DIVISION 23: HEATING, VENTILATING, AND AIR-CONDITIONING

23 0500 COMMON WORK RESULTS FOR HVAC

23 2000 HVAC PIPING AND PUMPS

23 8000 DECENTRALIZED HVAC EQUIPMENT

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. Furnish and install sealants relating to installation of systems installed under this Division.
   4. Furnish and install Firestop Penetration Systems for HVAC system penetrations as described in Contract Documents.

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 3111: 'Cast-In-Place Structural Concrete' for exterior concrete pads and bases for mechanical equipment.
   2. Section 05 0523: 'Metal Fastening' for quality and requirements for welding.
   3. Section 07 8400: 'Firestopping' for quality of Penetration Firestop Systems to be used on Project and submittal requirements.
   4. Section 07 9213: 'Elastometric Joint Sealant' for quality of sealants used at building exterior.
   5. Section 07 9219: 'Acoustical Joint Sealants' for quality of acoustical sealants.
   6. Sections Under 09 9000 Heading: Painting of mechanical items requiring field painting.
   7. Division 26: Raceway and conduit, unless specified otherwise, line voltage wiring, outlets, and disconnect switches.
   8. 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.
         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. Include following in Operations And Maintenance Manual specified in Section 01 7800:
      a. Operations and Maintenance Data (Modify and add to requirements of Section 01 7800):
         1) At beginning of HVAC section of Operations And Maintenance Manual, provide master index showing items included.
            a) Provide name, address, and phone number of Architect, Architect's Mechanical Engineer, General Contractor, and HVAC, Sheet Metal, Refrigeration, and Temperature Control subcontractors.
            b) Identify maintenance instructions by using same equipment identification used in Contract Drawings. Maintenance instructions shall include:
               (1) 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.
               (2) 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.
               (3) Summary list of mechanical equipment requiring lubrication showing name of equipment, location, and type and frequency of lubrication.
               (4) Manual for Honeywell T7350 thermostat published by Honeywell.
            c) Provide operating instructions to include:
               (1) General description of each HVAC system.
               (2) Step by step procedure to follow in putting each piece of HVAC equipment into operation.
               (3) Provide diagrams for electrical control system showing wiring of items such as smoke detectors, fuses, interlocks, electrical switches, and relays.
      b. Warranty Documentation:
         1) Include copies of warranties required in individual Sections of Division 23.
      c. Record Documentation:
         1) Manufacturers documentation:
            a) Copies of approved shop drawings.

1.3 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:
   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.
   3. Identification:
      a. 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.

B. Qualifications: Requirements of Section 01 4301 applies, but not limited to following:
   1. Company:
      a. Company specializing in performing work of this section.
         1) Minimum five (5) years experience in HVAC installations.
         2) Minimum five (5) satisfactorily completed installations in past three (3) years of projects similar in size, scope, and complexity required for this project before bidding.
      b. Upon request, submit documentation.
   2. Installer:
      a. Licensed for area of Project.
      b. Designate one (1) individual as project foremen who shall be on site at all times during installation and experienced with installation procedures required for this project.
      c. Upon request, submit documentation.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery And Acceptance Requirements:
   1. Accept valves on site in shipping containers with labeling in place.

B. Storage And Handling Requirements:
   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.
   2. Protect bearings during installation. Thoroughly grease steel shafts to prevent corrosion.

1.5 WARRANTY

A. Manufacturer Warranty:
   1. 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.

B. Special Warranty:
   1. Guarantee HVAC systems to be free from noise in operation that may develop from failure to construct system in accordance with Contract Documents.
   2. If HVAC sub-contractor with offices located more than 150 miles (240 km) 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. Pipe And Pipe Fittings:
   1. Use domestic made pipe and pipe fittings on Project.
   2. Weld-O-Let and Screw-O-Let fittings are acceptable.

C. Sleeves:
   1. In Framing: Standard weight galvanized iron pipe, Schedule 40 PVC, or 14 ga (2 mm) 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.

D. Valves:
   1. Valves of same type shall be of same manufacturer.

PART 3 - EXECUTION

3.1 INSTALLERS

A. Acceptable Installers:

1. Meet Quality Assurance Installer Qualifications as specified in Part 1 of this specification.

3.2 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.

3.3 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.

3.4 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 (9 meters) of straight run.
      2) Provide 12 inch (300 mm) 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 (6 mm) 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.

3.5 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.

3.6 FIELD QUALITY CONTROL

A. Field Tests:
1. Perform tests on HVAC piping systems. Furnish devices required for testing purposes.

B. Non-Conforming Work:
1. Replace material or workmanship proven defective with sound material at no additional cost to Owner.
2. Repeat tests on new material, if requested.

3.7 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.

3.8 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.

3.9 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 (8) hours.
         2) Temperature Control: Six (6) hours.
         3) Refrigeration: Four (4) 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.

3.10 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: 'Metal Fastening' for quality and requirements for welding.
   2. Section 07 8400: 'Firestopping' for quality of Penetration Firestop Systems to be used on Project and submittal requirements.
   3. 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	Rod Diameter	Pipe Size
3/8 inch	2 inches and smaller	10 mm	50 mm and smaller
1/2 inch	2-1/2 to 3-1/2 inches	13 mm	63 mm to 88 mm
5/8 inch	4 to 5 inches	16 mm	100 mm to 125 mm
3/4 inch	6 inches	19 mm	150 mm
7/8 inch	8 to 12 inches	22 mm	200 mm to 300 mm

      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

Rods		Number of Pipes per Hanger for Each Pipe Size						
No.	Diameter	50mm	63mm	75mm	100mm	125mm	150mm	200mm
2	10 mm	Two	0	0	0	0	0	0
2	13 mm	Three	Three	Two	0	0	0	0
2	16 mm	Six	Four	Three	Two	0	0	0
2	19 mm	Nine	Seven	Five	Three	Two	Two	0
2	22 mm	Twelve	Nine	Seven	Five	Three	Two	Two

1) Size trapeze angles so bending stress is less than 10,000 psi (69 Mpa).

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.

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 (2 400) mm on center maximum for pipe 1-1/4 inches (32 mm) or larger and 72 inches (1 800 mm) on center maximum for pipe 1-1/8 inch (28 mm) or less.
      2) Support thermoplastic pipe at 48 inches (1 200 mm) 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 (9 meters) of straight run.
      2) Provide 12 inch (300 mm) 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. Products Furnished But not Installed Under This Section:
   1. Identification of HVAC piping and equipment as described in Contract Documents including:

B. Related Requirements:
   1. Section 22 0529: 'Hangers And Supports For Plumbing' for field installation of pipe stencils and band colors for identification for piping used with HVAC equipment.

PART 2 - PRODUCTS

2.1 SYSTEMS

1. Labels:
   a. Equipment Identification:
      1) Black formica, with white reveal when engraved.
      2) Lettering to be 3/16 inch (5 mm) high minimum.

PART 3 - EXECUTION

3.1 APPLICATION

A. Labels:
   1. Identify following items with specified labels fastened to equipment with screws (unless noted otherwise):
      a. Condensing units.

B. Painting:
   1. New Surfaces:
      a. Remove rust spots by sanding and immediately spot prime. If all traces of rust cannot be removed, apply rust blocker recommended by Paint Manufacturer before applying full primer coat.
   2. Leave equipment in like-new appearance.

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.

B. Related Requirements:
   1. Section 23 0501: 'General HVAC Requirements'.
   2. Section 23 2300: 'Refrigerant Piping'.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Storage And Handling Requirements:
   1. Keep materials and work dry and free from damage.
   2. Replace wet or damaged materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 ASSEMBLIES

A. Manufacturers:
   1. Manufacturer Contact 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 or Owens-Corning Canada Inc, Willowdale, ON (416) 733-1600.
      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

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. Thickness:

Pipe Size, Outside Diameter	Insulation Thickness
25 mm and smaller	13 mm
29 to 50 mm	19 mm

1) 25 mm 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.

c. 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.

d. 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.

e. 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. Non-Conforming Work:
   1. 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 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'.
   3. Section 23 8126: 'Split System Air Conditioners'.

1.2 REFERENCES

A. Association Publications:
   1. Federal Emergency Management Agency (FEMA) / Vibration Isolation and Seismic Control Manufacturers Association (VISCMA) / American Society of Civil Engineers (ASCE):
      a. FEMA 412, 'Installing Seismic Restraints For Mechanical Equipment' (December 2002).
   2. Vibration Isolation and Seismic Control Manufacturers Association (VISCMA):
      a. VISCMA 101-15, 'Seismic Restraint Specification Guidelines for Mechanical, Electrical, and Plumbing Systems'.
      b. VISCMA 102-12, 'Vibration Isolation Specification Guidelines for Mechanical, Electrical, and Plumbing Systems'.

B. Definitions:
   1. Refrigerant: Absorbs heat by a change of state (evaporation) from liquid to a gas, and releases heat by a change of state (condenses) from gas back to a liquid.
   2. Vibration Isolation: Vibration reduction in which an isolation system is placed between the source of unwanted vibration and an item which needs to be shielded from the vibration.

C. Reference Standards:
   1. American National Standards Institute (ANSI) / American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. ANSI/ASHRAE 15-2016 and 34-2016, 'Safety Standard and Designation and Classification of Refrigerants'.
   2. American National Standards Institute / American Welding Society:
      a. ANSI/AWS A5.8M/A5.8-2011, 'Specification for Filler Metals for Brazing and Braze Welding'.
   3. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. 2011 ASHRAE Handbook - HVAC Applications.
         1) Chapter 48, 'Noise and Vibration Control'.
   4. ASTM International:
      a. ASTM A36/A36M-14, 'Standard Specification for Carbon Structural Steel'.
      b. ASTM B280-18, 'Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service'.
   5. Canadian Standards Association:
      a. CSA B52-18, 'Mechanical Refrigeration Code'.
   6. National Fire Protection Association / American National Standards Institute:
      a. NFPA 90A: 'Installation of Air-Conditioning and Ventilating Systems' (2018 or most recent edition adopted by AHJ).
   7. Underwriters Laboratories:

a. UL 2182, 'Refrigerants' (April 2006).

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 HFC and HCFC refrigerants.

1.4 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:
1. Refrigerants:
a. Underwriters Laboratories / Underwriters Laboratories of Canada:
1) Comply with requirements of UL 2182.

B. Qualifications. Section 01 4301 applies, but is not limited to the following:
1. Installer: Refrigerant piping shall be installed by refrigeration contractor licensed by State and by technicians certified in use of HFC and HCFC refrigerants.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Manufacturers:
1. Manufacturer Contact List:
a. Airtec, Fall River, MA, www.noventcaps.com.
b. Cooper Industries, Houston, TX www.cooperindustries.com.
c. Cush-A-Clamp by ZSI Manufacturing, Canton, MI www.cushaclamp.com.
d. Elkhart Products Corp, Elkhart, IN www.elkhartproducts.com.
e. Emerson Climate Technologies, St Louis, MO www.emersonflowcontrols.com.
f. Handy & Harman Products Division, Fairfield, CT www.handy-1.com.
g. Harris Products Group, Cincinnati, OH www.harrisproductsgroup.com.
h. Henry Valve Co, Melrose Park, IL www.henrytech.com.
i. Hilti Inc, Tulsa, OK www.hilti.com.
j. Hydra-Zorb Co, Auburn Hills, MI www.hydra-zorb.com.
k. JB Industries, Aurora, IL www.jbind.com.
l. Mason Industries, inc, www.Mason-ind.com
m. Mueller Steam Specialty, St Pauls, NC www.muellersteam.com.
n. Nibco Inc, Elkhart, IN www.nibco.com.
o. Packless Industries, Waco, TX www.packless.com.
p. Parker Corp, Cleveland, OH www.parker.com.
q. Sporlan Valve Co, Washington, MO www.sporlan.com. (also ZoomLock)
r. Sherwood Valves, Washington, PA www.sherwoodvalve.com.
s. Thomas & Betts, Memphis, TN www.superstrut.com.
t. Unistrut, Div of Atkore International, Inc., Harvey, IL www.unistrut.com.
u. Universal Metal Hose, Chicago, IL www.universalmetalhose.com.
v. Vibration Mountings & Controls, Bloomingdale, NJ www.vmc-kdc.com.
w. Virginia KMP Corp, Dallas, TX www.virginiakmp.com.

B. Materials:
1. Refrigerant Piping:
a. Meet requirements of ASTM B280, 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.
      4) Sporlan - ZoomLock [Flame-Free Refrigerant Fittings]
3. Tee Access:
   a. Brass:
      1) Category Four Approved Manufacturers. See Section 01 6200 for definitions of Categories:
         a) JB Industries: Part #A3 Series with Factory Cap and Valve Core.
4. Connection Material:
   a. Sporlan - ZoomLock Flame-Free Refrigerant Fittings with factory approved tools
   b. Brazing Rods in accordance with ANSI/AWS A5.8M/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.
   c. 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. 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 (19 mm) outside diameter and larger, filter-drier shall be replaceable core type with Schrader type valve.
   b. On lines smaller than 3/4 inch (19 mm) outside diameter, filter-drier shall be sealed type with brazed end connections.
   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. Refrigerant Piping Supports:
    a. Base, Angles, And Uprights: Steel meeting requirements of ASTM A36.
    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.
9. Locking Refrigerant Cap:
    a. Provide and install on charging valves:
        1) Class One Quality Standard: 'No Vent' locking refrigerant cap.
        2) Acceptable Manufacturers: Airtec.
        3) Equal as approved by Architect before installation. See Section 01 6200.

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 (25 mm in 3 meters).

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.

D. Refrigerant Supports:
1. Support Spacing:
    a. Piping 1-1/4 inch (32 mm) And Larger: 8 feet (2.450 m) on center maximum.
    b. Piping 1-1/8 inch (28.5 mm) And Smaller: 6 feet (1.80 m) 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 (21 deg C) 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.

B. Non-Conforming Work:
1. 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 2350

REFRIGERANT PIPE COVER

PART 1 - GENERAL

1.1 SUMMARY

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0501 apply to this Section.

PART 2 - PRODUCTS

2.1 BASIC COVER

A. Basic refrigerant line cover shall be 18 gauge steel, hot-dipped galvanized steel meeting the requirements of ASTM<A361-85.

B. Pop rivit attachments will not be allowed.

C. All fastening devices shall be plated screws. Arrange covers so they may be taken apart for service.

2.2 MANUFACTURED OUTER COVER

A. Refrigerant line covers at exterior walls shall be 24 ga steel, hot-dipped galvanized meeting requirements of ASTM<A361-85, "Specification for Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process for Roofing and Siding", 1.25 oz/sq ft and complete with accessories recommended by Manufacturer for proper installation.
   1. Approved Manufacturers –
      a. AEP / Span, Dallas, TX or San Diego, CA
      b. Idose Aluminum Products, Allentown, PA
      c. Berridge Manufacturing Co., Houston, TX
      d. Copper Sales Inc., Minneapolis, MN
      e. Engineered Components Inc., Stafford (Houston), TX
      f. Fashion Inc., Lenaxa, KS
      g. Alumax Building Specialties, Mesquite, TX
      h. MM Systems Corp., Tucker, GA
      i. Merchant & Evans Industries Inc., Burlington, NJ
      j. Reynolds Metals Company, Richmond VA

B. Finish:
   1. Fluoropolymer Resin-base finish for coil coating components. Thermo cured two coat system consisting of primer and top coat factory applied over properly pretreated metal.
   2. Color as selected by Engineer from Manufacturer's standard colors.
   3. Approved Manufacturers –
      a. Equal to Duranar 200 by PPG or Fluropon by Desoto containing 70% minimum Kynar 500 by Pennwalt Corp.

PART 3 - INSTALLATION

A. Do not use pop rivets. All fastening devices shall be plated screws and arranged so covers may be taken off for service.

B. Provide access opening for viewing the sight glass on the refrigerant line.

END OF SECTION

SECTION 23 2600

CONDENSATE DRAIN PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Coordinate installation of condensate drain piping with Section 22 0501 as described in Contract Documents.

B. Related Requirements:
   1. Section 22 0501: 'Common Plumbing Requirements'.
   2. Section 23 0501: 'Common HVAC Requirements'.

1.2 REFERENCES

A. Reference Standards:
   1. ASTM International:

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.
   2. Solvent Cement and Adhesive Primer:
      a. Use PVC solvent cement that has a VOC content of 510 g/L or less if required by local AHJ if required.
      b. Use adhesive primer that has a VOC content of 550 g/L or less if required by local AHJ if required.

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 8126

SPLIT SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

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

B. Related Requirements:
   1. Section 03 3053: Concrete pads.
   2. Section 23 0501: General Mechanical Requirements.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:
   1. Each unit shall be UL / ULC or ETL labeled.

1.4 WARRANTY

A. Special Warranty:
   1. Provide five-year warranty on compressors beginning from date of start-up.
   2. Record start-up date on warranty certificate for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer Contact List:
   1. Friedrich Air Conditioning Co, Austin, TX www.friedrich.com.
   2. Mitsubishi Electric & Electronics USA Inc, Suwanee, GA www.mrslim.com.
   3. Sanyo Air Conditioning Products, San Diego, CA www.us.sanyo.com.

2.2 MANUFACTURED UNITS

A. Heat Pumps:
   1. Indoor Units:
      a. Compact wall mounted units.
      b. Supplementary electric heater, size as scheduled.
      c. Cabinet finish as selected by Architect.
      d. Isolate moving parts from cabinets to reduce noise.
   2. Outdoor Units:

a. Compressor shall be of rotary or scroll design.
b. Fans shall be direct driven and discharge horizontally.
c. Casing shall be fully weatherproof for outdoor installations.
d. Microprocessor Controls shall be factory wired with field installed remote pendant station.
e. Refrigerant shall be R-410a.
f. Isolate moving parts from cabinets to reduce noise.
g. Use dry-charged tubing for connection of unit's refrigerant system.

3. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
   a. Model MW by Friedrich Air Conditioning Co.
   b. Mr. Slim Model PKAA (indoor unit) and PUZA (outdoor unit) by Mitsubishi Electric & Electronics USA.
   c. Model KHS by Sanyo Air Conditioning Products.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

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

END OF SECTION

END OF DIVISION 23