DIVISION 23: HEATING, VENTILATING, AND AIR-CONDITIONING

END OF TABLE OF CONTENTS

SECTION 23 0501

COMMON HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Common requirements and procedures for HVAC systems.
   2. Responsibility for proper operation of electrically powered equipment furnished under this Division.
   3. Interface with Testing And Balancing Agency.
   4. Furnish and install sealants relating to installation of systems installed under this Division.
   5. Furnish and install Firestop Penetration Systems for HVAC system penetrations as described in Contract Documents.
   6. Furnish and install sound, vibration, and seismic control elements.

B. Products Furnished But Not Installed Under This Section:
   1. Sleeves, inserts, and equipment for mechanical systems installed under other Sections.

C. Related Requirements:
   1. Section 03 3053: Exterior concrete pads and bases for mechanical equipment.
   2. Section 05 0523: Quality and requirements for welding.
   3. Section 07 8400: Quality of Penetration Firestop Systems to be used on Project and submittal requirements.
   4. Section 07 9213: Quality of sealants used at building exterior.
   5. Section 07 9219: Quality of acoustical sealants.
   6. Sections Under 09 9000 Heading: Painting of mechanical items requiring field painting.
   7. Section 26 2913: Magnetic starters and thermal protective devices (heaters) not factory mounted integral part of mechanical equipment.
   8. Division 26: Raceway and conduit, unless specified otherwise, line voltage wiring, outlets, and disconnect switches.
   9. Slots and openings through floors, walls, ceilings, and roofs provided under other Divisions in their respective materials.
   10. Sections Under 33 5000 Heading: Fuel Distribution Utilities.

1.2 SUBMITTALS

A. Action Submittals:
   1. Product Data:
      a. Manufacturer's catalog data for each manufactured item.
         1) Provide section in submittal for each type of item of equipment. Include Manufacturer's catalog data of each manufactured item and enough information to show compliance with Contract Document requirements. Literature shall show capacities and size of equipment used and be marked indicating each specific item with applicable data underlined.
         2) Include name, address, and phone number of each supplier.
   2. Shop Drawings:
      a. Schematic control diagrams for each separate fan system, heating system, control panel, etc. Each diagram shall show locations of all control and operational components and devices. Mark correct operating settings for each control device on these diagrams.
      b. Diagram for electrical control system showing wiring of related electrical control items such as firestats, fuses, interlocks, electrical switches, and relays. Include drawings showing electrical power requirements and connection locations.

c. Drawing of each temperature control panel identifying components in panels and their function.
d. Other shop drawings required by Division 23 trade Sections.

B. Closeout Submittals:
1. Operation And Maintenance Manual Data:
a. Modify and add to requirements of Section 01 7000 as follows:
1) At beginning of HVAC section of Operations And Maintenance Manual, provide master index showing items included.
2) Provide name, address, and phone number of Architect, Architect's Mechanical Engineer, General Contractor, and HVAC, Sheet Metal, Refrigeration, and Temperature Control subcontractors.
3) Provide operating instructions to include:
a) General description of each HVAC system.
b) Step by step procedure to follow in putting each piece of HVAC equipment into operation.
c) Provide diagrams for electrical control system showing wiring of items such as smoke detectors, fuses, interlocks, electrical switches, and relays.
4) Identify maintenance instructions by using same equipment identification used in Contract Drawings. Maintenance instructions shall include:
a) List of HVAC equipment used indicating name, model, serial number, and nameplate data of each item together with number and name associated with each system item.
b) Manufacturer's maintenance instructions for each piece of HVAC equipment installed in Project. Instructions shall include name of vendor, installation instructions, parts numbers and lists, operation instructions of equipment, and maintenance and lubrication instructions.
c) Summary list of mechanical equipment requiring lubrication showing name of equipment, location, and type and frequency of lubrication.
d) Manual for Honeywell T7350 thermostat published by Honeywell.
5) Include copies of approved shop drawings and copies of warranties required in individual Sections of Division 23.

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
1. Perform work in accordance with applicable provisions of Gas Ordinances applicable to Project. Provide materials and labor necessary to comply with rules, regulations, and ordinances.
2. In case of differences between building codes, laws, local ordinances, utility company regulations, and Contract Documents, the most stringent shall govern. Notify Architect in writing of such differences before performing work affected by such differences.

B. Identification:
1. Motor and equipment name plates as well as applicable UL / ULC and AGA / CGA labels shall be in place when Project is turned over to Owner.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Accept valves on site in shipping containers with labeling in place.

B. Storage:
1. In addition to requirements specified in Division 01:
a. Stored material shall be readily accessible for inspection by Architect until installed.
b. Store items subject to moisture damage, such as controls, in dry, heated spaces.
c. Provide temporary protective coating on cast iron and steel valves.
d. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Handling: Protect bearings during installation. Thoroughly grease steel shafts to prevent corrosion.

1.5 WARRANTY

A. Guarantee HVAC systems to be free from noise in operation that may develop from failure to construct system in accordance with Contract Documents.

B. Provide certificates of warranty for each piece of equipment made out in favor of Owner. Clearly record 'start-up' date of each piece of equipment on certificate.

C. If HVAC sub-contractor with offices located more than 150 miles from Project site is used, provide service / warranty work agreement for warranty period with local HVAC sub-contractor approved by Architect. Include copy of service / warranty agreement in warranty section of Operation And Maintenance Manual.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Components shall bear Manufacturer's name and trade name. Equipment and materials of same general type shall be of same make throughout work to provide uniform appearance, operation, and maintenance.

B. Valves: Valves of same type shall be of same manufacturer.

C. Pipe And Pipe Fittings: Use domestic made pipe and pipe fittings on Project. Weld-O-Let and Screw-O-Let fittings are acceptable.

D. Sleeves:
1. In Framing: Standard weight galvanized iron pipe, Schedule 40 PVC, or 14 ga galvanized sheet metal two sizes larger than bare pipe or insulation on insulated pipe.
2. In Concrete And Masonry: Sleeves through outside walls, interior shear walls, and footings shall be schedule 80 black steel pipe with welded plate.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Drawings:
1. HVAC Drawings show general arrangement of piping, ductwork, equipment, etc. Follow as closely as actual building construction and work of other trades will permit.
2. Consider Architectural and Structural Drawings part of this work insofar as these drawings furnish information relating to design and construction of building. These drawings take precedence over HVAC Drawings.
3. Because of small scale of Drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.

B. Verification Of Conditions::
1. Examine premises to understand conditions that may affect performance of work of this Division before submitting proposals for this work. Examine adjoining work on which mechanical work is dependent for efficiency and report work that requires correction.

2. No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.
3. Ensure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. If approval is received by Addendum or Change Order to use other than originally specified items, be responsible for specified capacities and for ensuring that items to be furnished will fit space available.
4. Check that slots and openings provided under other Divisions through floors, walls, ceilings, and roofs are properly located. Perform cutting and patching caused by neglecting to coordinate with Divisions providing slots and openings at no additional cost to Owner.

3.2 PREPARATION

A. Changes Due To Equipment Selection:
1. Where equipment specified or otherwise approved requires different arrangement or connections from that shown in Contract Documents, submit drawings, if requested by Architect, showing proposed installations.
2. If proposed changes are approved, install equipment to operate properly and in harmony with intent of Contract Documents. Make incidental changes in piping, ductwork, supports, installation, wiring, heaters, panelboards, and as otherwise necessary.
3. Provide any additional motors, valves, controllers, fittings, and other additional equipment required for proper operation of system resulting from selection of equipment.
4. Be responsible for the proper location of roughing-in and connections provided under other Divisions.

3.3 INSTALLATION

A. Interface With Other Work:
1. Furnish sleeves, inserts, supports, and equipment that are to be installed by others in sufficient time to be incorporated into construction as work proceeds. Locate these items and see they are properly installed.
2. Electrical: Furnish exact location of electrical connections and complete information on motor controls to installer of electrical system.
3. Testing And Balancing:
   a. Put HVAC systems into full operation and continue their operation during each working day of testing and balancing.
   b. Make changes in pulleys, belts, fan speeds, and dampers or add dampers as required for correct balance as recommended by Testing And Balancing Agency and at no additional cost to Owner.

B. Cut carefully to minimize necessity for repairs to previously installed or existing work. Do not cut beams, columns, or trusses.

C. Locating Equipment:
1. Arrange pipes, ducts, and equipment to permit ready access to valves, cocks, unions, traps, filters, starters, motors, control components, and to clear openings of doors and access panels.
2. Adjust locations of pipes, ducts, switches, panels, and equipment to accommodate work to interferences anticipated and encountered.
3. Install HVAC work to permit removal of equipment and parts of equipment requiring periodic replacement or maintenance without damage to or interference with other parts of equipment or structure.
4. Determine exact route and location of each pipe and duct before fabrication.
   a. Right-Of-Way:
      1) Lines that pitch shall have right-of-way over those that do not pitch. For example, steam, steam condensate, and drains shall normally have right-of-way.

2) Lines whose elevations cannot be changed shall have right-of-way over lines whose elevations can be changed.

b. Offsets, Transitions, and Changes in Direction:
1) Make offsets, transitions, and changes in direction in pipes and ducts as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.
2) Furnish and install all traps, air vents, sanitary vents, and devices as required to effect these offsets, transitions, and changes in direction.

D. Piping:
1. Furnish and install complete system of piping, valved as indicated or as necessary to completely control entire apparatus.
a. Pipe drawings are diagrammatic and indicate general location and connections. Piping may have to be offset, lowered, or raised as required or directed at site. This does not relieve this Division from responsibility for proper erection of systems of piping in every respect.
b. Arrange piping to not interfere with removal of other equipment, ducts, or devices, or block access to doors, windows, or access openings.
1) Arrange so as to facilitate removal of tube bundles.
2) Provide accessible flanges or ground joint unions, as applicable for type of piping specified, at connections to equipment and on bypasses.
a) Make connections of dissimilar metals with di-electric unions.
b) Install valves and unions ahead of traps and strainers. Provide unions on both sides of traps.
3) Do not use reducing bushings, street elbows, bull head tees, close nipples, or running couplings.
4) Install piping systems so they may be easily drained. Provide drain valves at low points and manual air vents at high points in hot water heating and cooling water piping.
5) Install piping to insure noiseless circulation.
6) Place valves and specialties to permit easy operation and access. Valves shall be regulated, packed, and glands adjusted at completion of work before final acceptance.
c. Do not install piping in shear walls.
2. Properly make adequate provisions for expansion, contraction, slope, and anchorage.
a. Cut piping accurately for fabrication to measurements established at site. Remove burr and cutting slag from pipes.
b. Work piping into place without springing or forcing. Make piping connections to pumps and other equipment without strain at piping connection. Remove bolts in flanged connections or disconnect piping to demonstrate that piping has been so connected, if requested.
c. Make changes in direction with proper fittings.
d. Expansion of Thermoplastic Pipe:
1) Provide for expansion in every 30 feet of straight run.
2) Provide 12 inch offset below roof line in each vent line penetrating roof.
3. Provide sleeves around pipes passing through concrete or masonry floors, walls, partitions, or structural members. Do not place sleeves around soil, waste, vent, or roof drain lines passing through concrete floors on grade. Seal sleeves with specified sealants.
a. Sleeves through floors shall extend 1/4 inch above floor finish in mechanical equipment rooms above basement floor. In other rooms, sleeves shall be flush with floor.
b. Sleeves through floors and foundation walls shall be watertight.
4. Provide spring clamp plates (escutcheons) where pipes run through walls, floors, or ceilings and are exposed in finished locations of building. Plates shall be chrome plated heavy brass of plain pattern and shall be set tight on pipe and to building surface.
5. Remove dirt, grease, and other foreign matter from each length of piping before installation.
a. After each section of piping used for movement of water or steam is installed, flush with clean water, except where specified otherwise.
b. Arrange temporary flushing connections for each section of piping and arrange for flushing total piping system.
c. Provide temporary cross connections and water supply for flushing and drainage and remove after completion of work.

E. Penetration Firestops: Install Penetration Firestop System appropriate for penetration at HVAC system penetrations through walls, ceilings, roofs, and top plates of walls.

F. Sealants:
   1. Seal openings through building exterior caused by penetrations of elements of HVAC systems.
   2. Furnish and install acoustical sealant to seal penetrations through acoustically insulated walls and ceilings.

3.4 REPAIR / RESTORATION

A. Each Section of this Division shall bear expense of cutting, patching, repairing, and replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
   1. Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown.
   2. Surface finishes shall exactly match existing finishes of same materials.

3.5 FIELD QUALITY CONTROL

A. Field Tests:
   1. Perform tests on HVAC piping systems. Furnish devices required for testing purposes.
   2. Replace material or workmanship proven defective with sound material at no additional cost to Owner. Repeat tests on new material, if requested.

3.6 SYSTEM START-UP

A. Off-Season Start-up:
   1. If Substantial Completion inspection occurs during heating season, schedule spring start-up of cooling systems. If inspection occurs during cooling season, schedule autumn start-up for heating systems.
   2. Notify Owner seven days minimum before scheduled start-up.
   3. Time will be allowed to completely service, test, check, and off-season start systems. During allowed time, train Owner's representatives in operation and maintenance of system.
   4. At end of off-season start-up, furnish Owner with letter confirming that above work has been satisfactorily completed.

B. Preparations that are to be completed before start up and operation include, but are not limited to, following:
   1. Dry out electric motors and other equipment to develop and properly maintain constant insulation resistance.
   2. Make adjustments to insure that:
      a. Equipment alignments and clearances are adjusted to allowable tolerances.
      b. Nuts and bolts and other types of anchors and fasteners are properly and securely fastened.
      c. Packed, gasketed, and other types of joints are properly made up and are tight and free from leakage.
      d. Miscellaneous alignings, tightenings, and adjustings are completed so systems are tight and free from leakage and equipment performs as intended.
   3. Motors and accessories are completely operable.
   4. Inspect and test electrical circuitry, connections, and voltages to be properly connected and free from shorts.
   5. Adjust drives for proper alignment and tension.
   6. Make certain filters in equipment for moving air are new and of specified type.
   7. Properly lubricate and run-in bearings in accordance with Manufacturer's directions and recommendations.

3.7 CLEANING

A. Clean exposed piping, ductwork, and equipment.

B. No more than one week before Final Inspection, flush out bearings and clean other lubricated surfaces with flushing oil. Provide best quality and grade of lubricant specified by Equipment Manufacturer.

C. Replace filters in equipment for moving air with new filters of specified type no more than one week before Final Inspection.

3.8 CLOSEOUT ACTIVITIES

A. Instruction Of Owner:
   1. Instruct building maintenance personnel and Stake Physical Facilities Representative in operation and maintenance of mechanical systems utilizing Operation And Maintenance Manual when so doing.
      a. Minimum Instruction Periods:
         1) HVAC: Eight hours.
         2) Temperature Control: Six hours.
         3) Refrigeration: Four hours.
      b. Conduct instruction periods after Substantial Completion inspection when systems are properly working and before final payment is made. None of these instructional periods shall overlap another.

3.9 PROTECTION

A. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system. Cap or plug open ends of pipes and equipment to keep dirt and other foreign materials out of system. Do not use plugs of rags, wool, cotton waste, or similar materials.

B. Do not operate pieces of equipment used for moving supply air without proper air filters installed properly in system.

C. After start-up, continue necessary lubrication and be responsible for damage to bearings while equipment is being operated up to Substantial Completion.

END OF SECTION

SECTION 23 0529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Common hanger and support requirements and procedures for HVAC systems.

B. Related Requirements:
   1. Section 05 0523: Quality and requirements for welding.
   2. Section 07 8400: Quality of Penetration Firestop Systems to be used on Project and submittal requirements.
   3. Sections Under 09 9000 Heading: Painting of mechanical items requiring field painting.
   4. Slots and openings through floors, walls, ceilings, and roofs provided under other Divisions in their respective materials.

1.2 SUBMITTALS

A. Action Submittals:
   1. Product Data:
      a. Manufacturer's catalog data for each manufactured item.

PART 2 - PRODUCTS

2.1 ASSEMBLIES

A. Manufacturers:
   1. Class Two Quality Standard Approved Manufacturers. See Section 01 6200:
      a. Anvil International, Portsmouth, NH www.anvilintl.com.
      b. Cooper B-Line, Highland, IL www.cooperbline.com.
      c. Erico International, Solon, OH www.erico.com.
      d. Hilti Inc, Tulsa, OK www.hilti.com.
      e. Minerallac, Hampshire, IL www.minerallac.com.
      f. Thomas & Betts, Memphis, TN www.superstrut.com.
      g. Unistrut, Wayne, MI www.unistrut.com.

B. Performance:
   1. Design Criteria:
      a. Support rods for single pipe shall be in accordance with following table:

Rod Diameter	Pipe Size
3/8 inch	2 inches and smaller
1/2 inch	2-1/2 to 3-1/2 inches
5/8 inch	4 to 5 inches
3/4 inch	6 inches
7/8 inch	8 to 12 inches

      b. Support rods for multiple pipes supported on steel angle trapeze hangers shall be in accordance with following table:

Rods		Number of Pipes per Hanger for Each Pipe Size						
No.	Diameter	2 Inch	2.5 Inch	3 Inch	4 Inch	5 Inch	6 Inch	8 Inch
2	3/8 Inch	Two	0	0	0	0	0	0
2	1/2 Inch	Three	Three	Two	0	0	0	0

2	5/8 Inch	Six	Four	Three	Two	0	0	0
2	5/8 Inch	Nine	Seven	Five	Three	Two	Two	0
2	5/8 Inch	Twelve	Nine	Seven	Five	Three	Two	Two

1) Size trapeze angles so bending stress is less than 10,000 psi.

C. Materials:
1. Hangers, Rods, Channels, Attachments, And Inserts
   a. Galvanized and UL approved for service intended.
   b. Support horizontal piping from clevis hangers or on roller assemblies with channel supports, except where trapeze type hangers are explicitly shown on Drawings. Hangers shall have double nuts.
   c. Class Two Quality Standards:
      1) Support insulated pipes with clevis hanger equal to Anvil Fig 260 or roller assembly equal to Anvil Fig 171 with an insulation protection shield equal to Anvil Fig 167. Gauge and length of shield shall be in accordance with Anvil design data.
      2) Except uninsulated copper pipes, support uninsulated pipes from clevis hanger equal to Anvil Fig 260. Support uninsulated copper pipe from hanger equal to Anvil Fig CT-65 copper plated hangers and otherwise fully suitable for use with copper tubing.
   d. Riser Clamps For Vertical Piping:
      1) Class Two Quality Standard: Anvil Figure 261.
   e. Furnace / Fan Coil Support Channel:
      1) Class One Quality Standard: Unistrut P1000.
      2) Acceptable Manufacturers: Hilti, Thomas & Betts
      3) Equal as approved by Architect before installation. See Section 01 6200.
   f. Swivel Attachment:
      1) Class One Quality Standard: Unistrut EM3127.
      2) Acceptable Manufacturers: Hilti, Thomas & Betts
      3) Equal as approved by Architect before installation. See Section 01 6200.

EXECUTION

2.2 INSTALLATION

A. Piping:
1. Properly support piping and make adequate provisions for expansion, contraction, slope, and anchorage.
   a. Except for underground pipe, suspend piping from roof trusses or clamp to vertical walls using support channels and clamps. Do not hang pipe from other pipe, equipment, or ductwork. Laying of piping on any building element is not allowed.
   b. Supports For Horizontal Piping:
      1) Support metal piping at 96 inches on center maximum for pipe 1-1/4 inches or larger and 72 inches on center maximum for pipe 1-1/8 inch or less.
      2) Support thermoplastic pipe at 48 inches on center maximum.
      3) Provide support at each elbow. Install additional support as required.
   c. Supports for Vertical Piping:
      1) Place riser clamps at each floor or ceiling level.
      2) Securely support clamps by structural members, which in turn are supported directly from building structure.
      3) Provide clamps as necessary to brace pipe to wall.
   d. Insulate hangers for copper pipe from piping by means of at least two layers of Scotch 33 plastic tape.
   e. Expansion of Thermoplastic Pipe:
      1) Provide for expansion in every 30 feet of straight run.
      2) Provide 12 inch offset below roof line in each vent line penetrating roof.

END OF SECTION

SECTION 23 0553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install identification of HVAC equipment and piping as described in Contract Documents.

PART 2 - PRODUCTS

2.1 SYSTEMS

A. Description:
   1. Abbreviations for Pipe Stencils and Equipment Identification and Band Colors for Pipe Identification:
      a. Apply stenciled symbols and continuous painting as follows:

Pipe Type	Pipe Color	Symbol
Gas	Yellow	GAS

B. Materials:
   1. Paint:
      a. Paints specified are from Pittsburgh Paint & Glass (PPG), Pittsburgh, PA www.ppgaf.com.
      b. One Coat Primer:
         1) 6-2 Quick Drying Latex Primer Sealer over fabric covers.
         2) 6-205 Metal Primer under dark color paint.
         3) 6-6 Metal Primer under light color paint.
      c. Finish Coats: Two coats 53 Line Acrylic Enamel.
      d. Class Two Quality Standard. See Section 01 6200.
         1) Paint of equal quality from other Manufacturers may be used. Maintain specified colors, shades, and contrasts.
   2. Labels:
      a. Equipment Identification: Black formica, with white reveal when engraved. Lettering to be 3/16 inch high minimum.

PART 3 - EXECUTION

3.1 APPLICATION

A. Labels:
   1. Identify following items with specified labels fastened to equipment with screws:
      a. Thermostats and control panels in mechanical spaces.
      b. Furnaces.
      c. Condensing units.
      d. Electric duct heaters.
      e. Accessible exhaust fans.
   2. Engrave following data from Equipment Schedules on Drawings onto labels:
      a. Equipment mark.
      b. Area served.
      c. Thermostat zone number, when different from equipment mark.

d. Panel and breaker from which unit is powered.

B. Painting:
1. Leave equipment in like-new appearance.
2. Only painted legends, directional arrows, and color bands are acceptable.
3. Locate identifying legends, directional arrows, and color bands at following points on exposed piping of each piping system:
   a. Adjacent to each item of equipment.
   b. At point of entry and exit where piping goes through wall.
   c. On each riser and junction.
   d. Every 25 feet on long continuous lines.
   e. Stenciled symbols shall be one inch high and black.

END OF SECTION

SECTION 23 0713

DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install thermal wrap duct insulation as described in Contract Documents.

B. Related Requirements:
   1. Section 23 3113: Low-Pressure Metal Ducts.
   2. Section 23 3300: Acoustic duct liner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer List:
   1. Certainteed St Gobain, Valley Forge, PA www.certainteed.com.
   2. Johns-Manville, Denver, CO www.jm.com.
   3. Knauf Fiber Glass, Shelbyville, IN www.knauffiberglass.com.
   4. Manson Insulation Inc, Brossard, QB www.isolationmanson.com.
   5. Owens-Corning, Toledo, OH www.owenscorning.com.

2.2 MATERIALS

A. Thermal Wrap Duct Insulation:
   1. 1-1/2 inch thick fiberglass with factory-laminated, reinforced aluminum foil scrim kraft facing and density of one lb/ per cu ft.
   2. Thermal Conductivity: 0.27 BTU in/HR SF deg F at 75 deg F maximum.
   3. Type One Acceptable Products:
      a. Type 100 standard duct insulation by Certainteed St Gobain.
      b. Microlite FSK by Johns-Manville.
      c. Duct Wrap FSK by Knauf Fiber Glass.
      d. Alley Wrap FSK by Manson Insulation Inc.
      e. FRK by Owens-Corning.
      f. Equal as approved by Architect before bidding. See Section 01 6200.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Thermal Wrap Duct Insulation:
   1. Install insulation as follows:
      a. On suuply air, return air, outside air ducts and combustion air ducts within building insulation envelope.
      b. On other air ducts where indicated on Drawings.
   2. Wrap insulation tightly on ductwork with circumferential joints butted and longitudinal joints overlapped minimum 2 inches.

a. Do not compress insulation except in areas of structural interference. Minimum thickness at corners shall be one inch thick.
b. Remove insulation from lap before stapling.
c. Staple seams at approximately 16 inches on center with outward clenching staples.
d. Seal seams with foil vapor barrier tape or vapor barrier mastic. Seal penetrations of facing to provide vapor tight system.

B. Insulate outside of ceiling diffusers, diffuser drops, and duct silencers same as ductwork.

C. Do not insulate ducts with internal liners.

END OF SECTION

SECTION 23 0719

HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install insulation on above ground refrigerant piping and fittings as described in Contract Documents.
   2. Furnish and install insulation for cooling tower and chilled water piping systems as described in Contract Documents.
   3. Furnish and install insulation for hot water heating and return piping system as described in Contract Documents.
   4. Furnish and install insulation for steam and condensate piping system as described in Contract Documents.

B. Related Requirements:
   1. Section 23 0501: General Mechanical Requirements.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Keep materials and work dry and free from damage.

B. Replace wet or damaged materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 ASSEMBLIES

A. Manufacturers:
   1. Manufacturer List:
      a. Armacell, Mebane, NC www.armaflex.com.
      b. Childers Products Co, Eastlake, OH www.fosterproducts.com.
      c. Foster Products Corp, Oakdale, MN www.fosterproducts.com.
      d. Johns-Manville, Denver, CO www.jm.com.
      e. Knauf, Shelbyville, IN www.knauffiberglass.com.
      f. Manson, Brossard, BC, Canada www.isolationmanson.com.
      g. Nitron Industries, Thousand Oaks, CA www.nitronindustries.com.
      h. Owens-Corning, Toledo, OH www.owenscorning.com.
      i. Ramco, Lawrenceville, NJ www.ramco.com.
      j. Nomac, Zebulon, NC www.nomaco.com.
      k. Speedline Corp, Solon, OH www.speedlinepvc.com.

B. Materials:
   1. Refrigeration Piping System:
      a. Thickness:

Pipe Size, Outside Diameter	Insulation Thickness
One inch and smaller	1/2 Inch
1-1/8 to 2 inch	3/4 Inch
2-1/8 inches and larger	One inch or two layers of 1/2 inch

         1) One inch sheet for fittings as recommended by Manufacturer.

2) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
   a) AP Armaflex 25/50 by Armacell.
   b) Nitrolite by Nitron Industries. White only for exterior.
   c) Nomaco K-Flex.

b. Joint Sealer:
   1) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
      a) Armacell 520 by Armacell.
      b) Namaco K-Flex R-373.

c. Insulation Tape:
   1) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
      a) Armaflex AP Insul Tape by Armacell.
      b) FT182 Tape by Nitron Industries.
      c) Elastomeric Foamtape by Nomac K-Flex.

d. Exterior Finish:
   1) For application to non-white, exterior insulation.
   2) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
      a) WB Armaflex Finish by Armacell.
      b) R-374 Protective Coating by Nomaco K-Flex.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before application of insulating materials, brush clean surfaces to be insulated and make free from rust, scale, grease, dirt, moisture, and any other deleterious materials.

B. Use drop cloths over equipment and structure to prevent adhesives and other materials spotting the work.

3.2 INSTALLATION

A. Refrigeration System Piping System:
   1. General:
      a. Install insulation in snug contact with pipe.
         1) Insulate flexible pipe connectors.
         2) Insulate thermal expansion valves with insulating tape.
         3) Insulate fittings with sheet insulation and as recommended by Manufacturer.
      b. Slip insulation on tubing before tubing sections and fittings are assembled keeping slitting of insulation to a minimum.
      c. Do not install insulation on lines through clamp assembly of pipe support. Butt insulation up against sides of clamp assembly.
      d. Stagger joints on layered insulation. Seal joints in insulation.
      e. Install insulation exposed outside building so 'slit' joint seams are placed on bottom of pipe.
      f. Paint exterior exposed, non*white insulation with two coats of specified exterior finish.
   2. System Requirements:
      a. Condensing Units: Install insulation on above ground refrigerant suction piping and fittings, including thermal bulb, from thermal expansion valve.

3.3 FIELD QUALITY CONTROL

A. Method of installing insulation shall be subject to approval of Architect. Sloppy or unworkmanlike installations are not acceptable.

3.4 CLEANING

A. Leave premises thoroughly clean and free from insulating debris.

3.5 PROTECTION

A. Protect insulation wherever leak from valve stem or other source might drip on insulated surface, with aluminum cover or shield rolled up at edges and sufficiently large in area and of shape that dripping will not splash on surrounding insulation.

END OF SECTION

SECTION 23 0933

ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install automatic temperature control system as described in Contract Documents.
   2. Furnish and install conductors and make connections to control devices, motors, and associated equipment.
   3. Assist in air test and balance procedure.

B. Related Requirements:
   1. Section 23 0501: Common HVAC Requirements.
   2. Section 23 0593: Air test and balance.
   3. Section 23 3300: Furnishing and installing of temperature control dampers.
   4. Division 26:
      a. Furnishing and installing of raceway, conduit, and junction boxes, including pull wires, for temperature control system except as noted above.
      b. Power wiring to magnetic starters, disconnect switches, and motors.
      c. Motor starters and disconnect switches, unless integral with packaged equipment.

1.2 SUBMITTALS

A. Informational Submittals:
   1. Qualification Statements: Submit document from Approved Distributor confirming sponsorship.

B. Closeout Submittals:
   1. Record Documentation:
      a. Provide two CD copies with fully commissioned LonSpec database.
      b. Leave with O&M Manual specified in Section 23 0501.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Installer:
      a. Before bidding, obtain sponsorship from a local, Approved Distributor specified under PART 2 PRODUCTS. Initial requirements for sponsorship are:
         1) Be one of following Honeywell supported partners:
            a) Honeywell-Automation Control Specialist (ACS).
            b) Honeywell-Commercial Comfort & Energy Specialist (CCES).
            c) Honeywell Authorized Control Integrator (ACI).
         2) Receive product training from and exhibit LCBS system skills to sponsoring Approved Distributor.

PART 2 - PRODUCTS

2.1 SYSTEMS

A. Manufacturers:
   1. Manufacturer List:

a. Air Products & Controls Ltd, Pontiac, MI www.ap-c.com.
b. Fire-Lite Alarms, Northford, CT www.firelite.com.
c. Honeywell Inc, Minneapolis, MN www.honeywell.com.
d. ICCA Firex, Carol Stream, IL www.icca.invensys.com.
e. System Sensor, St Charles, IL www.systemsensor.com.
f. Zimmerman Technologies, Renton, WA (425) 255-1906.

B. Distributors:
1. Obtain LonSpec database, RP panels, LCP panel, thermostats, and other control equipment from following Sponsoring Approved Distributors. See Section 01 4300.
2. Georgia:
a. Stromquist & Co Inc: (404) 794-3421. sammy@stromquist.com Steve Sams

C. Performance:
1. Design Criteria:
a. Automatic Temperature Control System design concept utilizes communicating thermostats located near furnace, with electronic sensors and electric / electronic actuation of dampers and with thermostats connected with Echelon approved communication cable. Display module will also reside on Echelon network and provide single point of system access.
b. Network communications and control devices will be LonWorks compliant. System shall include HVAC control, interface, and maintenance management functions related to normal building operations.

D. Components:
1. Thermostats And Sensors:
a. Thermostat and Sensor Kit:
1) Category Four Approved Product. See Section 01 6200 for definitions of Categories.
a) Part Number Y7335H1009 consisting of following:
(1) Communicating Thermostat: Low voltage type provided with automatic change-over feature for both heating and cooling stages, seven-day / 365 day program with two starts and stops per day, and provisions for damper operators. Honeywell T7350H1009.
(2) Push-Button Remote Room Sensor: Honeywell T7771A1005 with three push buttons, OVERRIDE, WARMER, COOLER, and with selectable ohm resistance, 10k or 20k.
(3) Discharge Air Sensor: Honeywell C7041B2005, 6 inch
b. Plain Face Remote Room Sensor:
1) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
a) Honeywell T7770A3002, plain face, 10k ohms.
b) Honeywell T7770A2004, plain face, 20k ohms.
c. Non-Programmable Thermostat:
1) Low voltage type.
2) Category Four Approved Product. See Section 01 6200 for definitions of Categories.
a) Honeywell T87F1009 with 50010944-001 range stop.
2. Guard For Cultural Center Sensors:
a. Match color of sensor.
b. Category Four Approved Product. See Section 01 6200 for definitions of Categories.
1) MSI-244 Sensor Guard with integral wood base by Zimmerman Technologies.
3. Duct Smoke Detectors:
a. Photoelectric duct mounted smoke detector in systems with airflow greater than 2000 CFM. Detectors to operate on 120 VAC.
b. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
1) Model DH100 ACDCP duct mounted smoke detector by System Sensor.
2) Model FL-D350RP by Fire-Lite.
3) Model SL-2000P by Air Products And Controls Inc.
4) Model 2650-761 by ICCA Firex.
4. Transformer:
a. 120 **/** 24 V, 50VA Honeywell AT150F.
b. 120 **/** 24 V, 75VA Honeywell AT175F.
5. Damper Actuators:

a. Electric type equipped for Class I wiring.
b. Shall not consume power during UNOCCUPIED cycle or use chemicals or expandable media.
c. Have built in spring return.
d. Category Four Approved Product. See Section 01 6200 for definitions of Categories.
1) Honeywell S0524-2POS. Also shown as MS8105 1008
2) Honeywell S0524-2POS-SW2 w/ Auxiliary switches.

6. Conductors:
a. Color-coded and No. 16 and No. 12 AWG Type TWN, TFN, or THHN, stranded.
b. Thermostat Cable: 12, 8, or 4 conductor, 18AWG solid copper wire, insulated with high-density polyethylene. Conductors parallel enclosed in brown PVC jacket (22 AWG cable not allowed).
c. Communicating Cable:
1) Category Four Approved Product. See Section 01 6200 for definitions of Categories.
a) Honeywell AK3798.

7. Local Relay (RP) Panels For Chapel And Cultural Center Systems:
a. 16-ga 1.59 mm screw cover, painted sheet metal. Box with cover and knockouts, pre-wired terminal strips, relay, and transformer.
b. Category Four Approved Product. See Section 01 6200 for definitions of Categories.
1) LDS Models RP-1 or RP-5.

8. Command Display Interface:
a. Category Four Approved Product. See Section 01 6200 for definitions of Categories.
1) Honeywell S7760A2031.

9. Outdoor Air Pre-Heat Coil Temperature Controller:
a. 0 to 100 deg F range.
b. 5 foot copper capillary and bulb.
c. Category Four Approved Product. See Section 01 6200 for definitions of Categories.
1) Honeywell: T991A1004 with 107324A bulb holder.

10. Control Valve And Motor:
a. Category Four Approved Product. See Section 01 6200 for definitions of Categories.
1) Honeywell: V5013N three-way modulating type.
2) Honeywell: ML7420A3063 valve motor.

11. Outdoor Air Temperature Sensor:
a. Minus 30 to plus 90 deg F operating range.
b. 5 foot capillary length.
c. Category Four Approved Product. See Section 01 6200 for definitions of Categories.
1) Honeywell: T6031A1052.

12. Aquastat Controller:
a. Strap-on type.
b. Category Four Approved Product. See Section 01 6200 for definitions of Categories.
1) Honeywell: L6006C1018.

E. Operation Sequences:
1. Programmable thermostat shall control unoccupied and occupied status of fan system based on adjustable seven day program and remote room sensor **/** push button. Fan shall run continuously in occupied mode and cycle in unoccupied mode.
2. Adjustable heating and cooling set points shall control space temperature by activating either heating or cooling equipment. Programmable thermostat provides automatic change over between heating and cooling.
3. Remote room sensor provides optional override of thermostat program by allowing three hour timed override of thermostat program at any time by pushing ON / OFF button on remote room sensor cover. This shall activate thermostat to occupied mode and system shall control to occupied set point.
4. Minimum outside air damper, spring return type, shall open in occupied mode and remain closed in unoccupied mode in zones using outside air.
5. Two Sensor Averaging, Bishop Zone:
a. Sensors shall control zone HVAC equipment by averaging temperature in spaces containing sensors.
b. Third dummy sensor, typically located in unlocked common space, is place-holder for OVERRIDE, WARMER, and COOLER buttons and does not sense temperature.

6. Two Sensor Averaging, Stake Suite: One sensor has OVERRIDE, WARMER, COOLER buttons. Set jumper to appropriate setting necessary to average with another sensor.
7. Three Sensor Averaging:
   a. Sensors shall control zone HVAC equipment by averaging temperature in spaces containing sensors.
   b. Fourth dummy sensor, typically located in unlocked common space, is place-holder for OVERRIDE, WARMER, and COOLER buttons and does not sense temperature.
8. Electric Booster Heat:
   a. On call for heat from non-programmable thermostat, blower motor of associated furnace shall energize and duct heater shall be enabled.
   b. Internal safeties and controls of duct heater shall be satisfied before operation of duct heater.
   c. Duct heater shall be locked out whenever T7350 thermostat cooling or heating circuits are energized.
9. Outdoor Air Pre-Heat System:
   a. Enable pre-heat system only under one of following conditions:
      1) At least one programmable thermostat is in occupied mode and outside air temperature is below setpoint, adjustable.
      2) Aquastat at pre-heat coil senses temperature below setpoint, adjustable, and outside air temperature is below setpoint, adjustable.
   b. Preheat boiler shall operate under its own safety and operating controls to maintain fluid temperature setpoint, adjustable. Flow switch installed in boiler shall prove flow before boiler will operate.
   c. Interlock circulating pump with boiler low voltage control panel. When boiler is enabled, pump shall be activated and run continuously. When boiler is disabled, circulating pump shall continue to run long enough to dissipate residual heat in boiler heat exchanger. Length of run time shall be sufficient to prevent tripping high water temperature alarm.
   d. When multiple boilers are used, sequencing control panel shall be enabled or disabled in accordance with paragraph >a=. Sequencing control panel shall then enable or disable boilers and shall determine firing order of boilers and staging sequence. Also, interlock circulating pump with sequencing control panel.
   e. Outdoor Air Damper Operation:
      1) Outdoor Air Pre-Heat Coil Serving Multiple Furnaces: Damper operates at full open position when at least one programmable thermostat in zones served is in occupied mode. Damper shall remain closed when all thermostats in zone served are in unoccupied mode.
      2) Outdoor Air Pre-Heat Coil Serving Single Furnace: Damper operates at full open position when programmable thermostat serving furnace is in occupied mode. Damper shall remain closed when thermostat is in unoccupied mode.
   f. Three-way control valve shall modulate to maintain outdoor air pre-heat coil discharge air temperature at setpoint, adjustable.

PART 3 - EXECUTION

3.1 ACCEPTABLE INSTALLERS

A. Approved HVAC Sub-Contractors shall be pre-approved and included in Construction Documents by Addendum.

3.2 INSTALLATION

A. Interface With Other Work:
   1. Calibrate room thermostats as required during air test and balance.
   2. Instruct air test and balance personnel in proper use and setting of control system components.
   3. Install low voltage electrical wiring in accordance with Division 26 of these Specifications.

B. Communication Cable:
   1. Network communicating thermostats together with specified communicating cable.
   2. Do not bundle communication cables with cables of other systems. Maintain 12 inches minimum distance from wires of other systems, except communication cable may cross other low-voltage wiring if done perpendicularly.

C. Safety Controls: Interlock duct smoke detectors to keep heating, cooling, and system fan from operating when detector is energized.

D. Mount damper actuators and actuator linkages external of airflow. Make certain dampers operate freely without binding or with actuator housing moving.

E. Paste copy of record control wiring diagram on back of relay panel door cover for each twin furnace system.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service:
   1. Calibrate, adjust, and set controls for proper operation, operate systems, and be prepared to prove operation of any part of control system. This work is to be completed before pre-substantial completion inspection.
   2. Test each individual heating, cooling, and damper control for proper operation using control system.

3.4 SYSTEM STARTUP

A. Using database provided by distributor, modify zone names to match local designations and input local schedules. Information shall be provided by Architect from local Facilities Manager.
   1. After installation, exercise system by commanding actuators to stroke dampers for smooth operation and tight close-off. Test controller outputs to prove proper fan, damper, cooling, and heating operation. Exercise and verify setpoint changes. Exercise and monitor specified relationships between area demands and equipment control for proper operation. Exercise remote wall sensor over-rides to make certain system can be placed into and out of over-ride from wall sensor.
   2. Download local time into designated time master thermostat.

3.5 ADJUSTING

A. Program minimum of one day’s operation into thermostat memory function.

3.6 CLOSEOUT ACTIVITIES

A. Instruction Of Owner:
   1. Include as part of training required in Section 23 0501, following training:
      a. Training shall be by personnel of installing company and utilize operator’s manuals and as-built documentation.
      b. Provide training in two sessions for up to six hours total. First session will occur between system completion and Substantial Completion. Second session will occur within 45 days of Substantial Completion when agreed upon by Owner.
      c. Training shall include sequence of operation review, selection of displays, modification of schedules and setpoints, use of specified command display interface functions, troubleshooting of sensors, etc, as follows:
         1) Control System Overview:

a) Show access to system through both individual thermostats and Command Display and how network works. Demonstrate scheduling for Stake and General Conferences.
b) Identify LonSpec database backup CD.

2) Thermostat Programming From Keypad And Command Display Module: Instructions on developing setpoints and schedules, including Stake and General Conference days, and adjusting program modify descriptive zone names, local zone schedules, and local zone temperatures..
3) Thermostat Operation:
   a) Identify and explain use of buttons on thermostat face, I.E. 'i' or information button, warmer button, and cooler button.
   b) Identify and explain buttons under thermostat cover.
   c) Provide training for Thermostat Palm Program.
   d) Identify thermostat used as ‘Time Master’ and provide training on its function.
4) Command Display Operations:
   a) Viewing equipment status screens.
   b) Changing building schedules.
   c) Changing individual thermostat setpoints, including details of Unoccupied and Standby.
   d) Zone status screen
   e) Provide Approved Distributor's PowerPoint presentation explaining use of command display.

END OF SECTION

SECTION 23 1123

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Perform excavation and backfill required for work of this Section.
   2. Furnish and install gas piping and fittings within building and from building to meter including connection to meter as described in Contract Documents.

B. Related Requirements:
   1. Sections Under 09 9000 Heading: Painting of exterior piping.
   2. Section 23 0501: Common HVAC Requirements.
   3. Section 31 2316: Procedure and quality of excavation.
   4. Section 31 2323: Procedure and quality of backfill and compaction.
   5. Section 33 5100: Gas line from meter to main.

1.2 REFERENCES

A. Reference Standards:
   1. ASTM International:
      a. ASTM A 53-05, 'Standard Specification for Pipe, Steel and Hot-Dipped, Zinc-Coated, Welded and Seamless.'
      b. ASTM A 234-05a, 'Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.'
      c. ASTM D 2513-05, 'Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.'

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Welders shall be certified and bear evidence of certification 30 days before commencing work on project. If there is doubt as to proficiency of welder, Owner's Representative may require welder to take another test. This shall be done at no cost to Owner. Certification shall be by Pittsburgh Testing Laboratories or other approved authority.
   2. Polyethylene pipe installers shall be properly trained and certified in procedure for joining polyethylene pipe.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Do not store polyethylene pipe so it is exposed to sunlight.

PART 2 - PRODUCTS

2.1 SYSTEM

A. Manufacturers:
   1. Manufacturer List:
      a. BrassCraft, Novi, MI www.brasscraft.com.

b. Cimberio Valve Co Inc, Malvern, PA www.cimberio.com.
c. ConBraCo Industries, Inc, Matthews, NC www.conbraco.com.
d. Dormont Manufacturing Company, Export, PA www.dormont.com.
e. Jomar International, Madison Heights, MI www.jomar.com.
f. KOSO by Pacific Seismic Products Inc, Lancaster, CA www.psp4gasoff.com.
g. Watts Regulator Co, North Andover, MA www.wattsreg.com.

B. Materials:
1. Above-Ground Pipe And Fittings:
a. Black carbon steel, butt welded, Schedule 40 pipe meeting requirements of ASTM A 53.
b. Welded forged steel fittings meeting requirements of ASTM A 234 or standard weight malleable iron screwed.
2. Below-Ground Pipe And Fittings: Polyethylene pipe and fittings meeting requirements of ASTM D 2513 with No. 14 coated copper trace wire.
3. Valves:
a. 125 psi bronze body ball valve, UL listed.
b. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
1) CIM 102.1 by Cimbrio Valve.
2) Apollo Series 80-100 by ConBraCo.
3) 'Red Cap' R602 by Jenkins NH Canada.
4) Model T-204 by Jomar International.
5) Model B-6000-UL by Watts Regulator.
4. Cocks:
a. Gauge Cocks: Conbraco 41-560 bronze gauge cock.
5. Flexible Connector:
a. Type 304 stainless steel corrugated tube coated for corrosion protection.
b. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
1) Dormont Supr-Safe.
2) BrassCraft Procoat.
6. Seismic Valves:
a. Natural gas seismic shut-off valves.
1) Rate at maximum 20 psi pressure with positive seating from minus 40 deg F to plus 150 deg for exterior mounting near gas meter.
2) UL listed valve, factory set for IBC Seismic Design Categories D, E, and F.
3) Size to be determined by total cu ft per hour gas flow requirement of building and following conditions: 0.1 inch water column maximum allowable pressure-drop through valve with available pressure of 4 oz.
4) Category Four Approved Product. See Section 01 6200 for definitions of Categories.
a) KOSO HPF Series.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Steel pipe installed through air plenums, in walls, and pipes 2-1/2 inches and larger shall have welded fittings and joints. Other steel pipe may have screwed or welded fittings.

B. Lay underground pipe in accordance with Manufacturer's recommendations and local gas utility company regulations and specifications.
1. Provide 24 inch minimum steel pipe between vertical rise of riser and end of polyethylene line if anode-less riser is not used. Use plastic-to-steel transition or compression fitting between end of polyethylene line and steel meter riser. Provide cathodic protection for steel riser or use anode-less riser.
2. Place tracer wire along side of polyethylene pipe from meter to point where pipe rises inside building.
3. Place 4 inches of sand around gas line buried underground.
4. Do not install gas piping under building floor slabs-on-grade.

C. On lines serving gas-fired equipment, install gas cocks adjacent to equipment outside of equipment cabinet and easily accessible.

D. Install 6 inch long minimum dirt leg, with pipe cap, on vertical gas drop serving each gas-fired equipment unit.

E. Use fittings for changes of direction in pipe and for branch runouts.

F. Install seismic valve in 24 inch long pipe section anchored to building wall at each end.

3.2 FIELD QUALITY CONTROL

A. Field tests: Subject all portions of gas piping system, in sections or in entirety, to air pressure of 75 psig and prove airtight for 4 hours. Disconnect equipment not suitable for 75 psig pressure from piping system during test period.

END OF SECTION

SECTION 23 2300

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install piping and specialties for refrigeration systems as described in Contract Documents.

B. Related Requirements:
   1. Section 23 0501: Common HVAC Requirements.
   2. Section 23 0719: Refrigerant Piping Insulation.

1.2 REFERENCES

A. Reference Standards:
   1. ASTM International:
      a. ASTM A 36-05, 'Standard Specification for Carbon Structural Steel.'
      b. ASTM B 280-05, 'Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.'
   2. American Welding Society / American National Standards Institute:
      a. AWS / ANSI A5.8-2004, 'Specification for Brazing Filler Metal.'

1.3 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings: Show each individual equipment and piping support.

B. Informational Submittals:
   1. Qualification Statements: Technician certificate for use of CFC and HCFC refrigerants.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Installer: Refrigerant piping shall be installed by a refrigeration subcontractor licensed by State and by technicians certified in use of CFC and HCFC refrigerants.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Manufacturers:
   1. Manufacturer List:
      a. Emerson Climate Technologies, St Louis, MO www.emersonflowcontrols.com.
      b. Cush-A-Clamp by ZSI Manufacturing, Canton, MI www.cushaclamp.com.
      c. Elkhart Products Corp, Elkhart, IN www.elkhartproducts.com.
      d. Handy & Harman Products Division, Fairfield, CT www.handy-1.com.
      e. Harris Products Group, Cincinnati, OH www.harrisproductsgroup.com.
      f. Henry Valve Co, Melrose Park, IL www.henrytech.com.

g. Hilti Inc, Tulsa, OK www.hilti.com.
h. Hydra-Zorb Co, Auburn Hills, MI www.hydra-zorb.com.
i. Mueller Steam Specialty, St Pauls, NC www.muellersteam.com.
j. Nibco Inc, Elkhart, IN www.nibco.com.
k. Packless Industries, Waco, TX www.packless.com.
l. Parker Corp, Cleveland, OH www.parker.com.
m. Sporlan Valve Co, Washington, MO www.sporlan.com.
n. Sherwood Valves, Washington, PA www.sherwoodvalve.com.
o. Thomas & Betts, Memphis, TN www.superstrut.com.
p. Unistrut Corp, Wayne, MI www.unistrut.com.
q. Universal Metal Hose, Chicago, IL www.universalmetalhose.com.
r. Vibration Mountings & Controls, Bloomingdale, NJ www.vmc-kdc.com.
s. Virginia KMP Corp, Dallas, TX www.virginiakmp.com.

B. Materials:
1. Refrigerant Piping:
a. Meet requirements of ASTM B 280, hard drawn straight lengths. Soft copper tubing not permitted.
b. Do not use pre-charged refrigerant lines.
2. Refrigerant Fittings:
a. Wrought copper with long radius elbows.
b. Category Four Approved Manufacturers. See Section 01 6200 for definitions of Categories.
1) Mueller Streamline.
2) Nibco Inc.
3) Elkhart.
3. Suction Line Traps:
a. Manufactured standard one-piece traps.
b. Category Four Approved Manufacturers. See Section 01 6200 for definitions of Categories.
1) Mueller Streamline.
2) Nibco Inc.
3) Elkhart.
4. Connection Material:
a. Brazing Rods in accordance with ANSI / AWS A5.8:
1) Copper to Copper Connections:
a) Classification BCuP-4 Copper Phosphorus (6 percent silver).
b) Classification BCuP-5 Copper Phosphorus (15 percent silver).
2) Copper to Brass or Copper to Steel Connections: Classification BAg-5 Silver (45 percent silver).
3) Do not use rods containing Cadmium.
b. Flux:
1) Type Two Acceptable Products:
a) Stay-Silv White Brazing Flux by Harris Products Group.
b) High quality silver solder flux by Handy & Harmon.
c) Equal as approved by Architect before use. See Section 01 6200.
5. Valves:
a. Expansion Valves:
1) For pressure type distributors, externally equalized with stainless steel diaphragm, and same refrigerant in thermostatic elements as in system.
2) Size valves to provide full rated capacity of cooling coil served. Coordinate selection with evaporator coil and condensing unit.
3) Category Four Approved Manufacturers. See Section 01 6200 for definitions of Categories.
a) Emerson Climate Technologies.
b) Henry.
c) Mueller.
d) Parker.
e) Sporlan.
b. Manual Refrigerant Shut-Off Valves:
1) Ball valves designed for refrigeration service and full line size.
2) Valve shall have cap seals.

3) Valves with hand wheels are not acceptable.
4) Provide service valve on each liquid and suction line at compressor.
5) If service valves come as integral part of condensing unit, additional service valves shall not be required.
6) Category Four Approved Manufacturers. See Section 01 6200 for definitions of Categories.
a) Henry.
b) Mueller.
c) Sherwood.
d) Virginia.

6. Filter-Drier:
a. On lines 3/4 inch outside diameter and larger, filter-drier shall be replaceable core type with Schraeder type valve.
b. On lines smaller than 3/4 inch outside diameter, filter-drier shall be sealed type using flared copper fittings.
c. Size shall be full line size.
d. Category Four Approved Manufacturers. See Section 01 6200 for definitions of Categories.
1) Emerson Climate Technologies.
2) Mueller.
3) Parker.
4) Sporlan.
5) Virginia.

7. Sight Glass:
a. Combination moisture and liquid indicator with protection cap.
b. Sight glass shall be full line size.
c. Sight glass connections and sight glass body shall be solid copper or brass, no copper-coated steel sight glasses allowed.
d. Category Four Approved Product. See Section 01 6200 for definitions of Categories.
1) HMI by Emerson Climate Technologies.

8. Flexible Connectors:
a. Designed for refrigerant service with bronze seamless corrugated hose and bronze braiding.
b. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
1) Vibration Absorber Model VAF by Packless Industries.
2) Vibration Absorbers by Virginia KMP Corp.
3) Anaconda 'Vibration Eliminators' by Universal Metal Hose.
4) Style 'BF' Spring-flex freon connectors by Vibration Mountings.

9. Refrigerant Piping Supports:
a. Base, Angles, And Uprights: Steel meeting requirements of ASTM A 36.
b. Securing Channels:
1) At Free-Standing Pipe Support:
a) Class One Quality Standard: P-1000 channels by Unistrut.
b) Acceptable Manufacturers: Hilti, Thomas & Betts
c) Equal as approved by Architect before installation. See Section 01 6200.
2) At Wall Support:
a) Class One Quality Standard: P-3300 channels by Unistrut.
b) Acceptable Manufacturers: Hilti, Thomas & Betts
c) Equal as approved by Architect before installation. See Section 01 6200.
3) At Suspended Support:
a) Class One Quality Standard: P-1001 channels by Unistrut.
b) Acceptable Manufacturers: Hilti, Thomas & Betts
c) Equal as approved by Architect before installation. See Section 01 6200.
4) Angle Fittings:
a) Class One Quality Standard: P-2626 90 degree angle by Unistrut.
b) Acceptable Manufacturers: Hilti, Thomas & Betts
c) Equal as approved by Architect before installation. See Section 01 6200.
c. Pipe Clamps:
1) Type Two Acceptable Manufacturers:
a) Hydra-Zorb.
b) ZSI Cush-A-Clamp.
c) Hilti Cush-A-Clamp.

d) Equal as approved by Architect before installation. See Section 01 6200.

d. Protective Cover: 18 ga steel, hot-dipped galvanized.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refrigerant Lines:
1. Install as high in upper mechanical areas as possible. Do not install underground or in tunnels.
2. Slope suction lines down toward compressor one inch/10 feet. Locate traps at vertical rises against flow in suction lines.

B. Connections:
1. Refrigeration system connections shall be copper-to-copper, copper-to-brass, or copper-to-steel type properly cleaned and brazed with specified rods. Use flux only where necessary. No soft solder (tin, lead, antimony) connections will be allowed in system.
2. Braze manual refrigerant shut-off valve, sight glass, and flexible connections.
3. Circulate dry nitrogen through tubes being brazed to eliminate formation of copper oxide during brazing operation.

C. Specialties:
1. Install valves and specialties in accessible locations. Install refrigeration distributors and suction outlet at same end of coil.
2. Install thermostatic bulb as close to cooling coil as possible. Do not install on vertical lines.
3. Install equalizing line in straight section of suction line, downstream of and reasonably close to thermostatic bulb. Do not install on vertical lines.
4. Provide flexible connectors in each liquid line and suction line at both condensing unit and evaporator on systems larger than five tons. Anchor pipe near each flexible connector.

D. Refrigerant Supports:
1. Support Spacing:
a. Piping 1-1/4 inch And Larger: 8 feet on center maximum.
b. Piping 1-1/8 inch And Smaller: 6 feet on center maximum.
c. Support each elbow.
2. Isolate pipe from supports and clamps with Hydrozorb or Cush-A-Clamp systems.
3. Run protective cover continuous from condensing units to risers or penetrations at building wall.

3.2 FIELD QUALITY CONTROL

A. Field Tests:
1. Make evacuation and leak tests in presence of Architect's Engineer after completing refrigeration piping systems. Positive pressure test will not suffice for procedure outlined below.
a. Draw vacuum on each entire system with two stage vacuum pump. Draw vacuum to 300 microns using micron vacuum gauge capable of reading from atmosphere to 10 microns. Do not use cooling compressor to evacuate system nor operate it while system is under high vacuum.
b. Break vacuum with nitrogen and re-establish vacuum test. Vacuum shall hold for 30 minutes at 300 microns without vacuum pump running.
c. Conduct tests at 70 deg F ambient temperature minimum.
d. Do not run systems until above tests have been made and systems started up as specified. Inform Owner's Representative of status of systems at time of final inspection and schedule start-up and testing if prevented by outdoor conditions before this time.
e. After testing, fully charge system with refrigerant and conduct test with Halide Leak Detector.
f. Recover all refrigerant in accordance with applicable codes. Do not allow any refrigerant to escape to atmosphere.

2. If it is observed that refrigerant lines are being or have been brazed without proper circulation of nitrogen through lines, all refrigerant lines installed up to that point in time shall be removed and replaced at no additional cost to Owner.

END OF SECTION

SECTION 23 2600

CONDENSATE DRAIN PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install condensate drain piping as described in Contract Documents.

B. Related Requirements:
   1. Section 23 0501: Common HVAC Requirements

1.2 REFERENCES

A. Reference Standards:
   1. ASTM International:
      a. ASTM B 88-03, 'Standard Specification for Seamless Copper Water Tube.'

PART 2 - PRODUCTS

2.1 SYSTEMS

A. Materials:
   1. Condensate Drains:
      a. Schedule 40 PVC for condensate drains from furnace combustion chambers and furnace cooling coils.
      b. 3 inch deep seal, vented water trap adjacent to cooling coil connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Condensate Drains:
   1. Support piping and protect from damage.
   2. Do not combine PVC condensate drain piping from furnace combustion chamber with copper condensate drain piping from cooling coil.

END OF SECTION

SECTION 23 3001

COMMON DUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. General procedures and requirements for ductwork.
   2. Repair leaks in ductwork, as identified by duct testing, at no additional cost to Owner.

B. Related Requirements:
   1. Section 01 4316: Duct testing, adjusting, and balancing of ductwork.
   2. Section 07 9219: Quality of acoustic sealant.
   3. Section 23 0501: Common HVAC Requirements.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Pre-Installation Conference: Schedule conference immediately before installation of ductwork.

1.3 SUBMITTALS

A. Action Submittals:
   1. Product Data: Specification data on sealer and gauze proposed for sealing ductwork.
   2. Samples: Sealer and gauze proposed for sealing ductwork.

B. Informational Submittals:
   1. Manufacturer Instructions: Installation manuals providing detailed instructions on assembly, joint sealing, and system pressure testing for leaks.

PART 2 - PRODUCTS

2.1 ASSEMBLIES

A. Performance:
   1. Design Criteria:
      a. Standard Ducts: Construction details not specifically called out in Contract Documents shall conform to applicable requirements of SMACNA HVAC Duct Construction Standards.

B. Materials:
   1. Duct Hangers:
      a. One inch by 18 ga galvanized steel straps or steel rods as shown on Drawings, and spaced not more than 96 inches apart. Do not use wire hangers.
      b. Attaching screws at trusses shall be 2 inch No. 10 round head wood screws. Nails not allowed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. During installation, protect open ends of ducts by covering with plastic sheet tied in place to prevent entrance of debris and dirt.

B. Make necessary allowances and provisions in installation of sheet metal ducts for structural conditions of building. Revisions in layout and configuration may be allowed, with prior written approval of Architect. Maintain required airflows in suggesting revisions.

C. Hangers And Supports:
   1. Install pair of hangers close to each transverse joint and elsewhere as required by spacing indicated in table on Drawings.
   2. Install upper ends of hanger securely to floor or roof construction above by method shown on Drawings.
   3. Attach strap hangers to ducts with cadmium-plated screws. Use of pop rivets or other means will not be accepted.
   4. Secure vertical ducts passing through floors by extending bracing angles to rest firmly on floors without loose blocking or shimming. Support vertical ducts, which do not pass through floors, by using bands bolted to walls, columns, etc. Size, spacing, and method of attachment to vertical ducts shall be same as specified for hanger bands on horizontal ducts.

3.2 CLEANING

A. Clean interior of duct systems before final completion.

END OF SECTION

SECTION 23 3114

LOW-PRESSURE METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install above-grade low-pressure steel ducts and related items as described in Contract Documents.

B. Products Installed But Not Furnished Under This Section:
   1. Duct smoke detectors.

C. Related Requirements:
   1. Section 01 4316: Duct, Testing, Adjusting, and Balancing.
   2. Section 23 0713: Thermal Insulation for ducts, plenum chambers, and casings.
   3. Section 23 3001: Common Duct Requirements.
   4. Section 23 0933: Temperature control damper actuators and actuator linkages.
   5. Section 23 0933: Furnishing of duct smoke detectors.

1.2 REFERENCES

A. Reference Standards:
   1. ASTM International:
      a. ASTM A 653-02a, 'Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.'

PART 2 - PRODUCTS

2.1 SYSTEM

A. Materials:
   1. Sheet Metal:
      a. Fabricate ducts, plenum chambers and casings of zinc-coated, lock-forming quality steel sheets meeting requirements of ASTM A 653, with G 60 coating.
   2. Duct Sealer For Interior Ducts:
      a. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
         1) Duct Butter or Butter Tak by Cain Manufacturing Co Inc, Pelham, AL www.cainmfg.com.
         2) DP 1010 by Design Polymerics, Fountain Valley, CA www.designpoly.com.
         3) SAS by Duro Dyne, Bay Shore, NY www.durodyne.com.
         4) Versa Grip 102 by Hardcast Inc, Wylie, TX www.hardcast.com.
         5) 15-325 by Miracle / Kingco, Div ITW TACC, Rockland, MA www.taccint.com.
         6) 44-39 by Mon-Eco Industries Inc, East Brunswick, NJ www.mon-ecoindustries.com.
         7) Airseal #11 by Polymer Adhesive Sealant Systems Inc, Weatherford, TX www.polymeradhesives.com.
         8) Water Base Duct Sealer by Airseal LLC, Columbus, OH www.mcgillairseal.com.
   3. Duct Sealer For Exterior Ducts:
      a. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
         1) Hardcast DT Tape and RTA-50 liquid adhesive by Hardcast Inc, Wylie, TX www.hardcast.com.

B. Fabrication:
   1. General:
      a. Straight and smooth on inside with joints neatly finished.
      b. Duct drops to diffusers shall be round, square, or rectangular to accommodate diffuser neck. Drops shall be same gauge as branch duct. Seal joints air tight.
   2. Standard Ducts:
      a. General:
         1) Ducts shall be large enough to accommodate inside acoustic duct liner. Dimensions shown on Drawings are net clear inside dimensions after duct liner has been installed.
      b. Rectangular Duct:
         1) Duct panels through 48 inch dimension having acoustic duct liner need not be cross-broken or beaded. Cross-break unlined ducts, duct panels larger than 48 inch vertical and horizontal sheet metal barriers, duct offsets, and elbows, or bead 12 inches on center.
            a) Apply cross-breaking to sheet metal between standing seams or reinforcing angles.
            b) Center of cross-break shall be of required height to assure surfaces being rigid.
            c) Internally line square and rectangular drops. Externally insulate round drops.
         2) Duct with height or width over 36 inches 900 mm shall be fabricated using SMACNA T-24 flange joints or of pre-fabricated systems as follows:
            a) Ducts with sides over 36 inches up to 48 inches Transverse duct joint system by Ductmate **/** 25, Ward, or WDCI (SMACNA Class 'F' joint).
            b) Ducts 48 Inches And Larger: Ductmate **/** 35, or WDCI (SMACNA Class 'J' transverse joint).
            c) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
               (1) Ductmate Industries Inc, Charleroi, PA www.ductmate.com.
               (2) Ward Industries Inc, Bensonville, IL www.wardind.com.
      c. Round Duct:
         1) Spiral Seam: 28 ga minimum for ducts up to and including 14 inches in diameter.
         2) Longitudinal Seam:
            a) 28 ga minimum for ducts up to and including 8 inches in diameter.
            b) 26 ga minimum for ducts over 8 inches and up to 14 inches in diameter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Interface With Other Work: Reseal transverse joint duct leaks and seal longitudinal duct joint leaks discovered during air test and balance procedures specified in Section 23 0593, at no additional cost to Owner.

B. Install internal ends of slip joints in direction of flow. Seal transverse and longitudinal joints air tight using specified duct sealer. Cover horizontal and longitudinal joints on exterior ducts with two layers of specified tape installed with specified adhesive.

C. Securely anchor ducts and plenums to building structure with specified duct hangers attached with screws. Do not hang more than one duct from a duct hanger. Brace and install ducts so they shall be free of vibration under all conditions of operation.

D. Ducts shall not bear on top of structural members.

E. Paint ductwork visible through registers, grilles, and diffusers flat black.

F. Properly flash where ducts protrude above roof.

G. Under no conditions will pipes, rods, or wires be allowed to penetrate ducts.

END OF SECTION

SECTION 23 3300

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install duct accessories in specified ductwork as described in Contract Documents.

B. Related Requirements:
   1. Section 23 0933: Temperature control damper actuators and actuator linkages.
   2. Section 23 3001: Common Duct Requirements.

1.2 REFERENCES

A. Reference Standards:
   1. ASTM International:
      a. ASTM A 653-02a, 'Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.'
      b. ASTM C 1071-00, 'Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Acoustical Material).'
      c. ASTM C 1338-00, 'Standard Test Method for Determining the Fungi Resistance of insulation Materials and Facings.'

PART 2 - PRODUCTS

2.1 ACCESSORY PRODUCTS

A. Manufacturers:
   1. Manufacturer List:
      a. Air Balance Inc, Holland, OH www.airbalance.com.
      b. Arrow United Industries, Wyalusing, PA www.arrowunited.com.
      c. Cain Manufacturing Company Inc, Pelham, AL www.cainmfg.com.
      d. Design Polymerics, Fountain Valley, CA www.designpoly.com.
      e. Ductmate Industries Inc, East Charleroi, PA www.ductmate.com.
      f. Flexmaster USA Inc, Houston, TX www.flexmasterusa.com.
      g. Greenheck Corp, Schofield, WI www.greenheck.com.
      h. Honeywell Inc, Minneapolis, MN www.honeywell.com.
      i. Johns-Manville, Denver, CO www.jm.com.
      j. Knauf Fiber Glass, Shelbyville, IN www.knauffiberglass.com.
      k. Nailor Industries Inc, Houston, TX www.nailor.com.
      l. Ruskin Manufacturing, Kansas City, MO www.ruskin.com.
      m. Titus, Richardson, TX (972) 699-1030. www.titus-hvac.com
      n. McGill AirFlow, Groveport, OH www.mcgillairflow.com.
      o. McGill AirSeal, Columbus, OH www.mcgillairseal.com.

B. Materials:
   1. Acoustical Liner System:
      a. Duct Liner:
         1) One inch thick, 1-1/2 lb density fiberglass conforming to requirements of ASTM C 1071. Liner will not support microbial growth when tested in accordance with ASTM C 1338.
         2) Category Four Approved Products. See Section 01 6200 for definitions of Categories.

a) Duct Liner E-M by Knauf Fiber Glass.
b) Permacote Linacoustic HP by Johns-Manville.

b. Adhesive:
1) Category Four Approved Water-Based Products. See Section 01 6200 for definitions of Categories.
a) Cain: Hydrotak.
b) Design Polymerics: DP2501 or DP2502 (CMCL-2501).
c) McGill Airseal: Uni-tack.
2) Category Four Approved Solvent-Based (non-flammable) Products. See Section 01 6200 for definitions of Categories.
a) Cain: ACA 40.
3) Category Four Approved Solvent-Based (flammable) Products. See Section 01 6200 for definitions of Categories.
a) Cain: HV200.
b) Polymer Adhesive: R-Tack.

c. Fasteners:
1) Adhesively secured fasteners not allowed.
2) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
a) AGM Industries Inc: 'DynaPoint' Series RP-9 pin.
b) Cain.
c) Gripnails may be used if each nail is installed by 'Grip Nail Air Hammer' or by 'Automatic Fastener Equipment' in accordance with Manufacturer's recommendations.

2. Flexible Equipment Connections:
a. 30 oz closely woven UL approved glass fabric, double coated with neoprene.
b. Fire retardant, waterproof, air-tight, resistant to acids and grease, and withstand constant temperatures of 250 deg F.
c. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
1) Cain: N-100.
2) Ductmate: ProFlex.

3. Duct Access Doors:
a. General:
1) Factory built insulated access door with hinges and sash locks, as necessary. Construction shall be galvanized sheet metal, 24 ga minimum.
2) Fire and smoke damper access doors shall have minimum clear opening of 12 inches square or larger as shown on Drawings.

b. Rectangular Ducts:
1) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
a) Air Balance: Fire**/**Seal FSA 100.
b) Flexmaster: Spin Door.
c) Nailor: 085H-01.
d) Ruskin: ADH-24.

c. Round Ducts:
1) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
a) Ductmate: ‘Sandwich’ Access Door.
b) Nailor: 0809.
c) Ruskin: ADR.

4. Dampers And Damper Accessories:
a. Locking Quadrant Damper Regulators:
1) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
a) Young: No. 1.

b. Concealed Ceiling Damper Regulators:
1) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
a) Cain.
b) Young: 301.

c. Volume Dampers:
1) Rectangular Duct:
a) Factory-manufactured 16 ga galvanized steel, single blade and opposed blade type with 3/8 inch axles and end bearings. Blade width 8 inches maximum. Blades shall have 1/8 inch clearance all around.

b) Damper shall operate within acoustical duct liner.
c) Provide channel spacer equal to thickness of duct liner.
d) Dampers above removable ceiling and in Mechanical Rooms shall have locking quadrant on bottom or side of duct. Otherwise, furnish with concealed ceiling damper regulator and cover plate.
e) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
(1) Arrow: OBDAF-207.
(2) Greenheck: VCD-20.
(3) Ruskin: MD-35.
Round Duct:
f) Factory-manufactured 20 ga galvanized steel, single blade with 3/8 inch axles and end bearings.
g) For use in outside air ducts.
h) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
(1) Air Balance: Model AC-22.
(2) Arrow: Type-70.
(4) Ruskin: MDRS-25.

d. Motorized Outside Air Dampers:
1) General:
a) Low leakage type. AMCA certified.
b) Make provision for damper actuators and actuator linkages to be mounted external of air flow.
2) Rectangular Ducts:
a) Damper Blades:
(1) Steel or aluminum airfoil type with mechanically locked blade seals, 8 inch blade width maximum measured perpendicular to axis of damper.
(2) Jamb seals shall be flexible metal compression type.
(3) Opposed or single blade type.
b) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
(1) Air Balance: AC 526.
(2) Arrow: AFD-20.
(3) Honeywell: D-643.
(4) Ruskin: CD-60.
3) Round Ducts:
a) Damper Blades:
(1) Steel with mechanically locked blade seals.
(2) Blade seals shall be neoprene or polyethylene.
(3) Single blade type.
b) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
(1) Air Balance: AC 25.
(2) Arrow: Type 70 or 75.
(3) Honeywell: D-690.
(4) Ruskin: CD25

e. Backdraft Dampers:
1) Backdraft blades shall be nonmetallic neoprene coated fiberglass type.
2) Stop shall be galvanized steel screen or expanded metal, 1/2 inch mesh.
3) Frame shall be galvanized steel or extruded aluminum alloy.
4) Category Four Approved Products. See Section 01 6200 for definitions of Categories.
a) Ruskin: NMS2.

5. Duct Silencers:
a. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
1) Titus Products Div.
2) McGill AirsealCorp.

6. Air Turns:
a. Single thickness vanes. Double thickness vanes not acceptable.
b. 4-1/2 inch wide vane rail. Junior vane rail not acceptable.

7. Branch Tap for Flexible Ductwork:
   a. Factory-manufactured rectangular-to-round 45 degree leading tap fabricated of 24 ga zinc-coated lock-forming quality steel sheets meeting requirements of ASTM A 653, with G-90 coating.
   b. One inch wide mounting flange with die formed corner clips, pre-punched mounting holes, and adhesive coated gasket.
   c. Manual Volume Damper:
      1) Single blade, 22 ga minimum
      2) 3/8 inch minimum square rod with brass damper bearings at each end.
      3) Heavy-duty locking quadrant on 1-1/2 inch high stand-off mounting bracket attached to side of round duct.
   d. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
      1) STO by Flexmaster.

C. Fabrication:
1. Duct Liner:
   a. Install mat finish surface on airstream side. Secure insulation to cleaned sheet metal duct with continuous 100 percent coat of adhesive and with 3/4 inch long mechanical fasteners 12 inches on center maximum unless detailed otherwise on Drawings. Pin all duct liner.
   b. Accurately cut liner and thoroughly coat ends with adhesive. Butt joints tightly. Top and bottom sections of insulation shall overlap sides. If liner is all one piece, folded corners shall be tight against metal. Ends shall butt tightly together.
   c. Coat longitudinal and transverse edges of liner with adhesive.
2. Air Turns:
   a. Permanently install vanes arranged to permit air to make abrupt turn without appreciable turbulence, in 90 degree elbows of above ground supply and return ductwork.
   b. Quiet and free from vibration when system is in operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Duct Liner:
1. Furnish and install acoustic lining in following types of ducts:
   a. Supply air.
   b. Return air.
   c. Mixed air.
   d. Transfer air.
   e. Relief air.
   f. Exhaust air.
   g. Elbows, fittings, and diffuser drops greater than 12 inches in length.

B. Flexible Connections: Install flexible inlet and outlet duct connections to each furnace.

C. Access Doors In Ducts:
1. Install at each manual outside air damper and at each motorized damper. Locate doors within 6 inches of installed dampers.
2. Install within 6 inches of fire dampers and in Mechanical Room if possible. Install on side of duct that allows easiest access to damper.

D. Dampers And Damper Accessories:
1. Install concealed ceiling damper regulators.
   a. Paint cover plates to match ceiling tile.
   b. Do not install damper regulators for dampers located directly above removable ceilings or in Mechanical Rooms.
2. Provide each take-off with an adjustable volume damper to balance that branch.
   a. Anchor dampers securely to duct.

b. Install dampers in main ducts within insulation.
c. Dampers in branch ducts shall fit against sheet metal walls, bottom and top of duct, and be securely fastened. Cut duct liner to allow damper to fit against sheet metal.
d. Where concealed ceiling damper regulators are installed, provide cover plate.

3. Install motorized dampers.

END OF SECTION

SECTION 23 3346

FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install supply air branch duct runouts to diffusers as described in Contract Documents.

B. Related Requirements:
   1. Section 23 3001: Common Duct Requirements.

PART 2 - PRODUCTS

2.1 SYSTEM

A. Manufacturers:
   1. Manufacturer List:
      a. Anco Products Inc, Elkhart, IN www.ancoproductsinc.com.
      b. Thermaflex by Flexible Technologies, Abbeville, SC or Mississauga, ON www.thermaflex.net.
      c. Flexmaster USA Inc, Houston, TX www.flexmasterusa.com or Flexmaster Canada Ltd, Richmond Hill, ON (905) 731-9411.

B. Materials:
   1. Ducts:
      a. Formable, flexible, circular duct which shall retain its cross-section, shape, rigidity, and shall not restrict airflow after bending.
      b. Insulation: Nominal 1-1/2 inches, 3/4 lb/cu ft density fiberglass insulation with air-tight, polyethylene or polyester core, sheathed in seamless vapor barrier jacket factory installed over flexible assembly.
      c. Assembly, including insulation and vapor barrier, shall meet Class I requirement of NFPA 90A-1989 and be UL 181 rated, with flame spread of 25 or less and smoke developed rating of 50 or under.
      d. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
         1) ANCO-FLEX 4625 by Anco Products.
         2) M-KC by Thermaflex by Flexible Technologies.
         3) Type 4m Insulated by Flexmaster.
   2. Cinch Bands: Nylon, 3/8 inch removable and reusable type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct in fully extended condition free of sags and kinks, using 72 inch maximum lengths.

B. Make duct connections by coating exterior of duct collar for 3 inches with duct sealer and securing duct in place over sheet metal collar with specified cinch bands.

END OF SECTION

SECTION 23 3400

HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install exhaust fans as described in Contract Documents.

B. Related Requirements:
   1. Section 23 3001: Common Duct Requirements.
   2. Division 26: Control device and electrical connection.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Bear AMCA seal and UL label.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer List:
   1. Acme Engineering & Manufacturing Corp, Muskogee, OK www.acmefan.com.
   2. Breidert Air Products, Jacksonville, FL www.breidert.com.
   3. Broan
   4. Carnes Co, Verona, MI www.carnes.com.
   5. Greenheck Corp, Schofield, WI www.greenheck.com.
   6. Loren Cook Co, Springfield, MO www.lorencook.com.
   7. PennBarry, Richardson, TX (215) 464-8900 www.pennbarry.com.

2.2 MANUFACTURED UNITS

A. Ceiling Mounted Exhaust Fans:
   1. Acoustically insulated housings. Sound level rating of 4.6 sones maximum for fan RPM and CFM listed on Drawings.
   2. Include chatterproof integral back-draft damper with no metal-to-metal contact.
   3. True centrifugal wheels.
   4. Entire fan, motor, and wheel assembly shall be easily removable without disturbing housing.
   5. Suitably ground motors and mount on rubber-in shear vibration isolators.
   6. Provide wall or roof cap, as required.
   7. Class One Quality Standards:
      a. Greenheck SP.
      b. PennBarry Zephyr.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Anchor fan units securely to structure.

END OF SECTION

SECTION 23 3713

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install diffusers, registers, and grilles connected to ductwork as described in Contract Documents.

B. Related Requirements:
   1. Section 23 3001: General Duct Requirements.

1.2 SUBMITTALS

A. Maintenance Material Submittals:
   1. Tools: Leave tool for removing core of each different type of grille for building custodian.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer List:
   1. Carnes Co, Verona, MI www.carnes.com
   2. J & J Register, Grand Rapids, MI www.jandjreg.com.
   3. Krueger Air System Components, Richardson, TX www.krueger-hvac.com.
   4. Metal*Aire by Metal Industries Inc, Clearwater, FL www.metalaire.com.
   5. Nailor Industries Inc, Houston, TX www.nailor.com.
   6. Price Industries Inc, Suwanee, GA www.price-hvac.com.
   7. Tuttle & Bailey, Richardson, TX www.tuttleandbailey.com.

2.2 MANUFACTURED UNITS

A. Supply Grilles And Registers:
   1. Finish: Off-white baked enamel.
   2. Removable core.
   3. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
      a. Carnes: RVEA.
      b. J & J: 2815.
      c. Krueger: 5815.
      d. Metal*Aire: 42C.
      e. Nailor: 51RCD.
      f. Price: LBMR/DV1.
      g. Tuttle & Bailey: VF5.

B. Ceiling Return And Transfer Grilles:
   1. Finish: Off-white baked enamel.
   2. 1/2 inch spacing.
   3. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
      a. Carnes: RSLA.
      b. J & J: S90H.

c. Krueger: S85H.
d. Metal*Aire: SRH.
e. Nailor: 6155H.
f. Price: 535.
g. Tuttle & Bailey: T70D.

C. High Side Wall Return Grilles:
1. Finish: Off-white baked enamel.
2. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
a. Carnes: RHEA.
b. J & J: 2810.
c. Metal*Aire: 41C.
d. Krueger: 5810.
e. Nailor: 51RC.
f. Price: LBMR.
g. Tuttle & Bailey: VF.

D. Floor / Toe Space Return Grilles:
1. Finish: Clear anodized.
2. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
a. Carnes: CCJB (with mitered corners welded on face and sanded).
b. J & J: 2500 with Frame 10.
c. Krueger: 1500F.
d. Metal*Aire: 2000F.
e. Nailor: 49-240-FN-MM.
f. Price: LBP-25B.
g. Tuttle & Bailey: LFD.

E. Low Sidewall Return Grilles:
1. Finish: Off-white baked enamel.
2. 38 or 45 degree deflection.
3. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
a. Carnes: RSHA.
b. J & J: S-590.
c. Krueger: S480H.
d. Metal*Aire: HD-RH.
e. Nailor: 6145H-HD.
f. Price: 90-L.
g. Tuttle & Bailey: T110.

F. Soffit Grilles:
1. Finish: Baked enamel. Match soffit color.
2. Aluminum with aluminum mesh insect screen.
3. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
a. Carnes: RAAA.
b. J & J: ALS95H.
c. Krueger: S585H.
d. Metal*Aire: RHE.
e. Nailor: 5155-IS.
f. Price: 635.
g. Tuttle & Bailey: A70D-5.

G. Ceiling Diffusers:
1. Finish: Off-white baked enamel.
2. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
a. Carnes: SKSA.
b. J & J: R-1400.
c. Krueger: SH.
d. Metal*Aire: 5500S.
e. Nailor: 65OOB.

f. Price: SMD-6.
g. Tuttle & Bailey: MS.

H. Ceiling Slot Diffusers:
1. Linear slot type with 180 deg adjustable air pattern and aluminum construction.
2. Provide type 2B frame and end border at each end.
3. Finish: Off-white baked enamel.
4. Class One Quality Standard: Titus ML-39.
5. Approved Manufacturers. See Section 01 6200.
a. Krueger, Metal*Aire, Titus.

I. Door Grilles:
1. Finish: Baked enamel. Match door as closely as possible as approved by Architect.
2. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
a. Carnes.
b. J & J.
c. Krueger.
d. Metal*Aire.
e. Nailor: 61OGD.
f. Price: STGI-BF.
g. Tuttle & Bailey.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Anchor securely into openings. Secure frames to ductwork by using four sheet metal screws, one per side. Level floor registers and anchor securely into floor.

3.2 ADJUSTING

A. Set sidewall supply register blades at 15 degrees upward deflection.

END OF SECTION

SECTION 23 3714

LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install louvers connected to ductwork as described in Contract Documents.

B. Products Furnished But Not Installed Under This Section:
   1. Architectural louvers not connected to ductwork.

C. Related Requirements:
   1. Section 06 2001: Installation of architectural louvers not connected to ductwork.
   2. Section 23 3001: General Duct Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer List:
   1. Airolite Co, Marietta, OH www.airolite.com.
   2. American Warming & Ventilating, Holland, OH www.awv.com.
   3. Arrow United Industries, Wyalusing, PA www.arrowunited.com.
   4. Carnes Co, Verona, WI www.carnes.com.
   5. Industrial Louvers Inc, Delano, MN www.industriallouvers.com.
   6. Ruskin Manufacturing, Kansas City. MO www.ruskin.com.
   7. Vent Products Co Inc, Chicago, IL www.ventprod.com.
   8. Wonder Metals Corp, Redding, CA www.wondermetals.com.

2.2 MANUFACTURED UNITS

A. Louvers:
   1. General:
      a. Extruded aluminum, with blades welded or screwed into frames.
      b. Frames shall have mitered corners.
      c. Louvers shall be recessed, flanged, stationary, or removable as noted on Drawings.
      d. Finish:
         1) Polyvinyledene Fluoride (PVF_2) Resin-base finish (Kynar 500 or Hylar 5000) containing 70 percent minimum PVF_2 in resin portion of formula. Thermo-cured two coat system consisting of corrosion inhibiting epoxy primer and top coat factory applied over properly pre-treated metal.
         2) Color as selected by Architect from Manufacturer's standard colors.
   2. Louvers Connected To Ductwork:
      a. 1/2 inch 13 mm mesh 16 ga 1.59 mm aluminum bird screen.
      b. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
         1) K638 by Airolite.
         2) LE48 by American Warming & Ventilating.
         3) EA-405 by Arrow United Industries.
         4) FKDA by Carnes.

5) 455-XP by Industrial Louvers.
6) ELF81S30 by Ruskin.
7) 2740-31 by Vent Products.
8) EX by Wonder Metals.Architectural Louvers:

a. Aluminum bug screen.
b. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
   1) T608 by Airolite.
   2) LE57 by American Warming & Ventilating.
   3) Equals by Arrow United Industries, Carnes, or Industrial Louvers as approved by Architect before installation. See Section 01600.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Anchor securely into openings.

B. Where louvers touch masonry or dissimilar metals, protect with heavy coat of asphaltum paint.

END OF SECTION

SECTION 23 4100

AIR FILTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install filters used in mechanical equipment.

B. Related Requirements:
   1. Section 23 3001: Common Duct Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Furnace Filters: One inch thick throw-away type as recommended by Furnace Manufacturer.

B. Fan Coil Unit Filters: One inch thick throw-away type as recommended by Fan Coil Unit Manufacturer.
   1. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
      a. DP-40 by Airguard Industries Inc, Louisville, KY www.airguard.com.
      b. Aerostar Series 400 by Filtration Group, Santa Rosa. CA www.filtrationgroup.com.
      c. PrePleat 40 by Flanders, St Petersburg, FL www.flanderscorp.com.
      d. Type 30/30 by Camfil Farr Co, Riverdale, NJ www.camfilfarr.com.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide ample access for filter removal.

3.2 FIELD QUALITY CONTROL

A. Inspection: At date of Substantial Completion, air filters shall be new, clean, and approved by Owner's representative.

END OF SECTION

SECTION 23 5134

FLUES

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install flues as described in Contract Documents.

B. Related Requirements:
   1. Sections Under 09 9000 Heading: Painting.
   2. Section 23 0501: Common HVAC Requirements.

PART 2 - PRODUCTS

2.1 ASSEMBLIES

A. Manufacturers:
   1. Manufacturer List:
      a. Acme Engineering & Manufacturing Corp, Muskogee, OK www.acmefan.com.
      b. AMPCO, Holland, MI www.americanmetalproducts.com.
      c. Breidert Air Products, Jacksonville, FL www.breidert.com.
      d. Heat-Fab Inc, Turners Falls, MA www.heat-fab.com.
      e. Metal-Fab Inc, Wichita, KS www.mtlfab.com.
      f. Metlvent by Hart & Cooley, Holland, MI www.hartandcooley.com.
      g. Protech Systems, Albany, NY www.protechinfo.com.
      h. Selkirk Metalbestos, Logan, OH www.selkirkusa.com.
      i. Simpson Dura-Vent Co, Vacaville, CA www.duravent.com.
      j. Z-Flex (US) Inc, Bedford, NH www.z-flex.com.

B. Materials:
   1. Flues For Instantaneous, Tankless Water Heaters:
      a. Double wall, factory-fabricated Category III type.
      b. AL-29-4C stainless steel inner conduit and Type 430 stainless steel outer jacket.
      c. Inspection cap, condensate drain, and roof flashing. Provide horizontal, vertical, and roof support.
      d. Seal joints as recommended by Flue Manufacturer.
      e. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
         1) Saf-T Vent C1 by Heat-Fab.
         2) Fasnseal W2 by Protech Systems.
         3) Z-Vent III by Z-Flex (US).
   2. All Other Flues:
      a. Double wall, factory-fabricated sectional type 'B', of aluminum construction designed to handle combustion products of fuel being used. Provide with inspection cap as required by local code, roof flashing, and clean-out.
      b. Size flues according to local codes except:
         1) No vertical flue shall have an area of less than 12-1/2 sq inches 313 sq mm, 4 inches 100 mm in diameter.
         2) In no case shall vent connector be smaller than outlet collar provided by Manufacturer.
      c. Horizontal flue connectors shall be double wall.
      d. Fittings shall be pre-fabricated double wall.
      e. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
         1) Ameri-Vent by AMPCO.
         2) Metal-Fab Inc.

3) Metlvent by Hart & Cooley.
4) Selkirk Metalbestos.
5) Simpson Dura-Vent.

3. Vent Caps:
   a. Non-backdraft type for installation on top of flue, aluminum construction.
   b. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
      1) Mastervent Type MVR by Acme Engineering & Manufacturing.
      2) Ameri-cap by AMPCO.
      3) Type L by Breidert Air Products.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Height of flue above roof shall be as shown on Drawings unless local code requires it be higher.

B. Every portion of flue connector shall have rise of one inch per ft minimum from appliance to vertical flue.

C. Length of horizontal flues or flue connectors shall not be longer than 75 percent of height of vertical flue between point at which horizontal flue enters vertical flue to top of vertical flue. In no case shall horizontal run exceed 15 feet.

D. When two or more flue connections enter common vertical flue, smaller flue connector shall enter at higher level. Do not enter flue connectors in same horizontal plane.

E. Every gas appliance flue shall have a 'backdraft preventer' installed at top of flue.

END OF SECTION

SECTION 23 5135

AIR PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install heating equipment exhaust piping and combustion air intake piping as described in Contract Documents.

B. Related Requirements:
   1. Sections Under 09 9000 Heading: Painting.
   2. Section 23 0501: Common HVAC Requirements.

1.2 REFERENCES

A. Reference Standards:
   1. ASTM International:
      a. ASTM D 1785-05, 'Standard Specification for Poly(Vinyl Chloride)(PVC) Plastic Pipe, Schedules 40, 80, and 120.'
      b. ASTM D 2564-02, 'Standard Specification for Solvent Cements for Poly(Vinyl Chloride)(PVC) Plastic Piping Systems.'
      c. ASTM D 2661-02, 'Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Drain, Waste, and Vent Pipe and Fittings.'
      d. ASTM D 2665-04a, 'Standard Specification for Poly(Vinyl Chloride)(PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.'

PART 2 - PRODUCTS

2.1 ASSEMBLIES

A. Manufacturers:
   1. Manufacturer List:
      a. Armaflex by Armacell, Mebane, NC www.armaflex.com.
      b. Nomaco, Youngsville, NC www.nomacokflex.com.

B. Materials:
   1. Air Piping: Schedule 40 pipe and fittings meeting requirements of ASTM D 1785, ASTM D 2661, or ASTM D 2665.
   2. Piping Primer And Cement: Meet requirements of ASTM D 2564.
   3. Flexible Foamed Pipe Insulation:
      a. Thickness:
         1) 1/2 inch for 2 through 3 inch outside diameter pipe.
         2) 1/2 inch sheet for fittings as recommended by Manufacturer.
      b. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
         1) Tubolit by Armaflex.
         2) ImcoLock or Therma-Cel by Nomaco K-Flex.
   4. Insulation Joint Sealer:
      a. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
         1) 520 by Armaflex.
         2) R-320 by Nomaco K-Flex.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation For Condensing Furnaces:
   1. Run individual vent and individual combustion intake piping from each furnace to concentric roof termination kit provided by Furnace Manufacturer. Slope lines downward toward furnace.
   2. Slope combustion chamber drain downward to funnel drain. Anchor to wall with wall clamps, allowing free movement through clamp for expansion.
   3. Use concentric roof termination kit provided by Furnace Manufacturer. Install vent and combustion air intake piping at clearance and distances required by Furnace Manufacturer.
   4. Attach factory-supplied neoprene coupling to combustion-air inlet connection and secure with clamp.
   5. Ensure that factory-supplied perforated metal disc is installed in flexible coupling, unless its removal is required.

B. Installation For Condensing Water Heaters:
   1. Run individual vent and individual combustion intake piping from each water heater to roof termination as recommended by Water Heater Manufacturer. Concentric roof termination kit may be used if approved by and provided by Water Heater Manufacturer. Slope lines downward toward water heater.
   2. Slope combustion chamber exhaust drain downward to floor drain.

C. Support:
   1. Support concentric roof termination kit at ceiling or roof line with 20 ga sheet metal straps as detailed on Drawings.
   2. Support horizontal sections of pipe in accordance with requirements of Section 23 0501. Anchor securely to structure, not allowing pipe to sway.

D. Insulation:
   1. General:
      a. Install insulation in snug contact with pipe and in accordance with Manufacturer's recommendations.
      b. Slip insulation on piping before piping sections and fittings are assembled keeping slitting of insulation to a minimum.
      c. Joints:
         1) Place 'slit' joint seams of insulation exposed outside building on bottom of pipe.
         2) Stagger joints on layered insulation.
         3) Seal joints in insulation.
      d. Paint exterior exposed insulation with two coats of finish recommended by Insulation Manufacturer, color selected by Architect.
   2. Install specified insulation on PVC air piping serving mechanical equipment as follows
      a. Combustion air PVC piping in truss space and in attic.
      b. Combustion vent PVC piping in attic, in truss space, and above roof.
      c. Insulate fittings with sheet insulation and as recommended by Manufacturer.

END OF SECTION

SECTION 23 5414

ELECTRIC-RESISTANCE DUCT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install flanged type duct furnaces as described in Contract Documents.

B. Related Requirements:
   1. Section 23 0501: Common HVAC Requirements.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Furnaces to conform to UL, NEC, and NFPA requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Category Four Approved Manufacturers. See Section 01 6200 for definitions of Categories.
   1. Brasch Manufacturing Co Inc, Maryland Heights, MO www.braschmfg.com.
   2. Delta-Flo Manufacturing Co Inc, San Bernardino, CA (800) 854-2317 or (909) 888-3291.
   3. INDEECO - Industrial Engineering & Equipment Co, St Louis, MO www.indeeco.com.

2.2 MANUFACTURED UNITS

A. Duct Furnace:
   1. Heaters:
      a. 80 percent nickel, 20 percent chromium resistance coils insulated by floating ceramic bushings and supported in an aluminized steel frame.
      b. Bushing shall be recessed into embossed openings and staked into supporting brackets spaced 3-1/2 inches 88 mm maximum center to center.
      c. Coils shall be machine crimped into stainless steel terminals and insulated with phenolic bushings.
      d. Heaters shall be listed by UL for zero clearance to combustible surfaces.
      e. Heater casings shall be of flanged type for attachment to external duct flanges and shall accommodate internally insulated ducts with insulation thickness as specified.
   2. Furnish disc-type thermal cutouts for primary and secondary protection.
      a. Automatic reset primary cutout shall be suitable for scheduled voltage operation.
      b. Manual reset secondary cutouts shall be factory wired directly in series with each circuit.
      c. Non-reusable thermal links are not acceptable.
   3. Voltage, phase, and number of heating stages to be furnished are shown on Drawings. Limit step controller to eight steps.
      a. Three phase heaters shall have equal, balanced circuits.
      b. Circuits shall be rated at 48 AMP maximum.
      c. Heating elements shall be de-rated to 35 watts per sq ft of element surface.
      d. Test heaters di-electrically at 2000 V before shipment.
   4. Each heater shall have following built-in components wired to terminal blocks for field connections. Internal wiring shall be suitable for 105 deg C.
      a. Use mercury contactors to disconnect ungrounded circuits.

b. Control transformer shall be dry industrial type, sized to carry full contactor holding coil load. Primary windings to be factory fused.
c. Door mounted un-fused disconnect switch, snap acting, industrial type to be built into access door. Hinged, latched disconnect switch and door cover shall lock in closed position when switch is on.
d. Built-in fuses properly sized complete with fuse block.
e. Airflow switch wired in series with automatic reset thermal cutout.
f. Provide heaters of 100 KW capacity or greater with recycling relay to prevent all steps from simultaneously energizing after power interruption.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide duct access doors on both sides of duct furnace.

END OF SECTION

SECTION 23 5417

GAS-FIRED FURNACES

PART 1 - GENERAL

1.1 SUMMARY

A. Products Installed But Not Furnished Under This Section:
   1. Furnaces.

B. Related Sections:
   1. Section 01 6400: Owner will furnish furnaces. PART 2 of this Section establishes quality of materials for information of Contractor, Architect, and Owner's Representatives.
   2. Section 23 0501: Common HVAC Requirements.
   3. Section 23 1123: Liquid Propane Gas Piping System.
   4. Section 23 2300: Refrigerant Piping System.
   5. Section 23 4100: Air Filters.

1.2 SUBMITTALS

A. Informational Submittals:
   1. Manufacturer Reports: Equipment check-out sheets.

1.3 WARRANTY

A. Provide 10-year part and labor warranty on furnace and 15-year minimum limited warranty on heat exchanger.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

A. Manufacturer:
   1. Manufacturer List:
      a. York International, York, PA www.york.com. Call David E. Carey (405) 419-6536 office / (405) 820-3012 cell or Roger W. Reeve (801) 268-4112 office / (801) 652-4387 cell.

B. Performance
   1. Design Criteria: Rated at 90 percent minimum AFUE (Annual Fuel Utilization Efficiency) calculated in accordance with DOE test procedures.

C. Manufactured Units:
   1. Furnaces:
      a. Factory assembled units certified by AGA complete with blower section, furnace section, steel casing, piped, and wired.
      b. Blower section shall consist of cabinet, blower, and motor.
         1) Cabinet shall be of 22 ga minimum cold rolled steel and have finish coat of baked-on enamel.
         2) Blower shall be Class 1, full DIDW, statically and dynamically balanced.
      c. Automatic controls shall consist of:
         1) 100 percent cut-off safety pilot.
         2) Manual gas shut-off valve.

3) Operating automatic gas valve.
4) Solid-state type fan and thermal limit controls.
5) 24-volt transformer.
6) Electronic ignition system.

d. Blower shall be driven by motor with adjustable pitch V-belt drive or by multi-speed direct driven motor.
e. Furnace section shall be enclosed in 22 ga minimum enameled steel casing lined with foil covered insulation.
f. Heat Exchanger: Aluminized steel.
g. Gas Burners: Aluminized steel.
h. PVC intake of outside air and PVC combustion product exhaust, with sealed combustion, direct vent system.
i. Concentric roof termination kit for roof mounting.
j. Approved Products:
1) Standard Furnaces:
a) York T695.
2) Two-Stage Furnaces:
a) York PT9.

2. Cooling Coil:
a. Cooling coil shall consist of heavy gauge steel cabinet with baked-on enamel finish to match furnace.
1) Coil shall have aluminum fins bonded to seamless copper tubing.
2) Coil shall be ARI rated. Provide drain pans with connections at one end.
3) Use thermal expansion valve with brazed joints in place of capillary tube metering device. Compression fittings not acceptable.
b. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
1) Horizontal: York MC.
2) Vertical: York MC.

2.2 ACCESSORY PRODUCTS

A. Build filter frame external to furnace as detailed on Drawings.

B. Vibration Isolators:
1. Horizontal Installation:
a. Neoprene hanger type with load of 75 lbs maximum.
b. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
1) RH by Kinetics Noise Control, Dublin, OH www.kineticsnoise.com.
2) Mason Industries, Hauppage, NY www.mason-ind.com.
3) RH by Vibration Mounting & Controls, Bloomingdale, NJ www.vmc-kdc.com.
2. Vertical Installation: 4 inches 100 mm square by 1/2 inch 13 mm thick minimum neoprene type vibration isolation pads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install vibration isolator on each hanger rod supporting horizontal furnace and under each corner of vertical furnace.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service:
1. Furnace distributor's technical service representative shall:
a. Verify proper liquid propane orifice size.
b. Clock gas meter for rated input.

c. Verify and set gas pressure at furnace.
d. Check and measure temperature rise.
e. Check safety controls for proper operation.
f. Check combustion vent sizes and combustion air sizes.

2. In addition, furnace distributor's technical service representative shall start up, check out, and adjust furnaces using equipment check-out sheet provided by Manufacturer. Complete and sign all items on sheet.

END OF SECTION

SECTION 23 6213

AIR-COOLED REFRIGERANT CONDENSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Products Installed But Not Supplied Under This Section:
   1. Condensing units.

B. Related Sections:
   1. Section 01 6400: Owner will furnish Condensing units. PART 2 of this Section establishes quality of materials for information of Contractor, Architect, and Owner's Representatives.
   2. Section 23 0501: Common HVAC Requirements.
   3. Section 23 2300: Refrigerant Piping System.

1.2 SUBMITTALS

A. Informational Submittals:
   1. Manufacturer Reports: Equipment check-out sheets.
   2. Qualification Statements: Technician certificate for use of CFC, HFC, and HCFC refrigerants.

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Each unit shall be UL / ULC labeled.

B. Qualifications:
   1. Installer: Refrigerant piping shall be installed by refrigeration contractor licensed by State and by technicians certified in use of CFC and HCFC refrigerants.

1.4 WARRANTY

A. Ten-year parts and labor warranty on condensing units from date of 'start-up.' Record 'start-up' date on warranty certificate for each unit.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

A. Manufacturer:
   1. Contact Information:
      a. York International, York, PA www.york.com. Call David E. Carey (405) 419-6536 office / (405) 820-3012 cell or Roger W. Reeve (801) 268-4112 office / (801) 652-4387 cell.

B. Performance:
   1. Capacities: SEER rating as defined by ARI shall be 13.0 or greater

C. Manufactured Units:
   1. Condensing Units:
      a. General:

1) Units shall be operable down to 0 deg F minus 18 deg C outdoor temperature when outside winter design temperature is below 35 deg F 2 deg C.
2) Use R-410a refrigerant.
3) Only one liquid line, one suction line, and one power connection shall be made to each compressor. Provide charging valves.

b. Condenser Coils:
1) Aluminum plate fins mechanically bonded to seamless copper tubes.
2) Provide coil guard for unit.

c. Fans:
1) Direct driven propeller upflow type.
2) Fan motor shall be single or two speed, thermostatically controlled, permanently lubricated, and designed with permanent protection.
3) Motors shall be resiliently mounted.
4) Each fan shall have a safety guard.

d. Compressor:
1) Each condenser unit shall have only one compressor.
2) Scroll design with following features:
a) Externally mounted brass service valves with charging connections.
b) Crankcase heater.
c) Resilient rubber mounts.
d) Compressor motor-overload protection.
e) Single speed.

e. Controls:
1) Factory wired and located in separate enclosure.
2) Factory installed safety devices:
a) High and low pressure cutout.
b) Condenser fan motor-overload devices.
3) Factory-installed anti-cycle timers to prevent units from starting up again for five minutes after any power interruption.
4) Low ambient kit.

f. Casing:
1) Fully weatherproof for outdoor installation. Finish shall be weather resistant.

g. Openings shall be provided for power and refrigerant connections.

h. Panels shall be removable for servicing.

i. Approved Products:
1) York CZB.

2.2 ACCESSORY PRODUCTS

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set condensing units level on concrete slab, securing to slab through manufacturer’s mounting holes inside manufacturer’s housing.

B. Do not use capillary tube and piston type refrigerant metering devices.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service:
1. Condensing units shall be started up, checked out, and adjusted by Condensing Unit Manufacturer's authorized factory trained service mechanic.
2. Use equipment checkout sheet provided by Manufacturer. Complete and sign all items on sheet.

END OF SECTION

SECTION 23 7223

PACKAGED AIR-TO-AIR ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install air-to-air energy recovery ventilation units as described in Contract Documents

B. Related Requirements:
   1. Section 23 0501: Common HVAC Requirements.
   2. Section 23 3114: Low-Pressure Metal Ductwork.
   3. Section 23 4100: Air filters.

1.2 REFERENCES

A. Reference Standards:
   1. American Society of Heating, Refrigerating, & Air-Conditioning Engineers:
      a. ASHRAE Standard 84-1991, 'Procedure for Testing Air to Air Heat Exchangers.'

1.3 WARRANTY

A. Special Warranty: Warranty energy transfer element for ten years from date of substantial completion of Project.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Category Four Approved Product. See Section 01 6200 for definitions of Categories.
   1. Model HE1XINV by RenewAire, Madison, WI www.renewaire.com.

2.2 PERFORMANCE

A. Capacities:
   1. Element rated by Manufacturer using method described in ASHRAE Standard 84. Exceed 70 percent temperature efficiency.
   2. Applicable for range of ventilation up to 800 CFM in each air stream without disposition of dust in elements.

2.3 MANUFACTURED UNITS

A. Energy Recovery Units:
   1. Construction:
      a. Vertical Configuration.
      b. Fixed plate element.
      c. 20 ga galvanized steel case with lapped corners.
      d. Leveling legs.
      e. Access door to blowers, energy transfer elements, and filters.

1) Gasketed to provide air tight seal.
2) Insulated with 1/4 inch Rubatex.
3) Attached to unit using stainless steel fasteners.

2. Duct Openings: Four each 1/2 inch by 1/2 inch square duct collars suitable for connection to duct work.
3. Blowers:
   a. Forward curved blades directionally driven by open, drip-proof PSC motor rated for continuous duty.
   b. Motor: 2-3/4 horse power, 115 VAC, single phase, 60 hertz.
   c. Baked enamel finish.
4. 24 VAC control voltage.

2.4 SOURCE QUALITY CONTROL

A. Testing: Provide evidence of independent testing of energy transfer elements by certification facility, establishing flame spread rating of 18 and smoke generation rating of 22. Meet NFPA 94-A and NFPA 94B requirements.

PART 3 - EXECUTION: Not Used

END OF SECTION

SECTION 23 8216

AIR COILS

PART 1 - GENERAL

1.1 SUMMARY

A. Products Furnished But Not Installed Under This Section:
   1. Outside air pre-heat coils.

B. Related Requirements:
   1. Section 23 0501: Common HVAC Requirements.
   2. Section 23 3114: Low-Pressure Metal Ducts and installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Category Four Approved Manufacturers And Suppliers. See Section 01 6200 for definitions of Categories.
   1. Carrier: U S Air Conditioning Distributors, attention Saad Khoury (801) 463-5306.
   2. Temtrol: Mechanical Products Utah Inc, attention Jeff Thomsen (801) 352-9003.
   3. Trane: Salt Lake Trane, attention Trent Hunt (801) 486-0500.
   4. USA Coil & Air Inc, Malvern, PA www.usacoil.com.

2.2 MANUFACTURED UNITS

A. Air Coils:
   1. Single or double row type suitable for hot water with same end connections.
   2. 1/2 inch diameter copper tubes with 0,024 inch minimum wall thickness
   3. 16 ga 1.59 mm galvanized steel casing and secondary drain pan installed underneath coil. Drain pan shall be properly reinforced to prevent collapse due to water held in pan. 2 inches 50 mm deep minimum with 3/4 inch 19 mm drain.

PART 3 - EXECUTION: Not Used

END OF SECTION

SECTION 23 8333

ELECTRIC RADIANT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install wall heaters as described in Contract Documents.

B. Related Requirements:
   1. Section 23 0501: Common HVAC Requirements.
   2. Division 26: Electrical service and connections.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Units shall be UL listed and comply with NEC.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers:
   1. Category Four Approved Manufacturers. See Section 01 6200 for definitions of Categories.
      a. Berko, Marley Electric Co, Bennettsville. SC www.berkomeh.com.
      b. QMark, Marley Electric Co, Bennettsville, SC www.qmarkmeh.com.
      c. Raywall, Johnson, TN www.raywall.com.

B. Wall Heaters.
   1. Fan type for recess mounting in wall.
   2. 20 ga minimum sheet metal casing.
   3. Heating element shall be encased in steel finned casting and protected by thermal switch.
   4. Fan motor shall be heavy duty enclosed and permanently lubricated.
   5. Fan shall be precision balanced and fan-motor assembly mounted to be vibration free.
   6. Units shall be controlled automatically by integral thermostat when heater is in 'ON' position.
   7. Heater shall have built-in fan delay.
   8. Finish: Baked-on enamel.
   9. Design Standard: AWH-4000 by Q-Mark.

PART 3 - EXECUTION: Not Used

END OF SECTION