SECTION 23 09 93 (15940) - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

B. Related Sections:
   1. Section 23 09 00 (15900) - Instrumentation and Control for HVAC.

1.02 SEQUENCES

A. (PTAC) Package Terminal Air Conditioning Units.
   1. Service: As shown on the drawings.
   2. Integral (remote) thermostat shall cycle fan, compressor and electric heat to maintain space set point temperature.
   3. Remove temperature limiters.

B. (FCU) Split System Fan Coil Units
   1. Service: As shown on the drawings.
   2. Where required, duct mounted addressable Smoke Detector shall stop unit and notify building fire alarm system upon detection of smoke.
   3. Provide complete with fan selector and sub-base with fan ON/OFF/AUTO switch.
   4. With system switch in “AUTO” position, heating or cooling shall be provided as required via automatic changeover, fan shall run continuously.
   5. With system switch in “COOL” position, cooling shall cycle on in stages when space temperature exceeds thermostat set point.
   6. With system switch in “HEAT” position, heat shall cycle on in stages when space temperature is below thermostat set point.
   7. In all occupied sequences, the outside air damper shall be set to the minimum position.

C. (EUH) Electric Unit Heaters.
   1. Service: As shown on the drawings.
   2. Integral thermostat shall cycle fan and resistance heat to maintain space set point temperature.

D. (ECH) Electric Cabinet Unit Heaters
   1. Service: As shown on the drawings.
   2. Integral thermostat shall cycle resistance heating, element to maintain space set point temperature.

E. (EWH) Electric Wall Heaters
   1. Service: As shown on the drawings.
   2. Integral thermostat shall cycle resistance heating, element to maintain space set point temperature.

F. (EBB) Electric Baseboard Heaters
   1. Service: As shown on the drawings. Various areas.

© GH2 ARCHITECTS, LLC 2009
20090060 SHS Grand Junction, CO

Add Section in its entirety. RFI #19 - 032410
2. Integral thermostat shall cycle resistance heating, element to maintain space set point temperature.

G. Janitor’s Closet Exhaust.
   1. The contractor shall interlock exhaust fan with light switch. When the lights are turned on, the exhaust fan shall start. When the lights are turned off, the fan shall stop.

H. Public Toilet Room Exhaust.
   1. The exhaust fan shall run continuously, 24 hours per day.

I. Guest Room Bathroom Exhaust.
   1. The contractor shall interlock exhaust fan with light switch. When the lights are turned on, the exhaust fan shall start. When the lights are turned off, the fan shall stop.

J. Meeting Room Exhaust
   1. The exhaust fan shall be started and stopped by a wall mounted switch. The switch shall be equipped with a pilot light for visual operation reference.

K. Elevator Equipment Room, Mechanical Room and Electrical Room Exhaust.
   1. Each space shall be controlled by a wall mounted thermostat. When the space temperature exceeds the set point, a signal shall be sent to open the outside air damper and start the exhaust fan. Once the space is satisfied, a signal shall be sent to stop the exhaust fan and close the outside air damper.

L. Attic Ventilation.
   1. The attic shall be controlled by a space mounted thermostat. When the space temperature exceeds the set point. A signal shall be sent to start the exhaust fan.

M. Kitchen Hood Exhaust
   1. The contractor shall interlock the related supply and exhaust fans with the kitchen hood. When the kitchen hood is activated, a signal shall be sent to start the exhaust fan, open the outside air damper and start the supply fan.
   2. When the kitchen hood is deactivated, a signal shall be sent to stop the supply fan, close the outside air damper and stop the exhaust fan.

N. (PDU) Pool Dehumidification Unit
   1. Service: Pool area
   2. The PDU shall operate as required by manufacturer's specification and be controlled by a microprocessor supplied with PDU equipment; sequence heating, cooling and dehumidification as called for by space thermostat and humidistat and system microprocessor.
   3. O.A. Damper with timeclock control for occupied and unoccupied.
   4. Flow switch shall be interlocked with pool recirculating pumps.
   5. Electric duct heaters shall operate in conjunction with the PDU Unit control sequence. Unit shall sequence heat on in multiple stages. Heater shall have overheat and airflow safety switches in addition to U.L., N.E.C. and Code requirements.
   6. Interlock pool PDU with water heaters for staging.
   7. Pool Exhaust fan runs continuous.

O. Combustion Air Louver Dampers
   1. Interlock with gas fired equipment to open when equipment fires up.
PART 2  PRODUCTS
Not Used

PART 3  EXECUTION
Not Used

END OF SECTION
PART 1  GENERAL

1.01  SUMMARY
   A.  Section Includes:
      1.  Pipe, Fittings and Joining Materials.
      2.  Protective Coating.
      3.  Piping Specialties.
      4.  Valves.
   B.  Related Sections:
      1.  Section 09 90 00 (09900) - Painting
      2.  Section 22 34 00 (15486) – Fuel-Fired, Domestic Water Heaters
      3.  Section 23 05 00 (15050) – Common Work Results for HVAC
      4.  Section 23 05 29 (15060) - Hangers and Supports for HVAC Piping and Equipment: for pipe hanger restraints.
      5.  Section 33 00 00 (02500) - Utility Services: For natural gas service piping, specialties, and accessories outside the building.

1.02  SUBMITTALS
   A.  Submit “Letter of Conformance” in accordance with Section 01 33 00 (01330) - indicating items selected for use in project with the following supporting data:
      1.  Product Data for the following:
          a.  Corrugated, stainless-steel tubing systems. Include associated components.
          b.  Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
          c.  Pressure regulators. Include pressure rating, capacity, and settings of selected models.

1.03  QUALITY ASSURANCE
   C.  UL Standard:  Provide components listed in UL's "Gas and Oil Equipment Directory" if specified to be UL listed.

1.04  PROJECT CONDITIONS
   A.  Gas System Pressure:  As indicated on Drawings
   B.  Design values of fuel gas supplied for these systems are as follows:
      1.  Nominal Heating Value:  As indicated on Drawings.
      2.  Nominal Specific Gravity:  As indicated on Drawings.

PART 2  PRODUCTS

2.01  MANUFACTURERS
   A.  Avendra, LLC Preferred Manufacturers:
   •  SECTION 23 11 23 (15194) - FACILITY NATURAL-GAS PIPING •
   •  PAGE 1 •
1. Corrugated, Stainless-Steel Tubing Systems:
   a. None.

2. Appliance Connector Valves:
   a. None.

3. Gas Valves, NPS 2 (DN 50) and Smaller:
   a. None.

4. Plug Valves, NPS 2-1/2 (DN 65) and Larger:
   a. None.

5. Automatic Gas Valves:
   a. None.

6. UL-Listed Earthquake Valves:
   a. None.

7. Service Pressure Regulators:
   a. None.

B. Approved Manufacturers:

1. Corrugated, Stainless-Steel Tubing Systems:
   a. Omega Flex, Inc. (800-355-1039)
   b. Titeflex Corporation (800-765-2525)
   c. Tru-Flex Metal Hose Corp. (800-255-6291)
   d. B&K Industries, Inc. (800-782-2385)
   e. Cimberio Valve Co. (877-228-9246)
   f. Conbraco Industries, Inc.; Apollo Div. (704-841-6000)

2. Gas Valves, NPS 2 (DN 50) and Smaller:
   a. Crane Valves (800-323-3679)
   b. Milwaukee Valve Co., Inc. (262-432-2700)

3. Plug Valves, NPS 2-1/2 (DN 65) and Larger:
   a. Milliken Valve Co., Inc. (610-861-8803)

4. Automatic Gas Valves:
   a. ASCO General Controls (800-524-1023)
   b. ASCO Power Technologies, LP; Division of Emerson (800-800-2726)
   c. Honeywell, Inc. (800-328-5111)

5. UL-Listed Earthquake Valves:
   a. Energy Pacific (800-638-2032)
   b. Safe T Quake Corp. (800-833-5353)
   c. Seismic Safety Products, Inc. (800-948-3782)
6. Service Pressure Regulators:
   a. American Meter Co. (215-830-1800)
   b. Invensys Metering Systems (800-375-8875)
   c. Fisher Controls, Division of Emerson. (800-558-5853)

2.02 PIPING MATERIALS
   A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.03 PIPES, TUBES, FITTINGS, AND JOINING MATERIALS
   A. Steel Pipe: ASTM A53; Type E or S; Grade B; Schedule 40; black.
      2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
      5. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
      7. Steel Flanges and Flanged Fittings: ASME B16.5.
      8. Gasket Material: Thickness, material, and type suitable for natural gas.
   B. Transition Fittings: Type, material, and end connections to match piping being joined.
   C. Common Joining Materials: Refer to Section 23 05 00 - "Common Work Results for HVAC" for joining materials not in this Section.

2.04 PROTECTIVE COATING
   A. Paint all exterior exposed gas piping with two coats of rust inhibitive paint.

2.05 PIPING SPECIALTIES
   C. Valves, NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
   D. Valves, NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
   F. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig (13.8-kPa) minimum pressure rating.
   G. Gas Valves, NPS 2 (DN 50) and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating.
   H. Plug Valves, NPS 2-1/2 (DN 65) and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating.

© GH2 ARCHITECTS, LLC 2009
20090060 SHS Grand Junction, CO
I. General-Duty Valves, NPS 2-1/2 (DN 65) and Larger: ASME B16.38, cast-iron body, suitable for fuel gas service, with "WOG" indicated on valve body, and 125-psig pressure rating.
   1. Gate Valves: MSS SP-70, OS&Y type with solid wedge.

J. Automatic Gas Valves: ANSI Z21.21, with electrical or mechanical operator for actuation by appliance automatic shut-off device.

K. Earthquake Valves: FM approved or listed in IAS Directory as complying with ANSI Z21.70 and UL listed. Include mechanical operator.

PART 3 EXECUTION

3.01 PREPARATION

3.02 SERVICE ENTRANCE PIPING
   A. Extend fuel gas piping and connect to fuel gas distribution for service entrance to building.
      1. Exterior fuel gas distribution system piping, service pressure regulator, and service meter will be provided by gas utility.
   B. Install strainer upstream from each earthquake valve. Refer to Section 22 10 13 - "Plumbing Specialties" for strainers.

3.03 CONCRETE BASE INSTALLATION
   A. Locate bases at service meters and service regulators.
   B. Excavate earth and make level beds to support bases. Set bases level with top surface projecting approximately 3 inches above grade.

3.04 PIPING APPLICATIONS
   A. Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.
   B. Fuel Gas Piping, 0.5 psig or Less: Use the following:
      1. NPS 3/4 (DN 20) steel pipe, malleable-iron threaded fittings, and threaded joints.
         a. Option: Soft copper tube, copper fittings, and brazed joints may be used for runouts at individual appliances.
      3. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): Steel pipe, malleable-iron threaded fittings, and threaded joints.
      4. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Steel pipe, steel welding fittings, and welded joints.
      5. Larger Than NPS 4 (DN 100): Steel pipe, steel welding fittings, and welded joints.

3.05 VALVE APPLICATIONS
   A. Appliance Shutoff Valves for Pressure 0.5 psig or Less: Appliance connector valve or gas stop.
   B. Appliance Shutoff Valves for Pressure 0.5 to 2 psig: Gas stop or gas valve.
   C. Piping Line Valves, NPS 2 (DN 50) and Smaller: Gas valve.
   D. Piping Line Valves, NPS 2-1/2 (DN 65) and Larger: Plug valve or general-duty valve.
   E. Valves at Service Meter, NPS 2 (DN 50) and Smaller: Gas valve.
F. Valves at Service Meter, NPS 2-1/2 (DN 65) and Larger: Plug valve.

3.06 PIPING INSTALLATION

A. Refer to Section 23 05 00 - "Common Work Results for HVAC" for basic piping installation requirements.

B. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.

1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.

2. In Floors: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in floors, subject to approval of authorities having jurisdiction. Surround piping cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

3. In Floor Channels: Gas piping may be installed in floor channels, subject to approval of authorities having jurisdiction. Channels must have cover and be open to space above cover for ventilation.

4. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls.
   a. Exception: Tubing passing through partitions or walls.

5. In Walls: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in masonry walls, subject to approval of authorities having jurisdiction.

6. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
   a. Exception: Accessible above-ceiling space specified above.

C. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches (75 mm) long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

D. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels, unless indicated to be exposed to view.

E. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

F. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

G. Connect branch piping from top or side of horizontal piping.

H. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
I. Install corrugated, stainless-steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.

J. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.

K. Install flanges on valves, specialties, and equipment having NPS 2-1/2 (DN 65) and larger connections.

L. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

M. Install containment conduits for gas piping below slabs, within building, in gastight conduits extending minimum of 4 inches outside building, and vented to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal-tar, epoxy-polyamide paint according to SSPC-Paint 16.

3.07 JOINT CONSTRUCTION

A. Refer to Section 23 05 00 "Common Work Results for HVAC" for basic piping joint construction.

B. Use materials suitable for fuel gas.
   1. Brazed Joints: Make with brazing alloy with melting point greater than 1000 deg F. Brazing alloys containing phosphorus are prohibited.

3.08 HANGER AND SUPPORT INSTALLATION

A. Refer to Section 23 05 29 - "Hangers and Supports for HVAC Piping and Equipment" for pipe hanger and support devices.

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches; minimum rod size, 3/8 inch.
   4. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet; minimum rod size, 1/2 inch.
   5. NPS 4 (DN 100) and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.09 CONNECTIONS

A. Drawings indicate general arrangement of fuel gas piping, fittings, and specialties.

B. Install piping adjacent to appliances to allow service and maintenance.

C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.10 PAINTING

A. Use materials and procedures in Section 09 90 00 "Painting"

B. Paint exterior service meters, pressure regulators, specialty valves, and piping.

3.11 FIELD QUALITY CONTROL
A. Inspect, test, and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing, and Purging," and requirements of authorities having jurisdiction.
B. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.
C. Report test results promptly and in writing to Owner’s Representative and authorities having jurisdiction.
D. Verify capacities and pressure ratings of service meters, pressure regulators, valves, and specialties.
E. Verify correct pressure settings for pressure regulators.
F. Verify that specified piping tests are complete.

3.12 ADJUSTING
A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

END OF SECTION
SECTION 23 23 00 (15530) - REFRIGERANT PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Tubes.
   2. Fittings.
   4. Specialties.

B. Related Sections:
   1. Section 07 92 00 (07920) - Joint Sealants
   2. Section 07 84 00 (07840) - Firestopping: Firestopping materials and requirements for penetrations through fire and smoke barriers.
   3. Section 23 05 00 (15050) – Common Work Results for HVAC
   4. Section 23 05 29 (15060) - Hangers and Supports for HVAC Piping and Equipment: for pipe hanger restraints.
   5. Section 23 05 53 (15075) – Identification for HVAC Piping and Equipment
   6. Section 22 07 00 (15083) - HVAC Insulation

1.02 SUBMITTALS

A. Submit "Letter of Conformance" in accordance with Section 01 33 00 (01330) indicating specified items selected for use in Project with the following supporting data:
   1. Product Data for each valve type and refrigerant piping specialty specified.
   2. Refrigerant piping indicated is schematic only. Contractor shall size and design the piping configuration and install the piping, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and conformance with warranties of connected equipment.
   3. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience.
   4. Maintenance data for refrigerant valves and piping specialties to include in the operation and maintenance manual specified in Division 01 Sections.

1.03 QUALITY ASSURANCE

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

B. Regulatory Requirements: Comply with provisions of the following codes:
   1. ASME B31.5, "Refrigeration Piping."

C. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Non-electrical"; or UL 429, "Electrically Operated Valves."

D. Listing and Labeling: Provide products specified in this Section that are UL listed and labeled.

© GH2 ARCHITECTS, LLC 2009
20090060 SHS Grand Junction, CO
Add Section in its entirety. RFI #19 - 032410
PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Avendra, LLC Preferred Manufacturers:
      1. Refrigerant Valves and Specialties:
         a. None.
   B. Approved Manufacturers:
      1. Refrigerant Valves and Specialties:
         a. **Henry Pratt Company**, Subsidiary of Mueller Water Products, Inc. (877-436-7966)
         b. **Parker-Hannifin Corporation; Refrigeration & Air Conditioning Division** (800-272-7537)
         c. **Sporlan Valve Company** (314-647-2775)

2.02 TUBES
   A. Use pre-charged tubing where possible.
   B. Soft Copper Tube: ASTM B280, Type ACR, annealed temper.

2.03 TUBE FITTINGS

2.04 JOINING MATERIALS
   A. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (Silver).

2.05 REFRIGERANT PIPING SPECIALTIES
   A. Moisture/Liquid Indicators: 500-psig operating pressure, 200 deg F operating temperature;
      forged-brass body, with replaceable, polished, optical viewing window with color-coded
      moisture indicator, and solder-end connections.
   B. Permanent Filter-Dryer: 350-psig maximum operating pressure, 225 deg F maximum
      operating temperature; steel shell, and wrought-copper fittings for solder-end connections;
      molded-felt core surrounded by desiccant.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Examine roughing-in for compliance with requirements for installation tolerances and other
      conditions affecting performance of refrigerant piping. Do not proceed with installation until
      unsatisfactory conditions have been corrected.

3.02 APPLICATIONS
   A. Above ground, within Building: Type ACR drawn-copper tubing.
   B. Below ground for 2-Inch NPS (DN50) and Smaller: Type L (Type B) annealed-copper tubing
      installed in schedule 40 PVC sleeve.

3.03 INSTALLATION
   A. Install refrigerant piping according to ASHRAE 15.
   B. Basic piping installation requirements are specified in Section 21/22/23 95 00 (15050) - "Basic
      Mechanical Materials and Methods."
   C. Install piping in short and direct arrangement, with minimum number of joints, elbows, and
      fittings.

© GH2 ARCHITECTS, LLC 2009
20090060 SHS Grand Junction, CO

Add Section in its entirety. RFI #19 - 032410
D. Arrange piping to allow normal inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.

E. Install piping with adequate clearance between pipe and adjacent walls and hangers, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation. Maximum fill: 40%

F. Below ground, install copper tubing in schedule 40 PVC conduit. Vent conduit outdoors.

G. Insulate suction lines.
   1. Do not install insulation until system testing has been completed and all leaks have been eliminated.

H. Install branch lines to parallel compressors of equal length, and pipe identically and symmetrically.

I. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

J. Slope refrigerant piping as follows:
   1. Install horizontal suction lines with a uniform slope of 0.4 percent downward to compressor.
   2. Install traps and double risers where indicated and where required to entrain oil in vertical runs.
   3. Liquid lines may be installed level.

K. Use fittings for changes in direction and branch connections.

L. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

M. Reduce pipe sizes using eccentric reducer fittings installed with level side down.

N. Provide bypass around moisture-liquid indicators in lines larger than 2-inch NPS (DN50).

O. Install unions to allow removal of solenoid valves, pressure-regulating valves, expansion valves, and at connections to compressors and evaporators.

P. Install refrigerant valves according to manufacturer's written instructions.

Q. When brazing, remove solenoid-valve coils; remove sight glasses; and remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties. Do not apply heat near bulb of expansion valve.

R. Electrical wiring for solenoid valves is specified in Division 16 Sections. Coordinate electrical requirements and connections.

S. Charge and purge systems, after testing, dispose of refrigerant following ASHRAE 15 procedures.

3.04 HANGERS AND SUPPORTS

A. General: Hangers, supports, and anchors are specified in Section 23 05 29 - "Hangers and Supports for HVAC Piping and Equipment." Provide according to ASME B31.5 and MSS SP-69.

B. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes. Tube sizes are nominal or standard tube sizes as expressed in ASTM B88.
   1. 1/2 Inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   2. 5/8 Inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. **1 Inch:** Maximum span, 60 inches; minimum rod size, 1/4 inch.

4. **1-1/4 Inches:** Maximum span, 72 inches; minimum rod size, 1/4 inch.

5. **1-1/2 Inches:** Maximum span, 96 inches; minimum rod size, 3/8 inch.

### 3.05 PIPE INSULATION

A. Piping insulation is specified in Section 23 07 00 “HVAC Insulation”.

### 3.06 SPECIALTIES APPLICATION AND INSTALLATION

A. Install permanent filter dryers in low-temperature systems using hermetic compressors, and before each solenoid valve.

### 3.07 PIPE JOINT CONSTRUCTION

A. Basic pipe and tube joint construction is specified in Section 23 05 00 - "Common Work Results for HVAC."

B. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent formation of scale.

### 3.08 VALVE INSTALLATIONS

A. Install refrigerant valves according to manufacturer’s written instructions.

### 3.09 CONNECTIONS

A. Electrical: Conform to applicable requirements of Division 26 Sections for electrical connections.

### 3.10 FIELD QUALITY CONTROL

A. Inspect and test refrigerant piping according to ASME B31.5, Chapter VI.

1. Pressure test with nitrogen to 200 psig. Perform final tests at 27-psig vacuum and 200 psig using halide torch or electronic leak detector. Test to no leakage.

B. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

C. Repair leaks using new materials; retest.

### 3.11 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

### 3.12 CLEANING

A. Before installation of copper tubing other than Type ACR, clean tubing and fittings with trichloroethylene.

### 3.13 COMMISSIONING

A. Charge system using the following procedures:

1. Install core in filter dryer after leak test, but before evacuation.

2. Evacuate refrigerant system with vacuum pump until temperature of 35 deg is indicated on vacuum dehydration indicator.

3. During evacuation, apply heat to pockets, elbows, and low spots in piping.

4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.

5. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.

---

© GH2 ARCHITECTS, LLC 2009
20090060 SHS Grand Junction, CO

Add Section in its entirety. RFI #19 - 032410
6. Complete charging of system, using new filter-dryer core in charging line. Provide full-operating charge.

END OF SECTION
SECTION 23 82 39 (15767) - UNIT HEATERS

PART 1 GENERAL
1.01 SUMMARY
A. Section includes:
   1. Unit Heaters.
   2. Cabinet Unit Heaters.
   3. Duct Heaters.
B. Related Sections:
   1. Section 23 05 00 (15050) – Common Work Results for HVAC
   2. Division 26 (16) Sections for electrical connections.

1.02 SUBMITTALS
A. Submit “Letter of Conformance” in accordance with Section 01 33 00 (01330) indicating specified items selected for use in Project with the following supporting data:
   1. Product data for each type of product specified.
   2. Wiring diagrams detailing power and control wiring and differentiating clearly between manufacturer-installed wiring and field-installed wiring.
   3. Samples of cabinet finish colors for approval.
   4. Qualification data for firms and persons specified in the “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Owner’s Representatives and owners, and other information specified.
   5. Field test reports from a qualified independent inspecting and testing agency indicating and interpreting test results relative to compliance with performance requirements of unit heaters.

1.03 QUALITY ASSURANCE
A. Manufacturer Qualifications: Firm experienced in manufacturing unit heaters similar to those indicated for this Project and that have a record of successful in-service performance.
B. Comply with NFPA 70 for components and installation.
C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Avendra, LLC Preferred Manufacturers:
   1. None
B. Approved Manufacturers:
   1. Indeeco (800-243-8162)
   3. QMark, Marley Engineered Products, An SPX Company (843-479-4006)
   4. Markel Products Company (800-682-3398)

2.02 ELECTRICAL UNIT HEATERS
A. Heating Elements: Nickel-chromium heating wire element; free from expansion noise and 60-Hz hum; embedded in magnesium oxide, insulating refractory; and sealed in high-mass steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends are enclosed in terminal box. Fin surface temperature does not exceed 550 deg F at any point during normal operation.

B. Heater Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for overtemperature protection of heaters.

C. Fan and Motor: Direct-drive propeller fan and manufacturer's standard motor. Motors sized 1 hp and less include motor overload protection.

D. Wiring Terminations: Match conductor materials and sizes indicated.

E. Discharge Configuration: Horizontal discharge with horizontal, adjustable louvers.

F. Optional Accessories: Include the following:
   1. Wall thermostat.
   2. Safety-switch disconnect on cover of terminal box.
   4. Fan-delay relay.

2.03 ELECTRICAL CABINET UNIT HEATERS
A. Description:
   1. Surface-mounted cabinet with front grille air inlet and front air outlet.
   2. Surface-mounted cabinet with front grille air inlet and top air outlet.
   3. Surface-mounted cabinet with bottom air inlet and front air outlet.
   4. Surface-mounted cabinet with bottom air inlet and top air outlet.
   5. Semi-recessed, wall-mounted cabinet with front grille air inlet and front air outlet.

B. Heating Elements: Nickel-chromium heating wire element; free from expansion noise and 60-Hz hum; embedded in magnesium oxide, insulating refractory; and sealed in high-mass steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch (4 mm). Element ends are enclosed in terminal box. Fin surface temperature does not exceed 550 deg F (288 deg C) at any point during normal operation.

C. Heater Circuit Protection: One-time fuses in terminal box for over-current protection and limit controls for over-temperature protection of heaters.

D. Fan and Motor: Centrifugal blower, direct driven by a single-phase, 2-speed electric motor with inherent overload protection and resilient motor/fan mount.

E. Wiring Terminations: Match conductor materials and sizes indicated.
F. Unit Controls: Thermostat, fan-speed switch, fan ON-AUTOMATIC switch, interval timer, and outside air-damper control switch.

G. Optional Accessories: Include the following:
   1. Integral thermostat.
   2. Disconnect switch.
   4. Fan-delay relay.
   5. Kickplate base for floor-mounted units.

H. Finish cabinet with manufacturer's standard enamel, color as selected by Owner's Representative.

2.04 ELECTRIC WALL HEATERS:

A. General: Provide electric wall heaters with architectural styling for exposed or recessed application.

B. Heater Assembly: The heater assembly which fits into the back box shall consist of a fan panel upon which is mounted all of the operational parts of the heater.

C. Heating Element: The heating elements shall be of the non-glowing design consisting of a special resistance wire enclosed in a steel sheath to which steel plate fins are copper brazed. It shall be warranted for 5 years.

D. Fan and Motor: Fan shall be five bladed aluminum. Fan motor shall be totally enclosed.

E. Fan Delay Switch: Fan control shall be of bi-metallic, snap-action type and shall activate fan after heating element reaches operating temperature. The fan shall continue to operate after the thermostat is satisfied and until the heating element is cool.

F. Thermostat: The tamper-proof thermostat shall be of the bimetallic snap-action type with enclosed contacts. It shall be completely concealed and reactive behind the front cover to become tamper proof.

G. Thermal Cutout: A thermal cutout shall be built into the system to automatically shut off the heater in the event of overheating and reactivate the heater when temperatures return to normal.

H. Disconnect Switch: A double-pole, single throw disconnect switch shall be mounted on the back box for positive disconnect of power supply. It will be completely concealed behind the front grid panel.

I. Back Box: The back box shall be designed for duty as a recessed rough-in box in either masonry or frame installations, and is also used with the surface mounting box in surface mounted installations. The back box shall be 20 gage cold-rolled steel and shall contain knockouts through which power leads are brought.

J. Front Panel: The front panel shall be of the bar grille type and shall be constructed of 16 gage cold-rolled steel, welded into a uniform grille to direct the warmed air toward the floor. The front grille shall be surrounded by a decorative satin-finish aluminum "picture" frame.

K. Three Piece Design: The heater shall be made up of a back box, a heater assembly and a front panel.

2.05 ELECTRIC DUCT HEATERS

A. Furnish electric duct heaters of the size, capacity, and mounting style indicated on plans. Heaters shall be UL listed for zero clearance and shall meet all applicable requirements of the National Electrical Code.
B. Elements: Construct of 80% nickel and 20% chromium; steps shall be arranged to prevent stratification when operating at less than full capacity.

C. Coil Terminals: Stainless steel, terminal insulators, and bracket bushings shall be constructed of ceramic and securely positioned. Terminals shall be machine crimped to coil.

D. Frame: Construct of heavy gauge galvanized steel to assure structural rigidity and vertical galvanized steel supports with stiffening ribs and gussets.

E. Terminal Box: Provide with solid cover and hinge if built-in fuses or interlocking disconnect switches are provided. Heater terminal box must be totally enclosed. Provide access panel on both sides of heater.

F. Controls: Include automatic reset thermal cutout, differential pressure air flow switch, and fan interlock relays. All safety devices shall be serviceable through the terminal box without removing the heating coil from the duct. Provide multiple stages of control as indicated on the drawings.

G. Wiring: Power circuits shall have single point termination to built-in disconnect switch. Each sub-circuit shall be fused per N.E.C. and a fuse control circuit transformer shall be provided.

2.06 ELECTRIC BASEBOARD HEATERS

A. Electric baseboard heaters shall be commercial grade having capacity as indicated.

B. Heating elements shall have aluminum fins bonded to steel sheathed electric heating elements.

C. Heater enclosures shall have baked enamel finish and bar-type grilles.

D. Heater shall have integral thermostat.

E. Heater shall be UL listed and shall meet the requirements of the N.E.C.

F. Baseboard heater shall be color as selected by Owner's Representative or prime painted ready for final field painters to match adjacent surface.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and supports to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install heaters as indicated, according to manufacturer's written instructions and NFPA 90A.

B. Connect heaters and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

3.03 FIELD QUALITY CONTROL

A. Testing: After installing unit heaters and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

B. Remove and replace malfunctioning units with new units and retest.

3.04 CLEANING

A. Replace filters in each cabinet unit heater at project closeout.