

DIVISION 23: HEATING, VENTILATING, AND AIR-CONDITIONING

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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: 'Miscellaneous Cast-In-Place 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. Section 26 2913: 'Enclosed Controllers' for 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. Informational Submittals:
- 1. Qualification Statement:
 - a. HVAC Firm:
 - 1) Provide Qualification documentation if requested by Architect or Owner.
 - b. Installer:
 - 1) Provide Qualification documentation if requested by Architect or Owner.
- C. 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. See Section 01 4301:

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 alignments, tightenings, and adjustments 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 Facility Manager 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.
 - 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. 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	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 0548

VIBRATION AND SEISMIC CONTROL FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Includes But Not Limited To:
 - 1. Quality of and requirements for anchorage and seismic restraint systems and vibration isolation systems for HVAC piping and equipment.
- B. Related Requirements:
 - 1. Section 03 3053: 'Miscellaneous Exterior Cast-In-Place Concrete'.
 - 2. Furnishing and installing of seismic restraint and vibration isolation systems is by installer of equipment requiring such systems. Manufacturers of equipment specified for seismic restraint shall provide product data needed for calculation of seismic restraint needs. This information shall include, but not be limited to, equipment dimensions, dimensioned anchor points, operating weight, and center of gravity dimension.

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 101-12, '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. 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 / Sheet Metal And Air Conditioning Contractors' National Association:
 - a. ANSI/SMACNA 001-2008, 'Seismic Restraint Manual: Guidelines For Mechanical Systems' (3rd Edition).
 - 2. American Society of Civil Engineers / Structural Engineering Institute:
 - a. ASCE/SEI 7-10, 'Minimum Design Loads for Buildings and Other Structures'.
 - 1) Chapter 13, 'Seismic Design Requirements For Nonstructural Components'.
 - 3. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. 2011 ASHRAE Handbook - HVAC Applications.
 - 1) Chapter 48, 'Noise and Vibration Control'.
 - 2) Chapter 55, 'Seismic- and Wind-Resistant Design'.
 - 4. ASTM International:
 - a. ASTM A615/A615M-12, 'Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement'.

1.3 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data:
 - a. Restraint system and anchorage method to be used for each piece of equipment.
 - b. Seismic restraints and calculations for all flexible mounted equipment.
 - c. Vibration isolators and flexible couplings.
 - d. Clearly outlined procedures for installing and adjusting isolators, seismic bracing anchors, and snubbers.
 - 2. Shop Drawings:
 - a. Show size, hanger length, and location of seismic restraints for piping and ductwork.
 - b. Show details for each isolator and seismic brace with snubbers proposed for specified equipment.
 - c. Show details for proposed structural steel frames and rails and for anchors to be used in conjunction with isolation of equipment.
 - d. Show locations of piping and ductwork restraints on installation and fabrication floor plans (not bid set of documents of floor plans), noting size and type of restraint to be used.
 - e. Show details of supports, hangers, anchorage, and bracing for isolated equipment as designed or proposed by professional engineer employed by Restraint Manufacturer and qualified with seismic experience in bracing for mechanical equipment. Shop drawings submitted for seismic bracing and anchors shall bear engineer's signed professional seal.
 - f. Include anchor bolt calculations, signed and stamped by registered engineer, showing adequacy of bolt sizing and type.
 - 1) Calculations shall include anchor embedment, minimum edge distance and minimum center distance.
 - 2) Design lateral forces shall be distributed in proportion to mass distribution of equipment.
 - 3) Furnish calculations for anchors on restraint devices, cable, isolators, and on rigidly mounted equipment.

1.4 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. System design and installation shall meet seismic requirements as defined in ASCE/SEI 7-10, 'Minimum Design Loads for Buildings and Other Structures' and applicable state and local codes in accordance with minimum restraint capability of 1.0 g.

PART 2 - PRODUCTS

2.1 ASSEMBLIES

- A. Manufacturers:
 - 1. Type One Acceptable Manufacturers:
 - a. Amber / Booth Company, Houston, TX www.amberbooth.com.
 - b. Mason Industries Inc, Hauppauge, NY www.mason-ind.com.
 - c. Vibration Mountings and Control Inc, Bloomington, NJ (201) 838-1780.
 - d. Equal as approved by Architect before bidding. See Section 01 6200.
- B. Performance:
 - 1. Design Criteria:
 - a. Isolation And Seismic Equipment:
 - 1) Piping: Restrain piping in accordance with ANSI/SMACNA 001 Seismic Restraint Manual, Chapter 4, Figures 4.11 to 4.19.
 - 2) Equipment with Fixed Anchor or Support:
 - a) Restraint designed according to ASCE/SEI 7-10, Chapter 13, 'Seismic Design Requirements For Nonstructural Components'.
 - b) Horizontal force factor for elements of structures:

- (1) In addition, vertical force restraint requirement shall be computed at 1/2 value of horizontal forces.
 - (2) Restrain equipment not anchored directly to floors by cable system designed and furnished by Restraint Manufacturer.
 - 3) Ductwork: Restrain ductwork in accordance with ANSI/SMACNA 001 Seismic Restraint Manual, Chapter 4, Figures 4.2 to 4.10 as appropriate.
- b. Vibration Isolation Requirements:
- 1) Isolate equipment from structure by means of resilient vibration and noise isolators.
 - 2) Unless otherwise noted, isolate HVAC equipment one horsepower and over from structure by means of resilient vibration and noise isolators in accordance with ASHRAE 'Handbook - HVAC Applications', Chapter 48, Table 1, 'Design Guidelines for HVAC-Related Background Sound in Rooms'.
 - 3) Design and install isolation equipment, hangers, connections, and other isolating devices to prevent transmission of vibration to structure from equipment and associated piping and ductwork.
 - 4) For floor-mounted equipment, use recommendations with ASHRAE 'Handbook - HVAC Applications', Chapter 48, Table 1, 'Design Guidelines for HVAC-Related Background Sound in Rooms'.
 - 5) For roofs and floors constructed with open web joints, thin long span slabs, wooden construction and unusual light weight construction, evaluate equipment weighing more than 300 pounds to determine additional deflection of structure caused by equipment weight. Isolator deflection shall be 15 times additional deflection or deflection shown in ASHRAE 'Handbook - HVAC Applications', Chapter 48, Table 1, 'Design Guidelines for HVAC-Related Background Sound in Rooms', whichever is greater.
 - 6) Under-Equipment Spring Isolators:
 - a) Equal to Mason SSLFH earthquake motion restrained spring mounts with freestanding stable steel springs, leveling bolts, corrosion resistant finish, motion limiting design, uplift restraining bolts, and 1/4 inch (6 mm) ribbed neoprene noise stop pad.
 - b) Isolators shall accept force in any direction up to 1.0 g without failure, and shall limit movement to 3/4 inch (19 mm) in any direction.
 - c) Springs shall have 50 percent overload capacity.
 - d) Size as required to achieve specified static deflection.
 - e) Outer diameter of spring proper shall not be less than 0.8 of spring height when in loaded position.
 - 7) Overhead Support Spring And Rubber Hangers:
 - a) Combination spring and neoprene hangers.
 - b) Hanger bracket shall have 500 percent overload capability and shall allow up to 15 degree hanger rod misalignment without short-circuiting.
 - c) Springs shall have 50 percent overload capacity.
 - d) Provide seismic bracing as required.
 - 8) Isolate piping and ductwork in mechanical equipment room and piping and ductwork three supports away or 50 feet (15 meters) from other mechanical equipment, whichever is greater, from structure by means of vibration and noise isolators.
 - a) Isolate suspended piping with combination spring and fiberglass hangers in supporting rods.
 - b) Support floor-mounted piping directly on spring mounts.
 - 9) Isolate vertical pipe risers from structure using vibration and noise isolating expansion hangers having minimum rated deflection of four times anticipated pipe movement. Enclose in housing for fail-safe equipment.
 - 10) Incorporate flexible connectors in piping adjacent to reciprocating equipment.
 - 11) Incorporate flexible connections in ductwork adjacent to air-moving units.
 - 12) Elastomeric Isolator: Neoprene or high quality synthetic rubber with anti-ozon and anti-oxidant additives.
 - 13) Nuts, Bolts, And Washers: Electroplated zinc.
 - 14) Isolators Exposed To Weather: Cadmium plated and neoprene coated springs.
- c. Seismic Requirements:
- 1) Mechanical equipment, piping, and ductwork shall be braced, snubbed, or supported to withstand seismic disturbances and remain operational.

- 2) Seismic restraint equipment and resilient isolation devices shall be designed and furnished by single Manufacturer:

C. Finishes:

1. Clean and paint steel components. Thoroughly clean structural steel bases of welding slag and prime with zinc-chromate or metal etching primer. Etch and paint hot dipped galvanized steel components.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Isolation Equipment:

1. Mount vibration isolated equipment on rigid steel frames or concrete bases unless Equipment Manufacturer certifies direct attachment capability.
2. Install snubbers with factory set clearances.
3. Piping:
 - a. Protect isolated and non-isolated piping 2-1/2 inches (64 mm) inside diameter and larger in all planes by restraints to accommodate thermal movement as well as restrain seismic motions.
 - b. Locations shall be as scheduled and include, but not be limited to:
 - 1) At drops to equipment and at flexible connections.
 - 2) At 45 degree or greater changes in direction of pipe.
 - 3) At horizontal runs of pipe 30 feet (9.15 m) maximum on center spacing.
 - 4) Gas piping shall have additional restraints as scheduled.

4. Ductwork:

- a. Protect isolated and non-isolated rectangular ductwork 4 feet square (0.372 sq m) in cross-sectional area and larger in all planes by restraints to accommodate thermal movement as well as restrain seismic motion.
- b. Locations shall be determined by Seismic Restraint Manufacturer and include, but not be limited to:
 - 1) Horizontal runs of ductwork 30 feet (9.15 m) maximum on center spacing.
 - 2) 45 degree or greater changes in direction of ductwork.
 - 3) Each end of duct runs and drops of equipment.
 - 4) Each flexible connection.

- B. Vibration Isolation: Install piping and ductwork to prevent transmission of noise and vibration into structure.

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.
- B. Products Furnished But not Installed Under This Section:
 - 1. Paint identification for gas piping used in HVAC equipment.
- C. Related Requirements:
 - 1. Section 22 0529: 'Hangers And Supports For Plumbing' for installation of paint identification for gas piping used with HVAC equipment.

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 color banding as follows. Extend color band 2 inches (50 mm) minimum beyond each side of stenciled symbols.

Pipe Type	Band Color	Symbol
Relief Vent	Carlsbad Canyon	RV
 - b. Apply continuous painting as follows:
 - 1) Mechanical Mezzanine And Exposed on Roof:

Pipe Type	Pipe Color
Gas	Yellow
- B. Materials:
 - 1. Paint:
 - a. Paints specified are from Pittsburgh Paint & Glass (PPG), Pittsburgh, PA www.ppgaf.com or PPG Canada Inc, Mississauga, ON (800) 263-4350 or (905) 238-6441.
 - 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.
 - 2) Maintain specified colors, shades, and contrasts.
 - 2. Labels:
 - a. Equipment Identification:
 - 1) Black formica, with white reveal when engraved.
 - 2) Lettering to be 3/16 inch (5 mm) high minimum.
 - 3. Pipe Markers:
 - a. Rigid vinyl or polyester, 360 degree wrap around pipe markers.

- b. Surface printed with UV ink and then thermoformed. Legend to include pipe contents and directional arrows.
- c. Provide pipe markers for natural gas piping.
- 4. Tags:
 - a. Regardless of size, each valve shall have brass tag 1-1/2 inches (38 mm) by 3 inch (76 mm) minimum in size and 0.051 inch (1.30 mm) thick.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Labels:
 - 1. Identify following items with specified labels fastened to equipment with screws (unless noted otherwise):
 - a. Thermostats and control panels in mechanical spaces (attach label to wall directly above or below thermostats).
 - b. Thermostats and control panels in mechanical spaces.
 - c. Rooftop Units.
 - d. Unit 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. Pipe Markers:
 - 1. Wrap pipe marker around pipe with 1/2 inch (12.7 mm) minimum overlap. Use adhesive strip at overlap to adhere ends of marker together.
 - 2. Locate markers as follows:
 - a. Adjacent to each item of equipment.
 - b. At points of entry and exit where piping goes through wall.
 - c. On each riser and junction.
 - d. Every 25 feet (7.620 m) maximum on long, continuous runs.
- C. 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 (7.620 m) on long continuous lines.
 - e. Stenciled symbols shall be one inch (25 mm) 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 3114: 'Low-Pressure Metal Ducts'.
 - 2. Section 23 3300: 'Acoustic Duct Accessories' for duct liner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer Contact 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 or Toronto, ON (416) 593-4322.
 - 4. Manson Insulation Inc, Brossard, QB www.isolationmanson.com.
 - 5. Owens-Corning, Toledo, OH or Owens-Corning Canada Inc, Willowdale, ON www.owenscorning.com.

2.2 MATERIALS

- A. Thermal Wrap Duct Insulation:
 - 1. 1-1/2 inch (38 mm) or 3 inch (76 mm) thick fiberglass with factory-laminated, reinforced aluminum foil scrim kraft facing and density of 0.75 lb / per cu ft (12 kg / per cu m).
 - 2. Thermal Conductivity: 0.27 BTU in/HR SF deg F at 75 deg F (24 deg C) maximum.
 - 3. Type One Acceptable Products:
 - a. Type 75 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. Within Building Insulation Envelope:
 - 1) 1-1/2 inches (38 mm) thick on rectangular outside air ducts and combustion air ducts.
 - 2) 1-1/2 inches (38 mm) thick on all round ducts.

- b. Outside Building Insulation Envelope:
 - 1) 3 inch (76 mm) thick on round supply and return air ducts.
 - 2) 1-1/2 inch (38 mm) thick on rectangular, acoustically lined, supply and return air ducts.
 - 2. Wrap insulation tightly on ductwork with circumferential joints butted and longitudinal joints overlapped minimum 2 inches (50 mm).
 - a. Do not compress insulation except in areas of structural interference. Minimum thickness at corners shall be one inch (25 mm) thick.
 - b. Remove insulation from lap before stapling.
 - c. Staple seams at approximately 16 inches (400 mm) 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.

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 fully functional Building Automation System (BAS) as described in Contract Documents.
- B. Related Requirements:
 - 1. Section 23 0501: Common HVAC Requirements.
 - 2. Section 26 0924: 'Lighting Control System'.

1.2 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data:
 - a. Installer to provide product literature or cut sheets for all products specified in Project.
 - b. Installer to provide questions of control equipment locations to Mechanical Engineer prior to installation.
- B. Informational Submittals:
 - 1. Certificates:
 - a. Installer must provide 'Certificate of Sponsorship' signed from Approved Distributor with bid confirming Installer sponsorship.
- C. Closeout Submittals:
 - 1. Include following in Operations And Maintenance Manual specified in Section 01 7800:
 - a. Operations and Maintenance Data:
 - 1) Maintenance Manual.
 - b. Record Documentation:
 - 1) Manufacturers documentation:
 - a) Provide two (2) digital copies and two (2) printed hard copies of complete automation system including device wiring.
 - b) Provide two (2) electronic copies of system database.
 - 2) Installer's 'Certificate of Sponsorship'.

1.3 QUALITY ASSURANCE

- A. Qualifications: Requirements of Section 01 4301 applies, but is not limited to the following:
 - 1. Installer:
 - a. Before bidding, obtain sponsorship from a local, Approved Distributor specified under PART 2 PRODUCTS of this specification. Initial requirements for sponsorship are:
 - 1) Be one of following Honeywell supported partners:
 - a) Honeywell Authorized Control Integrator (ACI).
 - b) Honeywell Building Controls Specialist (ACS).
 - c) Honeywell Building Controls Associate (BCS).
 - 2) Receive product training from Approved Distributor.
 - 3) Exhibit WEB's system skills to sponsoring Approved Distributor.

- 4) Installer to provide Distributor sponsorship by submitting 'Certificate of Sponsorship' as Informational Submittal with bid. Certificate available as Attachment in this Specification.

PART 2 - PRODUCTS

2.1 SYSTEM

- A. Manufacturers:
 1. Manufacturer Contact List:
 - a. Functional Devices, Brea, CA www.functionaldevices.com.
 - b. Honeywell Inc, Minneapolis, MN www.honeywell.com.
- B. Distributors: Obtain Relay Panels, Building Manager, Digital Controllers, Sub-Meters, CO₂ Sensor, Field Devices, and other control equipment from following Approved Distributors. See Section 01 4301:
 1. Idaho:
 - a. Wilson-Mohr, Inc: 801) 214-3313 Kathy.wright@wilsonmohr.com Kathy Wright.
 - b. Control Equipment Co: (800) 452-1457 rhowe@controlequiputah.com Ray Howe.
 - c. Control Solutions & Design: (208) 375-4422 pdl@csdidaho.com Paul Lachowsky.
 - d. RSD Total Control: (720) 648-2597 mjohnson@rsdtc.com Mark Johnson.
 2. Utah:
 - a. Wilson-Mohr, Inc: (801) 214-3313 Kathy.wright@wilsonmohr.com Kathy Wright.
 - b. Control Equipment Co: (800) 452-1457 rhowe@controlequiputah.com Ray Howe.
 - c. RSD Total Control: (720) 648-2597 mjohnson@rsdtc.com Mark Johnson.
- C. Design Criteria:
 1. Automatic Temperature Control System design concept utilizes Honeywell WEB's based Building Automation System (BAS) (Honeywell WEB's Building Manager). Locate Building Manager in conjunction Project Architect.
 - a. Building Automation System (BAS) shall provide the following:
 - 1) Monitor all digital control devices, including unitary controllers necessary for proper system analytics.
 - 2) Monitor all unitary controllers with Economizer control including but not limited to Free Cooling Run time, Damper positions.
 - 3) Main Meter feed Demand Limit Control with temperature bump schedule to be designed in conjunction with end-user.
 - 4) Lighting Panel; Building Automation System (BAS) shall be interfaced with Lighting Control Panel. Lighting schedules and operations shall be graphically displayed from Building Automation System (BAS).
 - 5) Monitor and track Lumen level in production area.
 - 6) Monitor and track Lumen level in retail area.
 - 7) Monitor and track input from exterior photo cell.
 - 8) Monitor and track OAT.
 - 9) Monitor and track CO₂ levels in specified areas.
 - 10) Monitor and track equipment run time with manual reset from computer screen for filter change reset.
 - 11) Monitor and track total building power usage.
 - b. Alarm notification sent to store manager when preset conditions are not met, indicating system malfunction.
 2. Unitary Equipment:
 - a. Provide and install PUL series unitary controllers and locate near equipment or appropriate Owner specified location.
 - b. Install unitary controller in panel/ box in accordance with electrical code.
 - c. Controllers shall be concealed in a screw type panel/equipment location.
 - d. Each PUL series unitary controller will have its associated electronic space sensor (TR70/TR21) and associated discharge air sensor.

- e. Equipment with economizer dampers Mixed Air sensors is required and Honeywell dampers with position feedback are required. Models accepted are Honeywell PUL6438S.
- f. PUL Unitary controllers shall:
 - 1) Monitor and display equipment operations.
 - 2) Current switches shall be installed on all stages of cooling for positive run validation.
 - 3) Building Manager shall be configured for space low limit space temperatures alarm at set point of 54 degrees F (12.2 deg C).
- 3. CO₂ Sensors:
 - a. Provide CO₂ sensors and installed as indicated on Contract Documents and interface with Demand Control Ventilation where economizer controls are specified.
 - 1) CO₂ sensor data from Zone 4 to be shared with Zones 1, 2, and 3.
- 4. Lighting Control Interface:
 - a. Provide Lonworks interface card/driver to interface Building Automation System (BAS) with lighting control. Lighting schedules and graphical display shall be provided via Building Automation System (BAS).
 - b. Tie in and monitor exterior photo-cell input as part of Building Automation System (BAS).
 - 1) Provide and install two (2) Lumen sensors located in following areas:
 - a) Production area.
 - b) Store area.
 - 2) Coordinate location and installation with Project Architect and associated trades.
- 5. Electrical Current Meter:
 - a. Provide and install current meter on main electrical feed.
 - b. Provide graphical display and trends from Building Automation System (BAS) including Demand Limit Control schedule.

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) WEB's Building Manager System.
 - b) Include all necessary power supplies, interface modules, embedded workbench tools, necessary for a completely operational system.
 - c) Unitary Controller: Part Number PUL6438S consisting of following:
 - (1) Unitary controller capable of fully controlling required unitary equipment, and field sensors.
 - (2) Push-Button Remote Room Sensor: Honeywell TR70 with programmed display according to user preference for DISPLAYED DATA, OVERRIDE, WARMER, and COOLER.
 - (3) Blank Sensors for existing area where display and override features are excluded. Honeywell TR21.
 - (4) Discharge Air Sensor, OAT, MAT: Honeywell C7041 series sensors.
 - b. System Sensor:
 - 1) Category Four Approved Products. See Section 01 6200 for definitions of Categories:
 - 2) Averaging Sensors:
 - a) Honeywell TR21, plain face, 20k ohms.
 - 3) Discharge Air Sensor and Mixed Air Sensor:
 - a) Honeywell C7041 B2005 (6 inch (152 mm) duct probe).
 - 4) Outdoor Air Sensor:
 - a) Honeywell C7041F2006.
 - 5) CO² Sensors:
 - a) Honeywell C7232A1016 Wall mounted / no display.
- 2. Building Manager:
 - a. Web-Based Building Manager.
 - b. Honeywell WEB's Building Manager.
 - c. Honeywell EWB-AX-EMB AX tool.
 - d. Honeywell NPB-LON Lon Card.
 - e. Honeywell NPM-256MB expanded memory.
 - f. Honeywell NPB-WPM-US power supply.
- 3. 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 MS series actuator. 24V or 120V, two position, floating or modulating with end switches and feedback where required by application.
4. Conductors:
- a. Communicating Cable:
 - 1) Category Four Approved Product. See Section 01 6200 for definitions of Categories:
 - a) Honeywell 32541101.
5. Current Switch (CT):
- a. Category Four Approved Product. See Section 01 6000 for definitions of Categories:
 - 1) Honeywell CSP-O-F10-001.
6. Current Meter – Sized for appropriate service amperage.
- a. Category Four Approved Product. See Section 01 6000 for definitions of Categories:
 - 1) Honeywell SXB35.
- E. Individual Zone Control:
- 1. Space Temperature:
 - a. Zone averaging:
 - 1) Place one sensor in each of two, three, or four spaces:
 - a) Distribute sensors in spaces for maximum comfort, taking into account exposure and room function.
 - b) Sensors shall control system by averaging temperature in spaces containing sensors.
 - c) Use 10k ohm element sensor when averaging remote sensors.
 - 2) Fifth dummy sensor, typically located in common space, is place-holder for OVERRIDE, WARMER, and COOLER buttons, and does not sense temperature.

2.2 OPERATION SEQUENCES

- A. Summary:
- 1. Coordinate control functions, such as scheduling and supervisory-level global control, points list, and control sequences needed for installation as listed below.
 - 2. Provide written documentation to archive system operation as accepted by Owner.
- B. Schedules:
- 1. Occupancy Schedule and Control:
 - a. Schedules will be programmed via WEB's Building Manager supervisory control. Coordinate with Owner occupied and unoccupied schedule times:
 - 1) Schedules will be adjustable via head end graphical user interface.
 - 2) Schedules will allow for seven (7) day programming with special events programming for holidays and other special events determined by Owner.
 - 3) Daily schedules will allow for at least four events per day.
 - 4) Remote wall module (where applicable) shall provide push button occupancy override to schedule.
 - a) Override time shall be one (1) hour (adjustable).
 - b) Wall module shall command DDC controller to occupied mode and system shall control to occupied set point.
- C. Set Points:
- 1. Occupied and Unoccupied Set Points:
 - a. Space temperature set points will be programmed via WEB's Building Manager supervisory control. Coordinate with Owner occupied and unoccupied set points.
 - b. Set points will be adjustable via head end graphical user interface.

- c. Some zones will have remote wall modules with set point capability. Maximum wall module set point deviation will be +/- 2 deg F (minus 16.7 deg C) (adjustable). Coordinate with owner which zones will allow for remote wall module set point deviation.
 - d. Unitary controllers shall provide automatic change over between heating and cooling operation.
- D. Package Roof Top Unit (RTU):
- 1. Space Temperature Control:
 - a. DDC Controller:
 - 1) Monitor space temperature and compare it to space temperature set point.
 - 2) If DDC controller is in occupied mode as determined by building schedule, controller shall use occupied cooling and heating set points.
 - 3) If DDC controller is in unoccupied mode as determined by building schedule, controller shall use unoccupied cooling and heating set points.
 - 4) When space temperature falls below heating set point, gas heating will be brought on to maintain set point. Heating will be staged if applicable.
 - 5) When space temperature rises above cooling set point, controller shall enable DX system to provide cooling to maintain space temperature. Cooling will be staged if applicable. DDC controller will supply cooling demand.
 - 6) If equipped with economizer the package roof top DDC controls will determine economizer operation.
 - 7) DDC controller will trend amount of time RTU is in "free cooling" operation.
 - 8) DDC controller shall report position of economizer damper via feedback or damper actuator end switch.
 - 2. Fan Control:
 - a. Occupied Mode:
 - 1) Supply fan shall run continuously when in occupied mode.
 - b. Unoccupied Mode:
 - 1) Supply fan shall run only when heating or cooling is needed.
 - 3. Safeties:
 - a. Unit shall operate subject internal safety controls, duct smoke detector, and fire alarm interlock (where applicable).
 - b. Upon detection of smoke by duct smoke detector or shutdown input by fire alarm system (where applicable), RTU shall shut down and close outside air dampers. RTU shall not resume normal operation until smoke alarm and/or fire alarm is reset.
- E. Evaporative Coolers And Unit Heaters:
- 1. Space Temperature Control:
 - a. DDC Controller:
 - 1) Monitor space temperature and compare it to space temperature set point.
 - 2) If DDC controller is in occupied mode as determined by building schedule, controller shall use occupied cooling and heating set points.
 - 3) If DDC controller is in unoccupied mode as determined by building schedule, controller shall use unoccupied cooling and heating set points.
 - 4) When space temperature falls below heating set point, gas fired unit heater will be brought on to maintain space temperature set point.
 - 5) When space temperature rises above cooling set point, controller shall enable evaporative cooler to maintain space temperature.
 - 2. Relief Damper Control:
 - a. Relief dampers shall open when respective evaporative cooler received call for cooling:
 - 1) Damper actuator end switch will be monitored by DDC controller to ensure relief damper opens before cooler fan starts.
 - 2) Relief damper actuators shall be spring return to allow damper to close in event of power outage.
- F. Main Building Sub-Meter:
- 1. Meter(s) for DLC, monitoring and trending purposes shall interface with Building Automation System (BAS).
 - 2. Trend histories and data collection will be coordinated with Owner.

- G. Building Manager:
 - 1. Building manager:
 - a. Building manager shall provide web access, alarming, trending to all unitary devices including but not limited to mechanical equipment, lighting controller, and main meter current switch (CT).
 - b. Building manager shall be fully commissioned at completion of project.
 - c. Building manager shall be configured with four (4) administrator level users, four (4) engineer level users, and up to twelve (12) tenant level users.
 - 2. System graphics:
 - a. System graphic of total building unitary controllers including positive feedback on mechanical compressors, lighting zones, damper positions, CO₂ levels, equipment run time, OAT, and light levels.
 - b. System shall show on page adjustable set points and schedules.

PART 3 - EXECUTION

3.1 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 line and 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 (300 mm) minimum distance from wires of other systems, except communication cable may cross other low-voltage wiring if done perpendicularly.
- C. Mount discharge air sensors a minimum of 6 feet (1.80 m) downstream of evaporator coils.

3.2 FIELD QUALITY CONTROL

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

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: 'Excavation' for procedure and quality of excavation.
 - 4. Section 31 2323: 'Fill' for procedure and quality of backfill and compaction.
 - 5. Section 33 5100: 'Natural-Gas Distribution' for gas line from meter to main.

1.2 REFERENCES

- A. Reference Standards:
 - 1. ASTM International:
 - a. ASTM A53/A53M-12, 'Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless'.
 - b. ASTM A234/A234M-11a, 'Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service'.
 - c. ASTM D2513-12ae1, 'Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings'.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Welders:
 - a. Welders shall be certified and bear evidence of certification thirty (30) days before commencing work on project.
 - b. 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. Pipe Installers:
 - a. Polyethylene pipe installers shall be properly trained and certified in procedure for joining polyethylene pipe.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Storage And Handling Requirements:
 - 1. Do not store polyethylene pipe so it is exposed to sunlight.

PART 2 - PRODUCTS

2.1 SYSTEM

A. Manufacturers:

1. Manufacturer Contact 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 or ConBraCo / Honeywell Ltd, Scarborough, ON (416) 293-8111.
 - d. Dormont Manufacturing Company, Export, PA www.dormont.com.
 - e. Jenkins-NH-Canada, Brantford, ON www.jenkins-nh-canada.com.
 - f. Jomar International, Madison Heights, MI www.jomar.com.
 - g. California Valves (formally KOSO) by Pacific Seismic Products Inc, Lancaster, CA, Distributed by Strand Earthquake Consultants www.strandearthquake.net.
 - h. Watts Regulator Co, North Andover, MA www.wattsreg.com or Watts Industries (Canada) Inc, Burlington, ON (888) 208-8927.

B. Materials:

1. Above-Ground Pipe And Fittings:
 - a. Black carbon steel, butt welded, Schedule 40 pipe meeting requirements of A53/A53M.
 - b. Welded forged steel fittings meeting requirements of ASTM A234/A234M or standard weight malleable iron screwed.
2. Below-Ground Pipe And Fittings: Polyethylene pipe and fittings meeting requirements of ASTM D2513 with No. 14 coated copper trace wire.
3. Valves:
 - a. 125 psi (862 kPa) 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 Series 50-56 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 (138 kPa) pressure with positive seating from minus 40 deg F to plus 150 deg F (minus 40 deg C to plus 66 deg C) for exterior mounting near gas meter.
 - 2) UL listed valve, factory set for IBC Seismic Design Category D, E, or F.
 - 3) Size to be determined by total cu ft (0.028 cu m) per hour gas flow requirement of building and following conditions: 0.1 inch (2.54 mm) water column maximum allowable pressure-drop through valve with available pressure of 4 oz (113 grams).
 - 4) Category Four Approved Product. See Section 01 6200 for definitions of Categories:
 - a) California Seismic Gas Shutoff Valve (formally KOSO):
 - (1) Horizontal installation: Model 314F or 315F.
 - (2) Vertical installation with bottom inlet: Model VB314F or VB315F.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Steel pipe installed through air plenums, in walls, and pipes 2-1/2 inches (64 mm) 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 (610 mm) 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 (100 mm) 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 (150 mm) 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 (610 mm) long pipe section anchored to building wall at each end.

3.2 FIELD QUALITY CONTROL

- A. Field tests:
 - 1. Subject all portions of gas piping system, in sections or in entirety, to air pressure of 75 psig (0.52 MPa) and prove airtight for 4 hours.
 - 2. Disconnect equipment not suitable for 75 psig (0.52 MPa) 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. Products Installed But Not Furnished Under This Section:
- C. Related Requirements:
 - 1. Section 23 0501: 'Common HVAC Requirements'.
 - 2. Section 23 0719: 'Refrigerant Piping Insulation'.
 - 3. Section 23 6213: 'Packaged Air-Cooled Refrigerant Compressor And Condenser Units'.
 - 4. Section 23 8216.01: 'Air Coils: DX'.
 - 5. Section 23 8219: 'Fan Coil Units'.

1.2 REFERENCES

- A. Association Publications:
 - 1. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. 2011 ASHRAE Handbook, Chapter 48, 'Noise and Vibration Control'.
 - 2. 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).
 - 3. Vibration Isolation and Seismic Control Manufacturers Association (VISCMA):
 - a. VISCMA 101-07, 'Seismic Restraint Specification Guidelines for Mechanical, Electrical, and Plumbing Systems'.
 - b. VISCMA 102-10, '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 / American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - a. ANSI/ASHRAE Standard 15-2010, 'Safety Standard for Refrigeration Systems'.
 - b. ANSI/ASHRAE Standard 34-2010, 'Designation and Classification of Refrigerants'.
 - c. ANSI/ASHRAE Standard 90.1-2010 (I-P Edition), 'Energy Standard for Buildings Except Low-Rise Residential Buildings' (ANSI Approved; IESNA Co-Sponsored).
 - 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. ASTM International:
 - a. ASTM A36/A36M-08, 'Standard Specification for Carbon Structural Steel'.
 - b. ASTM B280-08, 'Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service'.
 - 4. Canadian Standards Association:

- a. CSA B52-05 (R2009), 'Mechanical Refrigeration Code'.
- 5. National Fire Protection Association / American National Standards Institute:
 - a. NFPA 90A-2012, 'Installation of Air Conditioning and Ventilating Systems'.
- 6. Underwriters Laboratories:
 - a. UL 2182, 'Refrigerants' (2nd Edition).

1.3 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings: Show each individual equipment and piping support.
- B. Informational Submittals:
 - 1. Sustainable Design Submittals:
 - a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
 - b. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
 - 2. 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.
 - 2. Energy Efficiency: Equal to or greater than prescribed by ANSI/ASHRAE Standard 90.1.
- 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. Cush-A-Clamp by ZSI Manufacturing, Canton, MI www.cushaclamp.com.
 - c. Elkhart Products Corp, Elkhart, IN www.elkhartproducts.com.
 - d. Emerson Climate Technologies, St Louis, MO www.emersonflowcontrols.com.
 - e. Handy & Harman Products Division, Fairfield, CT www.handy-1.com.
 - f. Harris Products Group, Cincinnati, OH www.harrisproductsgroup.com.
 - g. Henry Valve Co, Melrose Park, IL www.henrytech.com.
 - h. Hilti Inc, Tulsa, OK www.hilti.com.
 - i. Hydra-Zorb Co, Auburn Hills, MI www.hydra-zorb.com.
 - j. JB Industries, Aurora, IL www.jbind.com.
 - k. Mueller Steam Specialty, St Pauls, NC www.muellersteam.com.
 - l. Nibco Inc, Elkhart, IN www.nibco.com.
 - m. Packless Industries, Waco, TX www.packless.com.
 - n. Parker Corp, Cleveland, OH www.parker.com.
 - o. Sporlan Valve Co, Washington, MO www.sporlan.com.
 - p. Sherwood Valves, Washington, PA www.sherwoodvalve.com.
 - q. Thomas & Betts, Memphis, TN www.superstrut.com.
 - r. Unistrut, Div of Atkore International, Inc., Harvey, IL www.unistrut.com.

- s. Universal Metal Hose, Chicago, IL www.universalmetalhose.com.
- t. Vibration Mountings & Controls, Bloomington, NJ www.vmc-kdc.com.
- u. 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.
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. 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.
5. Connection Material:
 - a. 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.
 - 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.
6. 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.
7. Filter-Drier:
 - a. On lines 3/4 inch (19 mm) outside diameter and larger, filter-drier shall be replaceable core type with Schraeder 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.
8. 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.
9. 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.
10. 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.
 - d. Protective Cover: 18 ga (1.2 mm) steel, hot-dipped galvanized.
11. 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). 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 (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 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:
 - a. ASTM D1785-12, 'Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120'.

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.

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 4546: 'Duct Testing, Adjusting, and Balancing' for ductwork.
 - 2. Section 07 9219: 'Acoustical Joint Sealants' for quality of acoustic sealant.
 - 3. Section 23 0501: 'Common HVAC Requirements'.

1.2 REFERENCES

- A. Reference Standards:
 - 1. Sheet Metal And Air Conditioning Contractors' National Association / American National Standards Institute:
 - a. SMACNA, 'HVAC Duct Construction Standards - Metal and Flexible' (Third Edition).

1.3 ADMINISTRATIVE REQUIREMENTS

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

1.4 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:
 - a. 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 - Metal and Flexible'.
- B. Materials:
 - 1. Duct Hangers:

- a. One inch (25 mm) by 18 ga (1.27 mm) galvanized steel straps or steel rods as shown on Drawings, and spaced not more than 96 inches (2 400 mm) apart. Do not use wire hangers.
- b. Attach threaded rod to steel joist with Anvil Steel washer plate Fig. 60. Double nut connection.

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 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 4546: 'Duct Testing, Adjusting, And Balancing' for ductwork.
 - 2. Section 23 0713: 'Duct Insulation' for thermal Insulation for ducts, plenum chambers, and casings.
 - 3. Section 23 3001: 'Common Duct Requirements'.
 - 4. Section 23 0933: 'Electric And Electronic Control System For HVAC':
 - a. Temperature control damper actuators and actuator linkages.
 - b. Furnishing of duct smoke detectors.

1.2 REFERENCES

- A. Reference Standards:
 - 1. ASTM International:
 - a. ASTM A653/A653M-11, 'Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process'.
 - 2. Sheet Metal And Air Conditioning Contractors' National Association / American National Standards Institute:
 - a. SMACNA, 'HVAC Duct Construction Standards - Metal and Flexible' (Third Edition).

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 A653/A653M, 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 or Duro Dyne Canada, Lachine, QB
www.durodyne.com.
 - 4) Iron Grip 601 by Hardcast Inc, Wylie, TX www.hardcast.com.
 - 5) MTS100 or MTS 200 by Hercules Mighty Tough, Denver CO,
www.herculesindustries.com.
 - 6) 15-325 by Miracle / Kingco, Div ITW TACC, Rockland, MA www.taccint.com.

- 7) 44-39 by Mon-Eco Industries Inc, East Brunswick, NJ www.mon-ecoindustries.com.
 - 8) Airseal Zero by Polymer Adhesive Sealant Systems Inc, Weatherford, TX www.polymeradhesives.com.
 - 9) Airseal #22 Water Base Duct Sealer by Polymer Adhesive Sealant Systems Inc, Weatherford, TX www.polymeradhesives.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 (1 200 mm) dimension having acoustic duct liner need not be cross-broken or beaded. Cross-break unlined ducts, duct panels larger than 48 inch (1 200 mm) vertical and horizontal sheet metal barriers, duct offsets, and elbows, or bead 12 inches (300 mm) 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 (900 mm) up to 48 inches (1 200 mm): Transverse duct joint system by Ductmate / 25, Elgen, Ward, or WDCI (SMACNA Class 'F' joint).
 - b) Ducts 48 inch (1 200 mm) And Larger: Ductmate / 35, Elgen, 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 or Ductmate Canada Ltd, Burlington, ON (905) 332-7678.
 - (2) Ward Industries Inc, Bensonville, IL www.wardind.com.
 - (3) Elgen Manufacturing Company, Inc., East Rutherford, NJ www.elgenmfg.com.
 - c. Round Duct:
 - 1) Spiral Seam: 28 ga (0.4 mm) minimum for ducts up to and including 14 inches (355 mm) in diameter.
 - 2) Longitudinal Seam:
 - a) 28 ga (0.4 mm) minimum for ducts up to and including 8 inches (200 mm) in diameter.
 - b) 26 ga 0.48 mm minimum for ducts over 8 inches (200 mm) and up to 14 inches (355 mm) 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 01 4546, 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.
- H. Where ducts are shown connecting to concrete or masonry openings and along edges of plenums at floors and walls, provide continuous 2 by 2 by 1/4 inches (50 by 50 by 6 mm) galvanized angle iron.
 - 1. Bolt angle iron to structure and make airtight by applying sealant between angle and structure.
 - 2. Bolt or weld sheet metal at these locations to angle and caulk airtight.
 - 3. Apply two coats of aluminum paint to angles after installation.

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: 'Electric And Electronic Control System For HVAC' for 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 A653/A653M-13, 'Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process'.
 - b. ASTM C1071-12, 'Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)'.
 - c. ASTM C1338-08, 'Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings'.

PART 2 - PRODUCTS

2.1 ACCESSORIES

- A. Manufacturers:
 - 1. Manufacturer Contact List:
 - a. AGM Industries, Brockton, MA www.agmind.com.
 - b. Air Balance Inc, Holland, OH www.airbalance.com.
 - c. Air Filters Inc, Baltimore, MD www.afinc.com.
 - d. Air-Rite Manufacturing, Bountiful, UT (801) 295-2529.
 - e. American Warming & Ventilating, Holland, OH www.american-warming.com.
 - f. Arrow United Industries, Wyalusing, PA www.arrowunited.com.
 - g. Cain Manufacturing Company Inc, Pelham, AL www.cainmfg.com.
 - h. C & S Air Products, Fort Worth, TX www.csairproducts.com.
 - i. CertainTeed Corp, Valley Forge, PA www.certainteed.com.
 - j. Cesco Products, Florence, KY www.cescoproducts.com.
 - k. Daniel Manufacturing, Ogden, UT (801) 622-5924.
 - l. Design Polymeric, Fountain Valley, CA www.designpoly.com.
 - m. Duro Dyne, Bay Shore, NY www.durodyne.com.
 - n. Dyn Air Inc. Lachine, QB www.dynair.ca
 - o. Elgen Manufacturing Company, Inc. East Rutherford, NJ www.elgenmfg.com
 - p. Flexmaster USA Inc, Houston, TX www.flexmasterusa.com.
 - q. Greenheck Corp, Schofield, WI www.greenheck.com.
 - r. Gripnail Corp, East Providence, RI www.gripnail.com.
 - s. Hardcast Inc, Wylie, TX www.hardcast.com.
 - t. Hercules Industries, Denver, CO, www.herculesindustries.com.

- u. Honeywell Inc, Minneapolis, MN www.honeywell.com.
- v. Industrial Acoustics Co, Bronx, NY www.industrialacoustics.com.
- w. Johns-Manville, Denver, CO www.jm.com.
- x. Kees Inc, Elkhart Lake, WI www.kees.com.
- y. Knauf Fiber Glass, Shelbyville, IN www.knauffiberglass.com.
- z. Manson Insulation Inc, Brossard, QB www.isolationmanson.com.
- aa. Metco Inc, Salt Lake City, UT (801) 467-1572 www.metcospiral.com.
- bb. Miracle / Kingco, Rockland, MA www.taccint.com.
- cc. Mon-Eco Industries Inc, East Brunswick, NJ www.mon-ecoindustries.com.
- dd. Nailor Industries Inc, Houston, TX www.nailor.com.
- ee. Owens Corning, Toledo, OH www.owenscorning.com.
- ff. Polymer Adhesive Sealant Systems Inc, Irving, TX www.polymeradhesives.com.
- gg. Pottorff Company, Fort Worth, TX www.pottorff.com.
- hh. Ruskin Manufacturing, Kansas City, MO www.ruskin.com.
- ii. Sheet Metal Connectors Inc, Minneapolis, MN www.smconnectors.com.
- jj. Tamco, Stittsville, ON www.tamco.ca.
- kk. Techno Adhesive, Cincinnati, OH www.technoadhesives.com.
- ll. Titus, Richardson, TX (972) 699-1030. www.titus-hvac.com
- mm. McGill AirFlow, Groveport, OH www.mcgillairflow.com.
- nn. McGill AirSeal, Columbus, OH www.mcgillairseal.com.
- oo. Utemp Inc, Salt Lake City, UT (801) 978-9265.
- pp. Ventfabrics Inc, Chicago, IL www.ventfabrics.com.
- qq. Young Regulator Co, Cleveland, OH www.youngregulator.com.

B. Materials:

1. Acoustical Liner System:

a. Duct Liner:

- 1) One inch (25 mm) thick, 1-1/2 lb (0.68 kg) density fiberglass conforming to requirements of ASTM C1071. Liner will not support microbial growth when tested in accordance with ASTM C1338.
- 2) Category Four Approved Products. See Section 01 6200 for definitions of Categories:
 - a) ToughGard by CertainTeed.
 - b) Duct Liner E-M by Knauf Fiber Glass.
 - c) Akousti-Liner by Manson Insulation.
 - d) Quiet R by Owens Corning.
 - e) Linacoustic RC 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) Duro Dyne: WSA.
 - d) Elgen Manufacturing: A-410-WB.
 - e) Hardcast: Coil-Tack.
 - f) Miracle / Kingco: PF-101.
 - g) Mon-Eco: 22-67 or 22-76.
 - h) Polymer Adhesive: Glasstack #35.
 - i) Techno Adhesive: 133.
 - j) McGill Airseal: Uni-tack.
- 2) Category Four Approved Solvent-Based (non-flammable) Products. See Section 01 6200 for definitions of Categories:
 - a) Cain: Safetak.
 - b) Duro Dyne: FPG.
 - c) Hardcast: Glas-Grip 648-NFSE.
 - d) Miracle / Kingco: PF-91.
 - e) Mon-Eco: 22-24.
 - f) Polymer Adhesive: Q-Tack.
 - g) Techno Adhesive: 'Non-Flam' 106.
- 3) Category Four Approved Solvent-Based (flammable) Products. See Section 01 6200 for definitions of Categories:

- a) Cain: HV200.
 - b) Duro Dyne: MPG.
 - c) Hardcast: Glas-Grip 636-SE.
 - d) Miracle / Kingco: PF-96.
 - e) Mon-Eco: 22-22.
 - f) Polymer Adhesive: R-Tack.
 - g) Techno Adhesive: 'Flammable' 106.
- 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) Duro Dyne.
 - d) 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 200 deg F (93 deg C).
 - c. Category Four Approved Products. See Section 01 6200 for definitions of Categories:
 - 1) Cain: N-100.
 - 2) Duro Dyne: MFN.
 - 3) Dyn Air: CPN with G-90 galvanized off-set seam
 - 4) Elgen: ZLN / SDN.
 - 5) Ventfabrics: Ventglas.
 - 6) 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 (0.635 mm) minimum.
 - 2) Fire and smoke damper access doors shall have minimum clear opening of 12 inches (300 mm) 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) Air-Rite: Model HAD-2.
 - c) Cesco: HDD.
 - d) Elgen Manufacturing: TAB Type / Hinge and Cam.
 - e) Flexmaster: Spin Door.
 - f) Kees Inc: ADH-D.
 - g) Nailor: 08SH.
 - h) Pottorff: 60-HAD.
 - i) Ruskin: ADH-24.
4. Dampers And Damper Accessories:
- a. Locking Quadrant Damper Regulators:
 - 1) Category Four Approved Products. See Section 01 6200 for definitions of Categories:
 - a) Duro Dyne: KS-385.
 - b) Dyn Air: QPS-385.
 - c) Elgen Manufacturing: EQR-4.
 - d) Ventfabrics: Ventline 555.
 - e) Young: No. 1.
 - b. Concealed Ceiling Damper Regulators:
 - 1) Category Four Approved Products. See Section 01 6200 for definitions of Categories:
 - a) Cain.
 - b) Duro Dyne.
 - c) Elgen Manufacturing.
 - d) Metco Inc.
 - e) Ventfabrics: 666 Ventlok.
 - f) Young: 301.

- c. Volume Dampers:
 - 1) Rectangular Duct:
 - a) Factory-manufactured 16 ga (1.6 mm) galvanized steel, single blade and opposed blade type with 3/8 inch (9.5 mm) axles and end bearings. Blade width 8 inches (200 mm) maximum. Blades shall have 1/8 inch (3 mm) 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) Air-Rite: Model CD-2.
 - (2) American Warming: VC-2-AA.
 - (3) Arrow: OBDAF-207.
 - (4) C & S: AC40.
 - (5) Cesco: AGO.
 - (6) Daniel: CD-OB.
 - (7) Greenheck: VCD-20.
 - (8) Nailor: 1810 or 1820.
 - (9) Pottorff: CD-42.
 - (10) Ruskin: MD-35.
 - (11) Utemp: CD-OB.
 - 2) Round Duct:
 - a) Factory-manufactured 20 ga (1.0 mm) galvanized steel, single blade with 3/8 inch (9.5 mm) axles and end bearings.
 - b) For use in outside air ducts.
 - c) Category Four Approved Products. See Section 01 6200 for definitions of Categories:
 - (1) Air Balance: Model AC-22.
 - (2) Air-Rite: Model CD-5.
 - (3) American Warming: V-22.
 - (4) Arrow: Type-70.
 - (5) C & S: AC21R.
 - (6) Cesco: MGG.
 - (7) Nailor: 1890.
 - (8) Pottorff: CD-21R.
 - (9) 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 (200 mm) 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) American Warming: AC526.
 - (3) Arrow: AFD-20.
 - (4) C & S: AC50.
 - (5) Cesco: AGO3.
 - (6) Honeywell: D-643.
 - (7) Nailor: 2020.
 - (8) Pottorff: CD-52.
 - (9) Ruskin: CD-60.

- (10) Tamco: Series 1000.
- 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 (13 mm) 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) Air-Rite: Model BDD-3.
 - b) American Warming: BD-15.
 - c) C & S: BD30.
 - d) Cesco: FBD 101.
 - e) Daniel: FBD-H/V.
 - f) Pottorff: 50FBD.
 - g) Ruskin: NMS2.
 - h) UTEMP: BFEA.
 5. Air Turns:
 - a. Single thickness vanes. Double thickness vanes not acceptable.
 - b. 4-1/2 inch (115 mm) wide vane rail. Junior vane rail not acceptable.
 6. Branch Tap for Flexible Ductwork:
 - a. Factory-manufactured rectangular-to-round 45 degree leading tap fabricated of 24 ga (0.635 mm) zinc-coated lock-forming quality steel sheets meeting requirements of ASTM A653, 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 (0.79 mm) minimum
 - 2) 3/8 inch (9.5 mm) minimum square rod with brass damper bearings at each end.
 - 3) Heavy-duty locking quadrant on 1-1/2 inch (38 mm) 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) ST-1HD by Air-Rite.
 - 2) STO by Flexmaster.
 - 3) HET by Sheet Metal Connectors.
- 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 (19 mm) long mechanical fasteners 12 inches (300 mm) 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 rectangular ducts unless noted otherwise on Contract Documents:
 - a. Supply air.
 - b. Return air.
 - c. Mixed air.

- d. Transfer air.
 - e. Relief air.
 - f. Elbows, fittings, and diffuser drops greater than 12 inches (300 mm) in length.
 - 2. Do not install acoustic lining in round ducts.
- 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 (150 mm) of installed dampers.
 - 2. Install within 6 inches (150 mm) 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.

1.2 REFERENCES

- A. Reference Standards:
 - 1. National Fire Protection Association / American National Standards Institute:
 - a. NFPA 90A: 'Standard for the Installation of Air-Conditioning and Ventilating Systems' (2012 Edition).
 - 2. Underwriters Laboratories:
 - a. UL 181, 'Factory-Made Ducts and Air Connectors' (10th Edition).
 - b. UL 181B, 'Closure Systems for Use With Flexible Air Ducts and Air Connectors' (3rd Edition).

PART 2 - PRODUCTS

2.1 SYSTEM

- A. Manufacturers:
 - 1. Manufacturer Contact 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 (38 mm), 3/4 lb per cu ft (12 kg per cu m) 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 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 (9.5 mm) 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 (1 800 mm) maximum lengths.
- B. Make duct connections by coating exterior of duct collar for 3 inches (75 mm) 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. Regulatory Agency Sustainability Approvals:
 - 1. Bear AMCA seal and UL label.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer Contact List:
 - 1. Acme Engineering & Manufacturing Corp, Muskogee, OK www.acmefan.com.
 - 2. Broan-Nu Tone LLC, Harford, WI www.broan.com.
 - 3. Carnes Co., Verona, MI www.carnes.com.
 - 4. Loren Cook Co., Springfield, MO www.lorencook.com.
 - 5. Soler & Palau (S&P USA Ventilation Systems, LLC), Jacksonville FL www.solerpalau-usa.com.

2.2 MANUFACTURED UNITS

- A. Ceiling Mounted Exhaust Fans:
 - 1. Acoustically insulated housings. Sound level rating of 5.0 sones maximum for CFM and static pressure listed on Contract 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. Category Four Approved Products. See Section 01 6200 for definitions of Categories:
 - a. Acme: VQ.
 - b. Broan: LoSone.
 - c. Carnes: VCD.
 - d. Cook: Gemini.
 - e. Soler & Palau: FF.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Anchor fan units securely to structure or to curb.

END OF SECTION

SECTION 23 3519

DRYER EXHAUST DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Includes But Not Limited To:
 - 1. Furnish and install dryer exhaust ducts as described in Contract Documents.
- B. Related Requirements:
 - 1. Section 23 3001: 'General Duct Requirements'.

1.2 REFERENCES

- A. Reference Standards:
 - 1. ASTM International:
 - a. ASTM B209-10, 'Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate'.

1.3 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Show complete installation of dryer exhaust duct system for approval before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE

- A. Design Criteria:
 - 1. Aluminum Ductwork And Fittings: Construct of 3003-H14 aluminum complying with ASTM B209.

2.2 FABRICATION

- A. Fabricate ducts using spiral lockseam method and 0.040 inch (1.0 mm) minimum thick.
- B. Fabricate round fittings and couplings 0.050 inch (1.27 mm) minimum thick
- C. Provide continuous welds along seams.
- D. Mitered elbows shall be of minimum five-piece construction with RD ratio of 1.5.
- E. Fabricate field joints for round ducts and fittings using initial coat of 3M EC-750 adhesive wrapping joint with 3 inch (75 mm) wide fiberglass strip and apply final seal coat of adhesive to fiberglass.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Anchor ducts and securely to building in approved manner and install so ducts are completely free from vibration under operational conditions.
- B. Under no conditions allow pipes, rods, or wires to penetrate ducts.

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: Common 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 Contact List:
 - 1. Carnes Co, Verona, MI www.carnes.com.
 - 2. Krueger Air System Components, Richardson, TX www.krueger-hvac.com.
 - 3. Nailor Industries, Houston, TX www.nailor.com.
 - 4. Price Industries Inc, Suwanee, GA www.price-hvac.com.
 - 5. Titus, Richardson, TX www.titus-hvac.com.
 - 6. Tuttle & Bailey, Richardson, TX www.tuttleandbailey.com.

2.2 MANUFACTURED UNITS

- A. Lay-In Ceiling Diffusers:
 - 1. Finish: White baked enamel.
 - 2. Removable inner core assembly.
 - 3. Performance Standard: Titus TMSA Border Type 3.
 - 4. Category Four Approved Products. See Section 01 6200 for definitions of Categories:
 - a. Carnes.
 - b. Krueger.
 - c. Nailor.
 - d. Price.
 - e. Titus.
 - f. Tuttle & Bailey.
- B. Ceiling Return And Transfer Grilles:
 - 1. Finish: White baked enamel.
 - 2. 1/2 inch by 1/2 inch aluminum cove.
 - 3. Class One Quality Standard: Titus 50F-3.
 - a. Carnes.
 - b. Kreuger.

- c. Nailor.
 - d. Price.
 - e. Titus.
 - f. Tuttle & Bailey.
- C. Hard Ceiling Diffusers:
- 1. Finish: White baked enamel.
 - 2. Category Four Approved Products. See Section 01 6200 for definitions of Categories:
 - a. Carnes: SKSA.
 - b. Krueger: SH Frame F21.
 - c. Price: SMD.
 - d. Titus: TDC Border Type 6.
 - e. Tuttle & Bailey: MS.
- D. Low Side Wall Return Grilles:
- 1. Finish: White baked enamel.
 - 2. Performance Standard: Titus 355.
 - 3. Category Four Approved Products. See Section 01 6200 for definitions of Categories:
 - a. Carnes.
 - b. Krueger.
 - c. Nailor.
 - d. Price.
 - e. Titus.
 - f. 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.

END OF SECTION

SECTION 23 3723

HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Includes But Not Limited To:
 - 1. Furnish and install roof vents as described in Contract Documents.
- B. Related Requirements:
 - 1. Section 23 3001: 'Common Duct Requirements'.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer List:
 - 1. Air-Rite Manufacturing, Bountiful, UT (801) 295-2529.
 - 2. Breidert Air Products, Jacksonville, FL www.breidert.com.
 - 3. Carnes Company, Verona, WI www.carnes.com.
 - 4. Greenheck Fan Corporation, Schofield, WI www.greenheck.com.
 - 5. Loren Cook Co, Springfield, MO www.lorencook.com.
 - 6. United Enertech Corporation, Chattanooga, TN www.unitedenertech.com.
 - 7. Vent Products Co, Inc, Chicago, IL www.ventprod.com.

2.2 MANUFACTURED UNITS

- A. Louvered Penthouses:
 - 1. Fabricated from (0.081 inch 2.15 mm) extruded aluminum.
 - a. All welded construction.
 - b. Screws or rivets will not be allowed.
 - 2. Blades:
 - a. Horizontal at 45 degree angle with return bends at upper edges.
 - b. Welded, mitered corners for continuous blade effect.
 - 3. Bird Screens: 1/2 inch (13 mm) square mesh 16 ga (1.6 mm) aluminum in extruded aluminum, rewirable frames on interior of louvers.
 - 4. Penthouse Finish: Clear anodized aluminum.
 - 5. Curbs:
 - a. Extruded aluminum, insulated, factory-fabricated curb.
 - b. Insulation: Minimum 1-1/2 inches (38 mm) thick, 3 lb 48 kg per cubic m density fiber glass.
 - c. Curb Extension: 8 inches (200 mm) above finished roof level.
 - 6. Provide automatic back draft damper on Relief Air Penthouses. Provide motorized damper where indicated on Drawings.
 - 7. Category Four Approved Products. See Section 01 6200 for definitions of Categories:
 - a. Air-Rite Manufacturing: Model LPE-1.
 - b. Breidert: Model RLX.
 - c. Carnes: GLAB.
 - d. Cook: Type TRE.
 - e. Greenheck: WIH/WRH.
 - f. United Enertech: Model PFL-D-4.
 - g. Vent Products: Model 7100.

- B. Hooded Gravity Relief Vents:
 - 1. Aluminum precision formed, locked rib, construction.
 - 2. Heavy gauge galvanized steel support members.
 - 3. 1/2 inch (13 mm) galvanized mesh bird screen.
 - 4. Motorized Damper: Internally mounted, 120 VAC, equal to WD-100 by Greenheck.
 - 5. Factory supplied roof curb.
 - 6. Performance Standard: Model FHR by Greenheck.
 - 7. Category Four Approved Products. See Section 01 6200 for definitions of Categories:
 - a. Breidert Air Products.
 - b. Carnes.
 - c. Greenheck.

PART 3 - EXECUTION: Not Used

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'.

1.2 REFERENCES

- A. Reference Standard:
 - 1. American National Standards Institute (ANSI) / American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. ANSI/ASHRAE 52.2-2012, 'Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size'.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Air Handling Unit Filters:
 - 1. 2 inch (50 mm) thick, ANSI/ASHRAE MERV 8, disposable type pre-formed pleated design, having at least 4.5 sq ft (0.42 sq meters) of filtering media per sq ft (sq m) of face area.
 - 2. Media shall be reinforced non-woven cotton fabric, treated with adhesive similar to 'Vyclad B' and continuously laminated to supporting steel wire grid conforming to configuration of pleats.
 - 3. Media pack shall be sealed in a chipboard frame or beverage board.
 - 4. Filters shall have rated average efficiency of 25 to 30 percent on ANSI/ASHRAE 52.2 Test Standard and be capable of operating with variable face velocities up to 500 FPM without impairing efficiency.
 - 5. Initial resistance shall not exceed 0.30 inch (7.62 mm) wg at 500 FPM or 0.14 inch (3.56 mm) wg at 300 FPM. Filter shall be listed Class 2 by UL.
 - 6. 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 or Farr Inc, Laval, QB (519) 629-3030.

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 Contact 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. Metal-Fab Inc, Wichita, KS www.mtlfab.com.
 - e. Metlvent by Hart & Cooley, Holland, MI www.hartandcooley.com.
 - f. Selkirk Metalbestos, Logan, OH www.selkirkusa.com.
 - g. Simpson Dura-Vent Co, Vacaville, CA www.duravent.com.
- B. Materials:
 - 1. 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 (80.65 sq cm), 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.
 - 2. 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 (25 mm) per 1 foot (300 mm) 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 (4.57 m).
- 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 5533

GAS-FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Includes But Not Limited To:
 - 1. Furnish and install gas-fired unit heaters as described in Contract Documents.
- B. Related Requirements:
 - 1. Section 23 0501: Common HVAC Requirements.
 - 2. Section 23 0933: Electric and Electronic Control.
 - 3. Section 23 1123: Gas piping systems.

1.2 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Show dimensions, weight loading, required clearances, and methods of assembly of components.
 - b. Manufacturer's electrical requirements for power supply wiring for gas fired unit heaters.
 - 1) Manufacturer's ladder-type wiring diagram for interlock and control wiring.
 - 2) Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

1.3 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Gas fired unit heaters shall be design certified by American Gas Association and bear AGA label.
 - a. 80 percent minimum thermal efficiency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer Contact List:
 - 1. Modine Manufacturing Co, Racine, WI www.modine.com.
 - 2. Reznor, Memphis, TN www.rezspec.com.
 - 3. Trane (business of Ingersoll Rand), La Crosse, WI www.trane.com.

2.2 MANUFACTURED UNITS

- A. Unit Heater:
 - 1. Provide with:
 - a. Single stage gas valve.
 - b. Multi-try direct spark ignition with 100 percent lock out.
 - c. Limit and safety controls, including combustion air pressure switch to verify proper vent flow before allowing operation of gas valve.
 - 2. Equip each unit for use with natural gas and 120/1, volt power supply.

- a. Aluminized steel heat exchanger.
- b. Die formed burners of aluminized steel. Include flared ports (burner air shutters) and stainless steel insert.
3. Each unit shall have propeller fan, 120 volt motor with internal overloads, and safety fan guard.
 - a. Horizontal louvers shall be provided for directing airflow downward.
 - b. Arrange unit for ceiling suspension with threaded hanger connections and provide with hanger kits.
 - c. Construct cabinet of cold-rolled steel with baked-on polyester powder-coat finish.
 - d. 60 degree deflector hood with adjustable vanes.
4. Category Four Approved Products. See Section 01 6200 for definitions of Categories:
 - a. Modine Model HDS or PTS.
 - b. Reznor Model UDAP.
 - c. Equal by Trane.

2.3 ACCESSORIES

- A. Electrical Control System:
 1. Include high limit automatic fan control with 24-volt gas valve, and transformer.
 2. Summer / winter toggle switch allowing continuous fan operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mounting Height:
 1. Bottom of Unit to be mounted 15 feet (4.57 m) minimum above floor.

END OF SECTION

SECTION 23 7413

PACKAGED, OUTDOOR, CENTRAL-STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Includes But Not Limited To:
 - 1. Furnish and install packaged air conditioning units as described in Contract Documents.
- B. Related Requirements:
 - 1. Section 23 0501: 'Common HVAC Requirements'.

1.2 REFERENCES

- A. Definitions:
 - 1. Compressor: Pump that increases vapor (refrigerant or air) pressure from one level to a higher level of pressure.
 - 2. Condenser: Device used to condense refrigerant in a cooling system.
 - 3. Condenser Coils: In an air conditioner, the coil dissipates heat from the refrigerant, changing the refrigerant from vapor to liquid.
 - 4. Condensing Unit: Outside section of an air conditioning system which pumps vaporized refrigerant from the evaporator, compresses it, liquefies it in the condenser and returns it to the evaporator coil. The outdoor portion of a split system air conditioner contains the compressor and outdoor coil.
 - 5. EER (Energy Efficiency Rating): Rating that lists how many BTU's per hour are used for each watt of power it draws.
 - 6. 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.
 - 7. SEER (Seasonal Energy Efficiency Ratio): Measure of cooling efficiency for air conditioners and heat pumps. A ratio of total cooling in comparison to electrical energy input in watts per hour. Higher the seer, the more energy efficient the unit. Since 2006, the minimum SEER required by the Department of Energy is 13.00 and 15.00+ SEER is considered high efficiency.

1.3 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Air-Cooled Condensing Unit Section shall be UL approved and rated according to ARI Standards.
 - 2. Air delivery of units certified in accordance with standard test code for centrifugal fans adopted by AMCA.
 - 3. Furnace sections shall be AGA approved.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Delivery And Acceptance Requirements:
 - 1. Ship units with lifting angles and fully charged with refrigerant R-22.

1.5 WARRANTY

- A. Manufacturer Warranty:
 - 1. 5 year warranty on compressors.

PART 2 - PRODUCTS

2.1 PERFORMANCE

- A. Capacities:
 - 1. SEER rating, as defined by ARI, shall be not less than 13.0 for units 5 tons and smaller.
 - 2. EER rating, as defined by ARI, shall be not less than 9.5 for units larger than 5 tons.

2.2 MANUFACTURED UNITS

- A. Manufacturers:
 - 1. Manufacturer Contact List:
 - a. Carrier Corporation:
 - 1) Carrier National: Steven L. Ament (979) 324-2304 steven.l.ament@carrier.utc.com.
 - 2) Carrier Utah: Rich Carpenter (Contractors HVAC Supply) (801) 410-6077 e-mail rcarpent@mtncom.net.
 - b. Lennox Industries:
 - 1) For pricing and information call Lennox National Account at 1-800-367-6285.
 - c. Honeywell Minneapolis, MN www.honeywell.com.
 - d. Trane Company:
 - 1) Salt Lake Trane, attention: Jason Bradford (801) 486-0500 www.Jason.Bradford@trane.com.
- B. Air Conditioning Units:
 - 1. Units shall be completely factory assembled and tested. Units shall include following components and features:
 - a. Condenser coils.
 - b. Condenser fans and motors.
 - c. Interconnected wiring.
 - d. Pre-wired control panel.
 - e. Filter section.
 - f. Factory installed 100 percent modulating economizer cycle including motorized dampers and controls with modulating power exhaust for unit of 3 tons and larger.
 - g. Factory installed 100 percent modulating economizer cycle including motorized dampers and controls with barometric exhaust for unit of 2.5 tons and smaller.
 - h. Corrosion-resistant all-weather cabinet.
 - 2. Air-Cooled Condensing Unit Section:
 - a. Strainer-dryer.
 - b. Time delay or cycle protection to prevent short cycling.
 - c. Condenser Coil: 1/2 inch (13 mm) outside diameter copper tube with aluminum fins. Include condenser coil hail guard assembly.
 - d. Compressors:
 - 1) Equip with crankcase heater.
 - 2) Hermetic or semi-hermetic type mounted on vibration isolators.
 - 3) Fully hermetic scroll type internally protected. Independent circuits for units 7-1/2 tons and larger.
 - 4) On units 3 tons and larger, mount on factory rubber-shock, internal spring vibration isolators.
 - e. Condenser Fan: Axial flow type propeller fan.
 - f. Refrigerant Coils: Constructed of copper tubes with mechanically bonded aluminum plate fins.
 - g. Refrigerant lines shall have:
 - 1) Flexible connections.
 - 2) Suction and liquid line service valves.
 - 3) Charging valves.
 - 4) Receiver valve.
 - 3. Furnace Section:

- a. Units Smaller Than 3 Tons:
 - 1) Aluminized or chromized heat exchanger.
 - 2) Induced-draft motor with solid-state sensor for adequate airflow.
 - b. Units 3 Tons And Larger:
 - 1) Tubular section type of 20 ga (0.95 mm) steel minimum with 1.2 mil (0.03 mm) nominal aluminum-silicone alloy coating.
 - 2) Factory-installed induced draft blower.
 - c. Gas shut-off valve.
 - d. High limit switches.
 - e. Fan switch safety pilot and control transformer.
 - f. Automatic electric ignition.
4. Fan Section:
- a. Indoor Blower (evaporator fan):
 - 1) Steel with corrosion-resistant finish and dynamically balanced. Bearings shall be sealed, permanently lubricated, ball bearing type.
 - 2) Belt driven, double inlet, forward curved centrifugal type with adjustable pitch motor pulley.
 - b. Condenser fan shall be direct-driven propeller type and discharge upward. Condenser fan shall have blades riveted to corrosion-resistant steel spiders and be dynamically balanced. Condenser motor shall be totally enclosed.
 - c. Constructed and tested in accordance with AMCA requirements.
 - d. Furnish with flexible connections with weather protection on supply and return air take-offs.
 - e. Evaporator-fan cabinet interior shall be insulated with 1/2 inch (13 mm) thick minimum fiber glass insulation coated on air side. Use Aluminum foil-faced insulation in heating compartment.
5. Controls:
- a. Low ambient and dual pressure.
 - b. Pre-wired.
 - c. Low voltage control circuit with fuse protection on 24 V transformer side.
 - d. Solid state compressor protection for following factory-supplied safeties:
 - 1) Compressor over-temperature, over-current.
 - 2) Loss of charge / low-pressure switch.
 - 3) Freeze protection thermostat, evaporator coil.
 - 4) High-pressure switch.
 - e. Following minimum protection for heating section:
 - 1) High temperature limit switch.
 - 2) Flame rollout switch.
 - 3) Induced draft motor speed sensor on units 2-1/2 tons and smaller.
 - 4) Flame proving controls on units 3 tons and larger.
6. Safety Controls:
- a. Factory Supplied Duct Smoke Detectors mounted in Supply Air Section of Roof top Cabinet:
 - 1) Description:
 - a) Intelligent low-flow photoelectric duct smoke detector with flashscan. Photo electric smoke detector mounted in systems with airflow greater than 2000 CFM.
 - 2) Category Four Approved Products. See Section 01 6200 for definitions of Categories:
 - a) Model FSD-751 RP by Notifier by Honeywell.
7. Cabinets:
- a. 3 Ton And Larger Units: Galvanized and weatherproof, with baked enamel finish on externally exposed surfaces and primed interior panel surfaces. Evaporator fan, compressor, and filter panels shall be hinged.
 - b. All Other Units: Galvanized, weatherproof, and coated inside and outside with corrosion-resistant paint.
8. Type Two Acceptable Manufacturers:
- a. Class One Quality Standard: Lennox LGH:
 - 1) Carrier.
 - 2) Lennox.
 - 3) Trane.
 - 4) Equal as approved by Architect before installation. See Section 01 6200.

2.3 ACCESSORIES

- A. Vibration Isolation Curbs:
 - 1. Spring type with 2 inch (50 mm) minimum deflection.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units on vibration isolators.
- B. Set minimum outside air set point.
- C. Install gas regulator so that it is not in direct path of power exhaust discharge.
- D. Do not install electrical disconnect so it interferes with access to power exhaust units.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer Services:
 - 1. Equipment Manufacturer to provide factory start-up service. This includes package roof top unit and economizer with power or barometric exhaust.

END OF SECTION

SECTION 23 7600

EVAPORATIVE AIR COOLING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Includes But Not Limited To:
 - 1. Furnish and install rooftop evaporative air handlers as described in Contract Documents.
- B. Related Requirements:
 - 1. Section 23 0501: Common HVAC Requirements.

1.2 DELIVERY, STORAGE, AND HANDLING

- A. Delivery And Acceptance Requirements:
 - 1. Ship units with lifting sky hooks.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Type One Acceptable Manufacturers:
 - 1. United Metal Products, Tempe, AZ www.unitedmetal.com.

2.2 MANUFACTURED UNITS

- A. Units shall include following components and features
 - 1. Casing:
 - a. Hot-dipped galvanized steel with epoxy powder coat finish. Double thick corners.
 - b. Unit braced by factory supplied support legs.
 - c. Curb and curb counter-flashing.
 - d. Auto-damper with grille diffuser.
 - e. Provide easy access to external distributor clean outs.
 - f. Height from top of curb to top of unit 3 feet (900 mm) maximum.
 - g. Provide over-flow drain through bottom of unit and within curb.
 - 2. Fan:
 - a. Axial, propeller type fan, dynamically balanced and with corrosion resistant finish. Down discharge. Self-aligning, heavy duty, greaseable, pillow block, ball bearing.
 - b. Belt driven, keyed steel shaft with self-tensioning belt.
 - c. Adjustable motor sheave.
 - d. Provide slide frame accessibility to fan, motor and drive.
 - 3. Motor:
 - a. Totally enclosed for wet environment.
 - 4. Pads:
 - a. 8 inch (200 mm) thick cross-fluted 80 percent efficient media with side access removal.
 - 5. Water Distribution:
 - a. Provide distribution system for uniform flow thru media.
 - b. Centrifugal pump.
 - c. Cold water make-up valve with float.

- B. Design Standard:
 - 1. United Metal Products, 'FAN-AIR' UMP-724 with UFD33-2 diffuser and full size barometric damper.

2.3 SOURCE QUALITY CONTROL

- A. Manufacturer Services:
 - 1. Units shall be completely factory assembled and tested. UL507 listed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units on factory supplied curb. Completely enclose wiring and piping within curb. Penetrations through curbs and roofing membrane are not allowed.
- B. Install barometric damper in discharge duct.
- C. Coordinate attachment of cooler support legs with Architect. Anchor leg supports to roof structure. However, attachment shall not distract from roofing system's integrity nor impact life expectancy of roofing system.
- D. Coat non-finished or unprotected surfaces with two coats of approved corrosion-resistant paint after installation. Color as selected by Architect.

END OF SECTION

END OF DIVISION 23