and rigging for equipment and materials specified herein.
  - 11. Testing and balancing
- B Provide any other component or related system (whether or not listed) which is part of the overall design and basic equipment and deemed necessary for its completion, thoroughness and readiness for operation in perfect condition.

##### 1.02 RELATED WORK

- A. Examine all other sections of the Specifications and all drawings for the relationship of the work under this Section and the work of other trades. Cooperate with all trades and coordinate all work under this section therewith.
- B. The following related items are included under sections listed below:
  - 1. Section 026001 – Electrical

1.03 PRODUCTS FURNISHED, BUT NOT INSTALLED UNDER THIS SECTION

- A. Furnish pipe sleeves for placement into formwork by the General Contractor.

1.04 REFERENCES

- A. For products or workmanship specified by association, trade, or federal standards, comply with the requirements of the standard, except when more rigid requirements are herein specified or are required by applicable codes.
- B. The date of the standard is that in effect at the Bid date.
- C. Schedule of References:
1. AABC Associated Air Balance Council  
1518 K Street, N.W.  
Washington, DC 20005
  2. ASHRAE American Society of Heating, Refrigeration and Air  
Conditioning  
Engineers, Inc.  
1791 Tullie Circle N.E.  
Atlanta, GA 30329
  3. FM Factory Mutual System  
1151 Boston-Providence Turnpike  
Norwood, MA 02062
  4. SMACNA Sheet Metal and Air Conditioning Contractor's National  
Association, Inc.  
4201 Lafayette Center Drive  
Chantilly, VA 22021

1.05 DEFINITIONS

- A. As used in this Section, the following terms shall be understood to have the following meaning:
1. Work: all labor, materials, equipment, apparatus, controls, accessories and all other items required for a proper and complete installation.
  2. Concealed: hidden from sight in chases, furred in spaces, shafts, embedded in construction, in a crawl space, and above hung ceilings.
  3. Exposed: not installed underground or concealed as defined above.
  4. "Furnish" shall mean purchase and deliver to the project site, complete with every necessary appearance and support.
  5. "Install" shall mean unload at the delivery point at the site and perform all work necessary to establish secure mounting, proper location and operation in the project.
  6. "Provide" shall mean furnish and install.
  7. "Piping" shall mean, in addition to pipe or tubing, all fittings, flanges, unions, valves, strainers, drains, hangers and other accessories relative to such piping.

8. "Furnished by others" shall mean materials or equipment purchased and set in place under other sections of the general contract and connected to the systems covered by this Section of the specifications by this trade contractor.
9. "Coordinate" shall mean all work provided under this Section of the specification shall be in compliance with work of other trades.
10. "HVAC Subcontractor," "Subcontractor," or "Installing Contractor" shall be the Subcontractor responsible for the Work of this Section of the Specifications, and shall be responsible for coordination of the Work of this Section of the Specifications with the Work of Paragraph 2.57-Automatic Temperature Controls, where applicable.
11. "ATC" shall mean Automatic Temperature Controls, and shall be interchangeable with HVAC Control Systems.

1.06 CODES, ORDINANCES AND PERMITS

- A. Unless otherwise specified or indicated, materials, workmanship and equipment performance shall conform with the latest governing edition of the following standards, codes, specifications, requirements, and regulations, but not limited to:
  1. State and Local Building Mechanical and Energy Codes
  2. American Society of Mechanical Engineers
  3. American Society of Testing and Materials
  4. Underwriters' Laboratories, Inc.
  5. Occupational Safety and Health Administration
- B. Any other local codes or authorities having jurisdiction including any other standards specifically indicated in other paragraphs of this specification.

1.07 SUBMITTALS

- A. Conform to the requirements of Section 013300-Submittals, for schedule and form of all submittals. Coordinate this submittal with submittals for all other finishes.
- B. Product Data: Submit complete manufacturer's product description and technical information including:
  1. Piping and Fittings (all types)
    - a. Hot Water Heating Piping
  2. Pipe Hangers and Supports
  3. Sleeves
  4. Ductwork
  5. Unit Heaters (Hot Water)

1.08 OPERATION AND MAINTENANCE (O&M) DATA

- A. Refer to SECTION 017700 – PROJECT CLOSEOUT
- B. Prepare and submit Operating and Maintenance manuals at least two (2) months prior to the date of Substantial Completion of the Project. Submit six complete sets of operation and maintenance data complete with at least the following.

1.09 MATERIAL AND EQUIPMENT STANDARD

- A. Where equipment or materials are specified with the name of a manufacturer, such specification shall be deemed to be used for the purpose of establishing a standard for that particular item. No equipment or material shall be used unless previously approved by the Architect.
- B. Substitutions may be offered for review provided the material, equipment or process offered for consideration is equal in every respect to that indicated or specified. The Request for each substitution must be accompanied by complete specifications together with drawings or samples to properly appraise the materials, equipment or process.
- C. If a substitution of materials or equipment in whole or in part is made, this HVAC Subcontractor shall bear the cost of any changes necessitated by any other trade as a result of said substitution.
- D. All materials, equipment and accessories provided under this Section shall be new and unused products of recognized manufacturers as approved.

1.10 ELECTRICAL WORK

- A. All electrical apparatus and controls furnished as a part of the work of this Section, but which are not integral with the equipment served, will be mounted by the Electrical Subcontractor and all wiring will be done under SECTION 260001 ELECTRICAL .
- B. Except for electrical apparatus specifically called for as part of this Section, all switches and controllers required will be provided under Section 260001-Electrical.
- C. All electrical apparatus and controls furnished as a part of the HVAC work shall conform to applicable requirements under SECTION 260001-ELECTRICAL.

1.11 RECORD DRAWINGS

- A. Refer to SECTION 011000 – SUMMARY OF WORK and SECTION 017700 – PROJECT CLOSEOUT.
- B. All costs for Record Drawings shall be borne by the HVAC contractor.

1.12 WARRANTIES

- A. Submit manufacturer's standard replacement warranties for material and equipment furnished under this Section. Such warranties shall be in addition to and not in lieu of all liabilities, which the manufacturer and the HVAC Subcontractor may have by law or by provisions of the Contract Documents.
- B. Guarantee that all elements of each system meet the specified performance requirements as set forth herein or as indicated on the Drawings.
- C. Upon receipt of notice from the Owner of the failure of any part of the systems during the guarantee period, the affected parts shall be replaced. Any equipment requiring excessive service shall be considered defective and shall be replaced.

1.13 COORDINATION

- A. The work shall be so performed that the progress of the entire building construction, including all other trades, shall not be delayed nor interfered with.

Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as required.

- B. Confer with all other trades relative to location of all apparatus and equipment to be installed and select locations so as not to conflict with work of other Sections. Any conflicts shall be referred immediately to the Architect for decision to prevent delay in installation of work. All work and materials placed in violation of this clause shall be readjusted to the Architect's satisfaction at no expense to the Owner.
- C. Keep fully informed as to the shape, size and position of all openings required for all apparatus, piping, ductwork, etc., and give information in advance to build openings into the work. Furnish all sleeves, pockets, supports and incidentals, and coordinate with the General Contractor for the proper setting of same.
- D. All distribution systems, which require pitch or slope such as condensate drains and water piping, shall have the right of way over those, which do not.
- E. The HVAC Subcontractor shall, with the approval of the Architect and without extra charge, make reasonable modifications in his work as required by normal structural interferences, or by interference with work of other trades, or for proper execution of the work.
- F. Keep fully informed as to the size, shape and location of all openings required for the work of this Section and give full information to all Subcontractors and the General Contractor.

#### 1.14 COORDINATION DRAWINGS

- A. Refer to SECTION 013300 –SUBMITTALS and SECTION 017700 PROJECT CLOSEOUT for coordination drawings submittal requirements and use of project CADD Files.

#### 1.15 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

- A. It is the intention of the Specifications and Drawings to call for complete, finished work, tested and ready for continuous operation. Any apparatus, appliance, material or work not shown on the Drawings, but mentioned in the Specifications or vice versa, or any incidental accessories necessary to make the work complete in all respects and ready for operation, even if not particularly specified, shall be provided by the HVAC Subcontractor or his/her Sub-subcontractors, without additional expense to the Owner.
- B. The Drawings are generally diagrammatic. The locations of all items that are not definitely fixed by dimensions are approximate only. The exact locations must be determined at the site and shall have the approval of the Architect before being installed. The HVAC Subcontractor shall follow Drawings, including shop drawings, in laying out work and shall check the Drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions. Where space conditions appear inadequate, notify the Architect before proceeding with the installation. The HVAC Subcontractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.
- C. Refer to the Architectural, Structural, Fire Protection, Plumbing and Electrical Drawings and coordinate location and requirements of all HVAC equipment.

1.16 SURVEY AND MEASUREMENTS

- A. Base all required measurements, horizontal and vertical, from referenced points established by the Contractor and be responsible for correctly laying out the Work required under this Section of the Specification.
- B. In the event of discrepancy between actual measurements and those indicated, notify the Contractor in writing and do not proceed with the related work until instructions have been issued.

1.17 DELIVERY, STORAGE AND HANDLING

- A. No materials shall be delivered or stored on site until Shop Drawings have been approved.
- B. All manufactured materials shall delivered to the site in original packages or containers bearing the manufacturer's labels and product identification.
- C. Protect materials against dampness. Store off floors, under cover, and adequately protected from damage.

1.18 PROTECTION OF WORK AND PROPERTY

- A. This Contractor shall be responsible for the care and protection of all work included under this Section until the completion and final acceptance of this Contract.
- B. Protect all equipment and materials from damage from all causes including, but not limited to, fire, vandalism and theft. All materials and equipment damaged or stolen shall be repaired or replaced with equal material or equipment at no additional cost to the Owner.
- C. Protect all equipment, outlets and openings with temporary plugs, caps and covers. Protect work and materials of other trades from damage that might be caused by work or workmen under this Section and make good damage thus caused.
- D. Damaged materials are to be removed from the site; no site storage of damaged materials will be allowed.

1.19 SUPERVISION

- A. Provide a Construction Supervisor with a minimum of 5 years of experience in HVAC Construction Supervision who shall be responsible for the installation of the Work of this Section of the Specifications, and in accordance with this Section of the Specifications and with the Contract Drawings.

1.20 SAFETY PRECAUTIONS

- A. Life safety shall be a primary consideration. Provide all required and prudent material, labor and equipment to comply with applicable safety regulations. Further, Provide all material, labor and equipment to comply with reasonable or generally accepted safety precautions as directed by the Owner or the Architect.
- B. Comply with all of the safety requirements of OSHA throughout the entire construction period of the project.
- C. Furnish, place and maintain proper guards for prevention of accidents and any other necessary construction required to secure safety of life and property.

- D. Perform work only in areas of the building as approved by the Owner or his representative. Personnel and equipment access to the site, lay down areas, parking areas and areas of work shall only be as designated and allowed by the Owner.

1.21 WELDING QUALIFICATIONS

- A. Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Owner shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with SECTION 051200-STRUCTURAL STEEL.
- B. A fire watchman with an approved fire extinguisher shall be posted at the site of the welding work, during that work, and for a minimum of 30 minutes after the work is completed, to see that sparks or drops of hot metal do not start fires.

1.22 SCHEDULE

- A. Construct work in sequence under provisions of General Conditions.

1.23 MAINTENANCE ACCESSORIES AND TOOLS

- A. All special tools necessary as recommended by the equipment manufacturer(s) for the operation and maintenance of boilers, pumps, fans, and other equipment shall be furnished. Small hand tools shall be furnished with a suitable lockable cabinet, mounted where directed.
- B. Special Wrenches
  - 1. Special wrenches shall be provided as required for opening boiler manholes, hand holes, and cleanouts.

1.24 SEALING

- A. All penetrations through the structure shall be sealed air and water tight where required for acoustical reason or where penetrating a fire rated element must be fire stopped. This contractor shall coordinate all penetrations of the floors and ceiling with G.C. Fire Stopping requirements is under section 078400.

1.25 SLEEVES, INSERTS AND ANCHOR BOLTS

- A. Coordinate with other trades the location of and maintaining in proper positions, sleeves, inserts and anchor bolts to be supplied and/or set in place under this Section of the specifications. In the event of incorrectly located preset sleeves, inserts and anchor bolts, etc., all required cutting and patching of finished work shall be done under this Section of the specifications.
- B. Unless otherwise specified herein, all pipes passing through floors, walls, ceilings or partitions shall be provided with sleeves and rating shall be maintained of fire stopping.
- C. Field drilling (core drilling), when required, shall be performed under this Section of the specifications, after receipt of approval by the General Contractor.

1. When coring cannot be avoided, provide ¼-inch pilot hole prior to coring. When coring through floor or slab, verify location of core on floor below and protect and piping, ductwork, wiring, personnel, etc., below the location of the core.

1.26 SUPPLEMENTARY STEEL, CHANNELS AND SUPPORTS

- A. Provide all supplementary steel, factory fabricated channels and supports required for proper installation, mounting and support of all equipment and systems provided under this Section of the specification.

1.27 ACCESSIBILITY

- A. All work provided under this Section of the Specification shall be installed so that parts requiring periodic inspection, maintenance and repair are readily accessible. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made prior to written approval from the General Contractor.

---

PART 2 - PRODUCTS

---

2.01 INSULATION

- A. Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following:
  1. General: The fire hazard rating of all insulation related materials shall not exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by UL723 "Test for surface burning characteristics of building materials", NFPA 225 or ASTM E84.
- B. Adhesives
  1. Contact Adhesive

Adhesive may be dispersed in a non-halogenated organic solvent with a low flash point (flash point plus or minus 25 degrees F)) or, dispersed in a nonflammable organic solvent which shall not have a fire point below 200 degrees F.
- C. Caulking: ASTM C 920, Type S, Grade NS, Class 25, Use A.
- D. Corner Angles: nominal 0.016-inch aluminum 1-inch by 1-inch with factory applied Kraft backing. Aluminum shall be ASTM B 209, Alloy 3003, 3105, or 5005.
- E. Finishing Cement: mineral fiber hydraulic-setting thermal insulating cement ASTM C 449.
- F. Pipe Insulation



1. Insulation for hot water piping (supply and return) shall be fibrous glass with factory-applied fire retardant vapor barrier jacket with insulation K factor of at least 0.23 at 75° F mean temperature: by Owens Corning, Certain-Teed, Manville or Knauf, installed as required by manufacturer. ASTM E-84 fire hazard ratings shall be 25 flame spread, 50 smoke developed and 50 fuel contributed.
2. Insulation and vapor barrier on piping which passes through walls or partitions shall pass continuously through sleeve, except that piping between floors and through fire walls or smoke partitions shall have space allowed for application of approved packing between sleeves and piping, to provide firestop as required by NFPA. Seal ends to provide continuous vapor barrier where insulation is interrupted.

## 2.02 PIPING AND FITTINGS

### A. General

Piping, tubing, and fittings shall be as follows:

1. Hot Water Piping:
  - a) Piping 2" or Less shall be black steel Schedule 40 ASTM A-53, or Type L hard drawn copper tubing with cast iron, malleable iron or steel, solder-joint, or flared-tube joint fittings wrought copper fittings, 95/5 soldered and shall conform to ASTM B-32.

### B. Copper Tubing

1. Tubing shall conform to ASTM B 88, Type K or L.
2. Malleable Iron Pipe Fittings
3. Fittings shall conform to ASME B16.3, type required to match adjacent piping.

### C. Fittings for Copper Tubing

1. Wrought copper and bronze fittings shall conform to ASME B16.22 and ASTM B 75. Cast copper alloy fittings shall conform to ASME B16.18. Flared fittings shall conform to ASME B16.26 and ASTM B 62. Adapters may be used for connecting tubing to flanges and threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

## 2.03 MATERIALS AND ACCESSORIES

### A. Iron and Steel Sheets

1. Galvanized Iron and Steel: Galvanized iron and steel shall conform to ASTM A 527, ASTM A 528, or ASTM A 642, with general requirements conforming to ASTM A 525. Gauge numbers specified are Manufacturer's Standard Gauge.
2. Uncoated (Black) Steel: Uncoated (black) steel shall conform to ASTM A 366 or ASTM A 569, composition, condition, and finish best suited to the intended use. Gauge numbers specified refer to Manufacturer's Standard Gauge.

- B. Solder: Solder shall conform to ASTM B 32. Solder and flux shall be lead free.
- C. Solder, Silver: Silver solder shall conform to FS QQ-B-654.
- D. Gaskets for Flanges: Composition gaskets shall conform to ASME B16.21. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16-inch thickness, full face or self-centering flat ring type. Gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service. Gaskets shall be suitable for pressure and temperatures of piping system.

#### 2.04 PIPE HANGERS AND SUPPORTS

- A. As manufactured by Carpenter & Patterson, Inc., Grinnell Corporation, B-Line Systems or approved equal. Hangers shall transmit the load exclusively to the structure of the building. All hangers and supports to conform to MSS standards SP-58 and SP-69 and ANSI B 31.1.

- B. Maximum spacing of hangers and supports for steel pipe:

Pipe Size (inches)	Max Spacing (feet)
Up to 1	8 ft
1¼-2½	10 ft

- C. Hanger rods shall be steel, threaded and furnished with two removable nuts at each end of positioning rod and hanger and locking each in place.

Except as otherwise noted, hanger rods shall be of the following sizes:

SCHEDULE OF PIPE HANGER ROD SIZES		
Pipe sizes (inches)	Single rod diameter (inches)	Double rod diameter (inches)
½-2	3/8	3/8

- D. Pipe covering protection saddles shall not be loaded to more than 80% of maximum loading as rated by the manufacturer.

#### 2.05 SLEEVES

- A. Size sleeves to provide a minimum of 1-inch clearance around piping and ductwork, and to allow continuous runs of insulation where specified. Ensure that insulated piping and ductwork do not touch sleeves.
- B. Pack clearance spaces with Thermafibre Fire stopping. Caulk with fire-resistant, resilient waterproof compound, Flintguard 120-13 or equal. Ensure that fire ratings of floors and walls are maintained.
- C. Duct sleeves shall be minimum 18-gauge galvanized steel. Provide adequate bracing for support of sleeves during concrete and masonry work. For fire rated floors and walls, build fire dampers into structure to attain fire rated construction, in a manner acceptable to the local and state authorities.
- D. Cover exposed duct sleeves in finished areas with 18-gauge galvanized steel plates in the form of duct collars. Fix in position with non-ferrous metal screws.

2.06 ESCUTCHEON PLATES

- A. Provide one piece or hinged type wall and ceiling expansion-type plates with round head set screws or integral pipe clips. Provide recessed type for floors. For copper lines and in finished rooms provide minimum 18-gage spun brass, chrome plated over nickel plates. For all other areas, provide 18-gage enameled cast-iron or steel plates.

2.07 VALVES FOR HYDRONIC SYSTEMS

A. General:

- 1. The figure numbers and manufacturers indicated below are to be used as a means of identifying the type, quality, materials and workmanship required. Ball, globe and check valves shall be of the same manufacturer. All plug valves shall be of the same manufacturer.
- 2. All valves shall be located and oriented as to valve stem direction to permit proper and easy operation, and access to valve bonnet for maintenance of packing, seat and disc. Valve stems shall not be tilted down.

B. Service:

- 1. Shutoff or Isolation Valves:
  - a. Shutoff valves shall be provided in all branch connections to mains and where shown on piping diagrams.
  - b. Smaller than 2 : Ball valves
- 2. Drain Valves and Manual Vent Valves
  - a. Globe with plug-type disc or ball valves (as shown on drawings).

C. Ball Valves

- 1. 2 inches and smaller: Forged brass body, standard port, chrome-plated forged brass ball and stem, TFE seat, Fluoroelastomer seals, pressure-sealed ends, 300 psi CWP. Victaulic Series 589 Vic Press 304™.

D. Air Vents

- 1. Automatic: Normal Capacity - cast brass body, stainless steel internals, ball check valve. Float operated type, for pressure up to 150-psiG and temperature to 250°F. Fitted with safe drainage piping for venting air/water to drain.
- 2. Manual: 1/8-inch brass, chrome plated, with two-detachable keys. Provide manual air vents rated for use with 300°F, 100-psig water.

E. Balancing Valves

- 1. Balancing valves shall have meter connections with positive shutoff valves. An integral pointer shall register degree of valve opening. Valves shall be calibrated so that flow in gpm can be determined when valve opening in degrees and pressure differential across valve is known. Each balancing valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation equal in R-value to the adjacent pipe insulation. Valves shall be suitable for 250 degrees F temperature and

working pressure of the pipe in which installed. Valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation.

## 2.08 DUCTWORK

### A. Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with THE SMACNA HVAC DUCT CONSTRUCTION STANDARDS, 2ND ED., 1995 unless otherwise specified. Elbows shall be radius type with a centerline radius of 1-1/2 times the width or diameter of the duct where space permits or unless noted otherwise. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure Class ½ and 1-inch WG ductwork shall meet the requirements of Seal Class C. Class 2-inch WG ductwork shall meet the requirements of Seal Class B. Class 3 through 10-inch WG shall meet the requirements of Seal Class A. Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct, and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced drive screws or other approved methods indicated in THE SMACNA HVAC DUCT CONSTRUCTION STANDARDS, 2ND ED., 1995. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 2-inch band width covering all screw heads and joint gap. Dents in the male portion of the slip-fitting collar will not be acceptable. Outdoor air intake ducts and plenums shall be fabricated with watertight soldered or brazed joints and seams.

#### 1. Rectangular ductwork schedules:

<b>SCHEDULE OF RECTANGULAR DUCTWORK CONSTRUCTION (UP TO 2-inch WG)</b>					
Duct Dimension (inches)	Metal gages		Transverse joint construction	Reinforcement spacing	Transverse joint Reinforcement
	Galvanized steel	B & S aluminum			
<=12	24	0.040"	1" pocket lock	---	None
13-18	24	0.040"	Standing "S" slip	8'-0"	1"x26 gauge
19-26	22	0.050"	Standing "S" slip	8'-0"	1"x26 gauge
27-30	20	0.064"	Standing "S" slip	8'-0"	1"x24 gauge

#### 2. Round:

- a. Round ductwork shall be furnished where shown or called for on the drawings, and may be substituted for rectangular, as an option to the Sheet Metal Sub-subcontractor when approved by the engineer, and shall be provided where shown on the Drawings.
- b. Round duct and fittings shall be of spiral lock seam construction and shall be fabricated from G-60 galvanized steel or 316 stainless steel.

Galvanized steel shall meet ASTM A525 & A527 standards and stainless steel shall meet ASTM A240 and shall be fabricated in accordance with the following table.

SCHEDULE OF ROUND DUCTWORK CONSTRUCTION						
Duct Diameter (inches)	0.0" to +10.0" WG		0.0" to -10.0" WG (Class B)			
	Galvanized		Galvanized		316 Stainless Steel	
	Ductwork	Fittings	Ductwork	Fittings	Ductwork	Fittings
3-8	26	22	24	20	24	20
9-14	26	22	22	18	22	18

3. Transitions

Diverging airflow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging airflow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.

B. Ductwork Accessories

1. Access Doors in ductwork up to 2-inch pressure class.

- Frame: 24 gage galvanized steel with seal
- Door: hinged, with 24 gage galvanized steel exterior and interior panels.
- Locks: doors 16" and under, one lock doors over 16", two locks
- Seals: foam gasket
- Insulation: ½-inch foam board with aluminum foil face, 0.12K at 75°F.
- Ruskin Model ADH-2, Inland Steel, Miami-Carey or approved equal.

2. Provide at all fire dampers, air inlets, motorized dampers and where shown on the drawings.

3. Motor Operated Dampers

Motor operated dampers shall be furnished by the Automatic Temperature Control Sub-subcontractor and installed by the Sheet Metal Sub-subcontractor unless specified as part of a piece of equipment.

4. Automatic Control Air Dampers:

- Furnish and install low leakage automatic control aluminum dampers including necessary linkages, supports, actuators, switches, etc.

- b. Damper blades shall not exceed 4" width. All blades are to be of 0.080 extruded aluminum construction, Type 6063-T5, located 4-inches o/c. All modulating dampers shall have blades arranged for opposed blade operation.
    - c. Replaceable seals are to be provided with the dampers. Seals are to be vinyl on blade edges, polyurethane foam on jambs. Seals are to be installed along the top, bottom and sides of extruded aluminum frame and along each blade edge. Seals shall provide a tight closing, low leakage damper. Dampers shall be similar and equal in all respects to Ruskin Type CD454, or equal.
  - C. Duct Sleeves, Framed Prepared Openings, Closure Collars
    - 1. Duct Sleeves

Duct sleeves shall be provided for round ducts 15-inches in diameter or less passing through floors, walls, ceilings, or roof, and installed during construction of the floor, wall, ceiling, or roof. Round ducts larger than 15-inches in diameter and square, rectangular, and oval ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 20-gauge galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53, Schedule 20 shall be used. Sleeve shall provide 1-inch clearance between the duct and the sleeve or 1-inch clearance between the insulation and the sleeve for insulated ducts.
    - 2. Framed Prepared Openings

Openings shall have 1-inch clearance between the duct and the opening or 1-inch clearance between the insulation and the opening for insulated ducts.

## 2.09 HOT WATER UNIT HEATERS (UH)

- A. General
  - 1. Fixed discharged hot water unit heaters shall be by Airtherm, Sterling, McQuay or approved equal.
- B. Construction
  - 1. Heating element: fin and tube extended surface of aluminum fins mechanically bonded to seamless copper tubing, free to expand or contract without damage to adjacent tubes or header connections and incorporate a replaceable tube feature with tubes connected to the header by means of a mechanical nut and ferrule compression union.
  - 2. Casing to be minimum 20-gauge die-formed steel. Casing top to be provided with threaded hanger connections for unit suspension.

3. The unit shall be factory tested at 500-psig hydrostatic and 200-psig steam pressure.
  4. Horizontal units to be furnished with safety fan guard and horizontal and vertical air deflector blades.
- C. Fan Unit
1. Each heater shall be provided with a non-overloading aluminum fan wheel connected to a constant speed motor with pre-lubricated, sealed ball bearings. The fan wheel shall be dynamically balanced and used in conjunction with an inlet venturi.
- D. Paint
1. Each heater shall be finished in gray baked on alkyd resin enamel with superior durability to withstand industrial environment, abrasion and impact.
- E. Accessories
1. Furnish with threaded rod for hanging from ceiling or wall bracket for wall installation.
  2. Furnish with local disconnect switch and wall mounted space thermostat, programmable through the BMS. If programmable space thermostat is not available as an equipment accessory, provide thermostat as specified under automatic temperature control section.

### **PART 3 - EXECUTION**

---

#### **3.00 GENERAL**

- A. Install all items specified under PART 2 - PRODUCTS, according to the applicable manufacturer's recommendations and shop drawings, the details shown on the drawings and as specified under this Section. Provide all required hangers and supports.
- B. All welding done under this Section shall be performed by experienced welders in a neat and workmanlike manner. All welding done on piping, pressure vessels and structural steel under this Section shall be performed only by persons who are currently qualified in accordance with ANSI Code B31.1 for Pressure Piping and certified by the American Welding Society, ASME or an approved independent testing laboratory; and each such welder shall present his certificate attesting his qualifications to the Engineer's representative whenever requested to do so on the job.
- C. All pipe welding shall be oxyacetylene or electric arc. High test welding rods suitable for the material to be welded shall be used throughout. All special fittings shall be carefully laid out and joints shall be accurately matched intersections. Care shall be exercised to prevent the occurrence of protruded weld metal into the pipe. All welds shall be of sound metal free from laps, cold shots, gas pockets, oxide inclusions and similar defects.
- D. All necessary precautions shall be taken to prevent fire or damage occurring as the result of welding operations.

#### **3.01 SPECIAL RESPONSIBILITIES**

- A. Perform work such that progress of entire project including work of other Sections shall not be interfered with or delayed.
- B. Provide information as requested on items furnished under this Section which shall be installed under other Sections.
- C. Obtain detailed installation information from manufacturers of equipment provided under this Section.
- D. Obtain final roughing dimensions or other information as needed for complete installation of items furnished under other Sections or by Owner.
- E. Keep fully informed as to shape, size and position of openings required for material or equipment to be provided under this and other Sections. Give full information so that openings required by work of this Section may be coordinated with other work and other openings and may be provided for in advance. In case of failure to provide sufficient information in proper time, provide cutting and patching or have same done, at own expense and to full satisfaction of Architect.
- F. Provide information as requested as to sizes, number and locations of concrete housekeeping pads necessary for floor-mounted vibrating and rotating equipment provided under this Section.
- G. Maintenance of equipment and systems: Maintain equipment and systems until Final Acceptance. Ensure adequate protection of equipment and material during delivery, storage, installation and shutdown and during delays pending final test of systems and equipment because of seasonal



- H. Remove and dispose of dirt and debris, and keep premises clean. During progress of work, remove equipment and unused material. Put building and premises in neat and clean condition, and do cleaning and washing required to provide acceptable appearance and operation of equipment, to satisfaction of Architect.

3.02 MISCELLANEOUS

- A. Unload materials and equipment delivered to site. Pay costs for rigging, hoisting, lowering and moving electrical equipment on and around site, in building or on roof.

3.03 COORDINATION

- A. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
- B. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

3.04 MATERIALS AND WORKMANSHIP

- A. Work shall be neat and rectilinear. Ductwork, piping, conduit, etc. shall run concealed except in mechanical rooms and areas where no hung ceiling exists. Install material and equipment as required by manufacturers. Installation shall operate safely and without leakage, undue wear, noise, vibration, corrosion or water hammer. Work shall be properly and effectively protected, and pipe and duct openings shall be temporarily closed to prevent obstruction and damage before completion.
- B. Except as specified otherwise, material and equipment shall be new. Provide supplies, appliances and connections necessary for complete and operational installation. Provide components required or recommended by OSHA and applicable NFPA documents.

3.05 VALVE TAGS

- A. Valve tags shall be at least 1" in diameter with numerals at least 3/8" high and attached by "S" hooks or chains. Equipment tags shall be at least 2" diameter securely attached to apparatus.
- B. Provide manufacturer's equipment nameplates, catalog numbers and rating identification securely attached to electrical and mechanical equipment with screws or rivets. Adhesives or cements will not be permitted.

3.06 PIPE AND DUCT IDENTIFICATION

- A. Provide color-coded pipe identification markers on piping installed under this Section. Pipe markers shall be snap-on laminated plastic protected by clear acrylic coating. Pipe markers shall be applied after architectural painting where such is required.
- B. Mains shall be labeled at points of entrance and exit from mechanical room, adjacent to each valve, on each riser, at each tee fitting, at points of entrance and exit from building, at least once in each room, and at intervals no longer than 20 ft.
- C. Size of legend letters on markers and length of color field shall be per the latest edition of ANSI.
- D. Markers shall be "Setmark" by Seton Name Plate Corp., or approved equal.

3.07 PIPING

- A. Provide and erect in a workmanlike manner according to the best practices of the trade, all piping shown on the plans or required to complete the installation intended by these specifications.
- B. All other connections are to be made with screwed fittings.
- C. Make such offsets as are shown or required to place pipes on risers in proper position or to avoid other work. Make such offsets neatly and properly locate them to the satisfaction of the Architect.
- D. All pipe lines shall be provided with sufficient number of flange fittings or unions to make possible the taking down of the pipes without breakage of fittings. Lines 2" in diameter and less may be connected by R & L couplings, unless otherwise required by the Architect. All of the piping shall be erected so as to provide for the easy flow of water and noiseless circulation. Whenever pipes are cut, three wheel cutters are to be used and the pipes are to be carefully reamed out.
- E. The entire piping system shall be provided with shutoff valves and draw-off valves so that sections of the system may be drained without interrupting the entire system.
- F. Extreme care shall be exercised in the location of all piping.
- G. No crosses or bullhead tees shall be used in any part of the work.
- H. Piping connections to all equipment shall be made with companion flanges, grooved mechanical couplings, or unions for ease in removal of equipment.

3.08 VALVES

- A. Valves shall be installed where shown on plans and elsewhere as necessary for the proper operation or balancing of the systems.
- B. At completion, this Subcontractor shall install stamped brass tag on each valve held on with brass drain with numbers. This subcontractor is to make up schedule with number of each valve. Schedule to describe use of each valve. One copy of the schedule shall be framed under glass and hung in boiler room. Two more copies are to be supplied to the Architect.
- C. Extreme care must be used in locating fin tube radiation valves and fittings in order that they shall be installed so as to be readily accessible.
- D. Install on each coil, a key type compression air valve.

3.09 PIPE HANGERS

- A. Pipe hangers of the types specified shall be installed for the support of all piping. Maximum center-to-center hanger spacing shall be as follows, except as otherwise indicated on the Drawings.

Pipe Size	Max. Spacing
Up to 1-1/4"	5'-0"

Pipe Size	Max. Spacing
1-1/2" and 2"	8'-0"
2-1/2" and 3"	8'-0"
Over 4"	10'-0"

3.10 PENETRATIONS AND SLEEVES

A. General

1. Lay out penetration and sleeve openings in advance, to permit provision in work. Set sleeves and conduit in forms before concrete is poured. Provide remedial work where sleeves and conduits are omitted or improperly placed.
2. Provide sleeves and packing materials at all penetrations of foundations, walls, slabs (except on-grade), partitions and floors. Sleeves shall meet NFPA-101 requirements and materials requirements of these specifications.
3. Sleeves that penetrate outside walls, basement slabs, footings and beams shall be waterproof.
4. Coordinate work carefully with architectural and structural work. Set sleeves in forms before concrete is poured. Provide core drilling as necessary if walls are poured, or otherwise constructed, without sleeves and a wall penetration is required. Provide core drilling as required for penetrations of existing construction. Do not penetrate structural members without Architect's approval.
5. Sleeves for insulated pipe and duct in non-fire rated construction shall accommodate continuous insulation without compression. Sleeves and/or penetrations in fire rated construction shall be packed with fire rated material that shall maintain the fire rating of the wall. Seal ends of penetrations to provide continuous vapor barrier where insulation is interrupted.
6. Where pipes, etc. passing through openings are exposed in finished rooms, finishes of filling materials shall match and be flush with adjoining floor, ceiling, and wall finishes.
7. Identify unused sleeves and slots for future installation.
8. Fill slots, sleeves and other openings in floors or walls if not used. Fill spaces in openings after installation of pipe or duct.
9. Fill for floor penetrations shall prevent passage of water, smoke, fire, and fumes. Fill shall be fire resistant in fire floors and walls, and shall prevent passage of air, smoke and fumes.
10. Sleeves through floors shall be water-tight and shall extend 2" above floor surface.

B. Pipe Sleeves

1. Annular space between pipe and sleeve shall be at least 1/4".
2. Sleeves are not required for slabs-on-grade unless specified otherwise.

3. Sleeves and packing materials, through rated fire walls and smoke partitions shall maintain fire rating of construction penetrated.
4. Do not support piping risers on sleeves.

C. Duct Sleeves and Prepared Openings

1. Provide duct sleeves for round ducts 15" and smaller; provide prepared, framed openings for round ducts larger than 15" and for square, rectangular and flat oval ducts, except as specified otherwise. Sleeves shall meet SMACNA requirements.
2. Prepared openings shall be framed to provide 1" clearance between framing and duct or duct insulation.
3. Inspect foamed sealants to ensure manufacturer's optimum cell structure and color ranges.
4. Sleeves shall be installed for each pipe passing through masonry floors or walls.

3.11 ESCUTCHEON PLATES

- A. Escutcheon plates shall be installed on all piping passing through finished floors, walls or ceilings. Escutcheon plates shall be sized for outside diameter of insulation and installed after insulation is completed.

3.12 SPECIALTIES

- A. Specialties of the type specified shall be installed at points specified and elsewhere where shown on the drawings.
- B. Air vent valves shall be installed at every high point throughout the system.

3.13 INSULATION

- A. All of the insulation work shall be done by contractors regularly engaged in this type of work in a neat and workmanlike manner. All insulation shall be completely sealed with no glass fibers exposed to the air.
- B. The entire hot water piping system and applicable ductwork systems, including piping, valve bodies, fittings, specialties, etc., shall be carefully insulated throughout for thermal control and to prevent condensation.
  1. All piping insulation in mechanical room shall be enclosed in a PVC Jacket.

3.14 EQUIPMENT INSTALLATION

- A. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways, to satisfaction of Architect and in accordance with code requirements. Installation shall permit clearance for access to equipment for repair, servicing and replacement.
- B. Install equipment so as to properly distribute equipment loads on building structural members provided for equipment support under other Sections. Roof-mounted equipment shall be installed and supported on structural steel provided under other Sections.
- C. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs as necessary for floor, wall or ceiling mounting of equipment as required.

- D. Provide steel supports and hardware for proper installation of hangers, anchors, guides, etc.
- E. Provide cuts, weights, and other pertinent data required for proper coordination of equipment support provisions and installation.
- F. Equipment shall be installed complete with all required hangers and supports in accordance with the manufacturer's recommendations.
- G. Furnish and install all steel structural support members for proper hanging and support of equipment. Provide vibration isolation on all hangers.

### 3.15 SHEET METAL WORK

- A. All of the sheet metal work shall be done by contractors regularly engaged in this type of work.
- B. Fabrication, installation, sealing, protecting and testing of all ductwork and duct liner shall comply with the most recent publications from the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) including but not limited to the following:
  - a) SMACNA Duct Cleanliness for New Construction Guideline. :This project must comply with SMACNA Duct Cleanliness Guidelines Advanced Level.
  - b) SMACNA HVAC Duct Construction Standards – Metal and Flexible
  - c) SMACNA Air Duct Leakage Test Manual
- C. All metal work in dead or furred down spaces is to be erected in time to occasion no delay in the work of other trades on the building.
- D. Supply collars to diffusers shall be installed inside the neck of the diffusers. Dampers on all registers and diffusers shall be installed in the open position.
- E. Joints in all ductwork throughout shall be sealed per Seal Class as specified in Ductwork in Section 2 of this specification. All ductwork shall be taped and sealed.
- F. During the progress of the work and after the completion of the same, this Subcontractor shall remove from the premises all dirt, debris, rubbish, waste materials, etc., cause by him in the performance of this work, together with all his tools and appliances.

### 3.16 MISCELLANEOUS IRON AND STEEL

- A. Provide steel supports and hangers required to support fans, tanks, air handling units, pipe, ductwork, and other equipment or materials. Submit details of steel supports and method of fabrication for approval.
- B. All work shall be cut, assembled, welded and finished by skilled mechanics. Welds shall be ground smooth. Stands, brackets, and framework shall be properly sized and strongly constructed.

- C. Measurements shall be taken on the job and worked out to suit adjoining and connecting work. All work shall be by experienced metal working mechanics. Members shall be straight and true and accurately fitted. Scale, rust, and burrs shall be removed. Welded joints shall be ground smooth where exposed. Drilling, cutting and fitting shall be done as required to properly install the work and accommodate the work of other trades as directed by them.
- D. Members shall be generally welded, except that bolting may be used for field assembly where welding would be impractical. Welders shall be skilled.
- E. All shop-fabricated iron and steelwork shall be cleaned and dried and given a shop coat of paint on all surfaces and in all openings and crevices.

3.17 PAINTING

- A. Equipment installed shall have shop coat of non-lead gray paint. Hangers and supports shall have one coat of non-lead red primer. Machinery such as pumps, fans, etc., shall be stenciled with equipment name. Stencil shall be at least 6" high for large equipment, 2" high for small equipment. Finish painting, including painting of various piping and duct systems, shall be done under other Sections.

END OF SECTION 230001