SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 15 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Escutcheons.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Piping Specialties.
6. Equipment nameplate data requirements.
7. Labeling and identifying mechanical systems and equipment.
8. Nonshrink grout for equipment installations.
9. Piping Systems common requirements.
10. Field-fabricated metal and wood equipment supports.
11. Installation requirements common to equipment specification sections.
12. Cutting and patching.
13. Touchup painting and finishing.
14. Excavating and backfilling.
15. Foundations and anchor Bolts.
16. Access Doors.

B. Pipe and pipe fitting materials are specified in Division 15 piping system Sections.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. NP: Nylon plastic.
4. PE: Polyethylene plastic.
5. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
1. CR: Chlorosulfonated polyethylene synthetic rubber.
2. EPDM: Ethylene propylene diene terpolymer rubber.

1.4 SUBMITTALS

A. Shop Drawings

1. Submit shop drawings on all equipment to be furnished under this Division of the Specifications, in accordance with the General and Special Conditions.

2. Shop Drawings shall be submitted only after the Contractor has checked and verified all field measurements, quantities, equipment dimensions, specified performance criteria, installation requirements, electrical requirements, materials, catalog numbers, and similar data with respect thereto and reviewed or coordinated each shop drawing with the requirements of the work and the Contract Documents.

3. At the time of each submission the Contractor shall give the Architect specific written notice of each variation that the shop drawings may have from the requirements of the Contract Documents.

4. The shop drawings shall have a stamp or specific written indication that the Contractor has satisfied the requirements stated hereinbefore. Shop drawings submitted without the Contractor's review and stamp shall be immediately returned to the Contractor without the Architect's review.

B. Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, and identification materials and devices.

C. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

1.5 QUALITY ASSURANCE

A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

B. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in

writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."

G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

1.8 PERMITS, CODES, INSPECTIONS AND APPROVALS

A. Permits

1. All permits necessary for the complete heating, air conditioning, ventilating, sprinkler, boilers and plumbing systems shall be obtained by the Contractor from the authorities governing such work. The cost of all permits shall be borne by the Contractor.

B. Mechanical Work

1. Heating and ventilating and air conditioning work shall be performed in accordance with the rules and regulations of the Kentucky Building Code, National Fire Protection Association, the latest standards recognized by the American Society of Heating and Air Conditioning Engineers and International Mechanical Code as adopted by the Commonwealth of Ky. All HVAC work shall be performed by a Licensed Kentucky Master HVAC Contractor.

2. All plumbing work shall be installed according to requirements of the Commonwealth of Kentucky State Plumbing Laws and Codes, Rules and Regulations and local ordinances. Where there is a conflict between the Drawings and Specifications and the above codes, the rules of the code shall apply. Any changes required shall be called to the attention of the Architect before Bid Date; otherwise this Contractor shall make the required changes at his own expense.

3. There shall be furnished to the Owner, free of charge, a Certificate of Inspection and Approval from the Kentucky State Department of Health plumbing inspector pursuant to all plumbing work performed. Final payment will be contingent upon this certificate.

4. Where the scope of mechanical work includes electrical work, all provisions included in the electrical sections of the work shall apply.

C. Inspection Requirements

1. The inspection work shall be scheduled for rough as well as the finished work. The rough inspection shall be divided into as many inspections as may become necessary to cover all roughing-in. A punch list inspection shall be scheduled with the Architect or his representative present.

2. The Architect shall be notified twenty-four (24) hours in advance when any tests or inspections are to be made and before any work is insulated or concealed. Failing to do so, the Contractor shall uncover and retest lines as directed by the Architect. The Contractor shall notify the Architect when he is ready for final inspection.

1.9 MECHANICAL DRAWINGS AND SPECIFICATIONS

A. The drawings and specifications are intended to cover all work enumerated under the respective headings. The drawings are diagrammatic only as far as final location of pipes, relative size, is concerned. Any item of work not clearly included, specified and/or shown, any errors or conflict between plans (Mechanical, Architectural, Structural or Electrical), specifications, codes and field conditions, shall be clarified by a written request to the Architect by the Bidder before bidding; otherwise the bidder shall, at his own expense, supply the proper labor and materials to make good any damages or defects in his work caused by such error, omission or conflict.

B. Piping schematics, risers and details shown on the drawings are for the equipment specified hereinafter. All revisions, modifications or changes in piping, accessories, etc. due to using equipment of a different manufacturer than specified hereinafter, shall be the responsibility of the Bidder and shall be made at no additional cost to the Owner. All modifications or changes

shall be submitted to the Architect in writing and meet with his approval before the equipment is released for shipment.

C. This Contractor shall be responsible for all revisions, modifications or changes necessary in the structural or architectural or electrical systems to accommodate the equipment to be furnished under this Section of the Specifications. This shall be made at no additional cost to the Owner.

D. The contractor in all areas where his work and/or expense is involved shall verify scale of Drawings and/or details. This may involve all contract drawings: Architectural, Structural, Mechanical, Electrical, etc. due to the advent of computers, copiers, and faxes, which change drawing scales so easily, this is very important. If drawings are scaled to determine quantities of materials, labor, etc., no allowances will be due the contractor due to inaccurate scales shown on any of the contract drawings or reproductions thereof.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Dielectric Unions:
   a. Capitol Manufacturing Co.
   b. Central Plastics Co.
   c. Eclipse, Inc.; Rockford-Eclipse Div.
   d. Epco Sales Inc.
   e. Hart Industries International, Inc.
   f. Watts Industries, Inc.; Water Products Div.
   g. Zurn Industries, Inc.; Wilkins Div.

2. Dielectric Couplings:
   a. Calpico, Inc.
   b. Lochinvar Corp.

2.2 PIPE AND PIPE FITTINGS

A. Refer to individual Division 15 piping Sections for pipe and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 15 piping Sections for special joining materials not listed below.

B. Solder Filler Metals: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: Approximately 95 percent tin and 5 percent silver, with 0.10 percent lead content.

2. Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.10 percent maximum lead content.

3. Alloy HA: Tin-antimony-silver-copper zinc, with 0.10 percent maximum lead content.

4. Alloy HB: Tin-antimony-silver-copper nickel, with 0.10 percent maximum lead content.

5. Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.20 percent maximum lead content.

C. Brazing Filler Metals: AWS A5.8.
1. BCuP Series: Copper-phosphorus alloys.
2. BAg1: Silver alloy.

D. Solvent Cements: Manufacturer's standard solvent cements for the following:
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

E. Plastic Pipe Seals: ASTM F 477, Elastomeric gasket.

F. Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.
1. Sleeve: ASTM A 126, Class B, gray iron.
2. Followers: ASTM A47 malleable iron or ASTM A 536 ductile iron.
3. Gaskets: Rubber.
4. Bolts and Nuts: AWWA C111.
5. Finish: Enamel paint.

2.4 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.

C. Insulating Material: Suitable for system fluid, pressure, and temperature.

D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

2.5 PIPING SPECIALTIES

A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:

1. Steel Sheet Metal: 0 0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.

2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.

3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.

5. PVC: Manufactured, permanent, with nailing flange for attaching to wooden forms.

6. PVC Pipe: ASTM D 1785, Schedule 40.
7. PE: Manufactured, reusable, tapered, cup shaped, smooth outer surface, with nailing flange for attaching to wooden forms.

B. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.

1. ID: Closely fit around pipe, tube, and insulation of insulated piping.

2. OD: Completely cover opening.

3. Cast Brass: One piece, with set screw.
   a. Finish: Polished chrome-plate.

4. Cast Brass: Split casting, with concealed hinge and set screw.
   a. Finish: Polished chrome-plate.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 15 piping Sections specify unique piping installation requirements.

B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.

C. Install piping at indicated slope.

D. Install components with pressure rating equal to or greater than system operating pressure.

E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.

F. Install piping free of sags and bends.

G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

I. Install piping to allow application of insulation plus 1-inch clearance around insulation.

J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

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

L. Install couplings according to manufacturer's written instructions.

M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
   1. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
   2. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with setscrew.
   3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
   4. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
   5. Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.

N. Sleeves are not required for core drilled holes.

O. Permanent sleeves are not required for holes formed by PE removable sleeves.

P. Install sleeves for pipes passing through concrete and masonry walls, and concrete floor and roof slabs.

Q. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

   2. Build sleeves into new walls and slabs as work progresses.

   3. Install sleeves large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS.
      b. PVC Pipe Sleeves: For pipes smaller than 6-incn NPS.
      c. Steel, Sheet-Metal Sleeves: For pipes 6-inch NPS and larger, penetrating gypsum board partitions.
      d. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
         1) Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Refer to Division 7 Section "Joint Sealants" for materials.

5. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.

R. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches in diameter and larger.
3. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.

S. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

V. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
4. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube."
5. Soldered Joints: Construct joints according to CDA's "Copper Tube Handbook."
6. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
7. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
   b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
   c. Align threads at point of assembly.
   d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.

e. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

8. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean clothe or paper towels. Join pipe and fittings according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. ABS Piping: ASTM D 2235 and ASTM D 2661.
   c. CPVC Piping: ASTM D 2846 and ASTM F 493.
   d. PVC Pressure Piping: ASTM D 2672.
   e. PVC Nonpressure Piping: ASTM D 2855.
   f. PVC to ABS Nonpressure Transition Fittings: Procedure and solvent cement according to ASTM D 3138.

W. Piping Connections: Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
   2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
   4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment giving right of way to piping installed at required slope.

F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.3 PAINTING AND FINISHING

A. Refer to Division 9 Section "Painting" for paint materials, surface preparation, and application of paint.

B. Apply paint to exposed piping according to the following, unless otherwise indicated:
   1. Interior, Ferrous Piping Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
   2. Interior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
   3. Interior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
   4. Exterior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
   5. Exterior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
   6. Exterior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.

C. Do not paint piping specialties with factory-applied finish.

D. Cleaning and Painting

   1. The Contractor shall remove all temporary stickers, tags, etc. from all items installed under this Contract and shall thoroughly clean all equipment or materials installed under this Contract. Scratched and damaged paint and/or other finishes shall be touched up and/or repainted as required. All equipment shall be cleaned and made ready for painting by the General Contractor.

   2. Upon completion of the work, the Contractor shall thoroughly clean and lubricate all equipment; clean and flush all piping as often as necessary to satisfy the Architect that the system is clear of oil, dirt, scale or other foreign matter; clean all strainers after flushing operation and prior to acceptance. Clean ductwork to insure system is clear of dirt or other foreign matter.

   3. Surplus material, rubbish and equipment resulting from the Contractor's work shall be removed from the building and premises by the Contractor upon completion of the work in accordance with the Architectural Specifications.

   4. All permanent nameplates on equipment shall be kept clean and exposed for easy reading. If field conditions warrant (in the opinion of the Architect), the Contractor may be requested to vacuum clean all equipment and installation materials which are unduly filled or covered with dust, debris, etc.

3.4 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair cut surfaces to match adjacent surfaces.

3.5 EXCAVATION AND BACKFILLING

A. General

1. Refer to Contract Documents and the Architectural Specifications and bid rock and earth excavation with the requirements listed.

B. Excavation

1. Rock excavation and excavation for sewer piping shall be made to a depth of 4" below pipes or as shown on the Drawings and bedded with crushed rock or dense graded aggregate to proper grade. The Contractor shall be responsible for locating in the field the lines shown on the Drawings. The location shall be approved by the Architect before trench excavation is begun. The Contractor shall use reference points as shown on the Drawings for locating control points on the lines. Trench bottom shall follow uniform grades insofar as possible and shall be relatively flat from side to side.

2. Minimum depth of bury for all lines outside building shall be 36" to top of pipe or as shown on the Drawings and/or profiles. The width of the trench above that level shall be as wide as necessary for sheathing and bracketing. The width for other lines shall be as shown on the Drawings or as required. All piping under slab shall be deep enough to allow vertical code bends.

C. Dewatering and Shoring

1. Trenches and other excavation shall be maintained adequately free of water and shall be adequately shored, where necessary, to protect workmen, materials, equipment and adjacent structures. Discharge from pumps, drains or bailing shall be placed in ditches, storm drains or natural drainageways. No extra will be paid for this work.

D. Backfilling

1. Under all backfill conditions, with exceptions as listed below, earth shall be hand-placed to a height of at least 6" above the top of the pipe. After backfilling and tamping with earth to a depth of 6" above the top of the pipe, the backfilling operation may be continued by a machine in 12" layers, compacted with approved mechanical tampers. Any trenches improperly backfilled, or where settlement occurs, shall be re-opened to the depth required and compacted with the surface restored to the required grade and compaction, and smoothed off. All trenches which run under sidewalks, roadways, etc. shall be filled to sub-grade with dense graded aggregate.

2. Dense graded aggregate shall be crushed limestone blended into a homogeneous mixture and graded in conformance with Article 208.2.0 of the latest edition of the standard Specifications of the Kentucky Department of Highways.

3. Sewer piping shall be backfilled with #6 crushed rock or smaller, or dense graded aggregate to a height of at least 6" above the top of the pipe. The remainder of backfilling material shall be as specified hereinbefore.

4. Compaction of backfill under building slabs and other paved areas outside of the building shall be 95% of maximum density.

5. In trenches cut in existing paving, backfill with a flowable fill consisting of a blend of cement, sand and water and may also include fly ash or other materials. The mixture

shall have a one-day strength of 10-20 p.s.i. And twenty-eight day strength of 50-100 p.s.i. The fill shall be poured up to the bottom of the base of the specified paving repair.

E. Surplus Materials

1. All surplus material, particularly rock, resulting from this operation, shall be removed from the grounds. Disposal of such materials is the responsibility of the Contractor. Earth shall be disposed of only after rock has been removed from the site.

F. Blasting

1. All blasting on this project shall be done as set forth in the contract documents and the architectural specifications.

3.6 FOUNDATIONS AND ANCHOR BOLTS

A. The Contractor shall be responsible for the location of all concrete pads required for all equipment installed under this Contract. All pads required will be poured at the expense of the Contractor.

B. The Contractor shall furnish anchor bolts for all equipment installed on concrete slabs and/or bases. Bolts shall be placed in exact positions prior to pouring concrete. Sizes and location of bolts shall be determined by the manufacturer's recommendations for the equipment served.

3.7 PROTECTION

A. All work, equipment and material shall be protected at all times. All pipe openings shall be closed with caps or plugs during construction. All equipment and accessories shall be tightly covered and protected against dirt, water or other injury during period of construction.

B. No plumbing or heating piping shall be installed in any part of the building where danger of freezing may exist without adequate protection being given by the Contractor installing the pipe, whether or not insulation is specified for the particular piping. All damages resulting from leaking pipes shall be borne by the Contractor whose work is at fault.

C. It shall be the responsibility of the Contractor to install and maintain pipe and equipment which is clean and free of rust, dirt, scale, etc. Where roughed-in only, the Contractor shall provide temporary airtight covers at all conduit, duct and equipment openings.

3.8 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS

A. The Architectural, Structural, Electrical, Plumbing and Heating and Ventilating Drawings and Specifications are complementary to one another. Respective Contractors shall rough-in for and furnish all labor and materials necessary to make final connections to all equipment furnished by the Owner or any other Contractor or Sub-Contractor which requires mechanical or electrical connections.

B. The Contractor making the required connections shall be responsible for making proper connections and shall be responsible for any damages caused by erroneously connected equipment.

3.9 LINTELS

A. In general, others will provide all lintels. However, the Contractor shall refer to the Architectural Drawings and Specifications and ascertain whether or not lintels are included in the general construction.

B. If lintels are NOT included in the general construction, then the Contractor is responsible for all lintels where ductwork, louvers and/or equipment furnished by him is installed under this contract.

C. All lintels shall be subject to the approval of the Architect or his representative.

3.10 ACCESS DOORS

A. The Contractor shall refer to the Architectural Drawings to ascertain which rooms have removable ceilings. Where removable ceilings are specified, access to equipment may be obtained by removing the ceiling pieces. Where non-removable ceilings are specified, the Contractor shall furnish all required access doors for servicing valves, equipment, etc.

B. Access doors shall be L.M. Walsh Company "Way-Loctor", Milcor, Miami or approved equal. No. 3 shall be used for concrete block or tile walls having no plaster finish and No. 20 shall be used for plastered walls and ceilings or for acoustical tile ceilings. All doors shall be prime coated and key operated and keys shall be the same for plumbing and heating work.

C. Installation of doors will be done by the General Contractor. However, the Contractor shall be responsible for the correct location of them for servicing equipment. These access doors shall be sized large enough to service the equipment with a minimum size of 20"x20".

3.11 ELIMINATION OF NOISE AND VIBRATION (CONSTRUCTION EQUIPMENT)

A. During construction of this project, if any system or piece of equipment produces noise or vibration which is, in the opinion of the Architect, objectionable to the Owner, the Contractor shall, at his own expense, make changes in equipment and do all work necessary to eliminate the objectionable noise or vibration.

END OF SECTION

SECTION 15100 - PIPING & VALVES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe; pipe fittings, valves, and connections for piping systems.

1. Sanitary sewer.
2. Domestic water.
3. Condensate Removal.
4. Natural Gas.
5. See Variable Refrigeration System for piping for that system.

1.2 RELATED SECTIONS

A. Division 15 - Mechanical Insulation.

B. Division 16 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

1.3 REFERENCES

A. ASME B31.9 - Building Service Piping.

B. Kentucky Building Code.

C. Kentucky Plumbing Code.

D. IMC, International Mechanical Code.

1.4 SUBMITTALS FOR REVIEW

A. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

A. Project Record Documents: Record actual locations of valves and piping. Provide maintenance data for all valves, which can be rebuilt.

1.6 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME SEC IX and applicable state labor regulations.

C. Welder's Certification: In accordance with Kentucky standards for trade involved.

D. Identify pipe with marking including size, ASTM material classification, ASTM specification, water pressure rating.

E. Pipe is to be stored covered, off the ground, with end caps in place. Pipe installed that is dirty or rusted shall be cleaned and painted.

1.7 REGULATORY REQUIREMENTS

A. Perform Work in accordance with Codes listed in Paragraph 1.3 references.

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 - PRODUCTS

2.1 PIPING SCHEDULE

A. Furnish and install piping of sizes and locations shown on the drawings. Piping and fitting material shall be as shown in the accompanying table.

B. Table of Piping Fittings (Interior)

Service	Sizes	Pipe	Fittings
Domestic Water	All Sizes	Type L Hard Copper Or PEX	Wrought Copper or Cast Brass Solder Joint
Condensate Drain Above Slab	All Sizes	Type L Hard Copper	Wrought Copper Solder Joint
Condensate Drain Below Slab	All Sizes	DWV PVC	Glue Joints

* The Contractor shall have the option of using Type "L" Hard Copper with wrought copper or cast brass solder joint fittings.

1. All pipe nipples shall be of the same material as the lines in which they are installed.

2. All piping not covered in the above table shall be Schedule 40 Black Steel with 125 lb. cast iron fittings.

3. Screwed fittings shall be Midwest, Grinnell, Crane or equal. Welding fittings shall be long radius type, Tube Turns, Midwest, Crane or equal.

4. Solder joint fittings shall be "Nibco", Ohio Brass, Chase or equal. Solder shall be lead-free 95-5 for all applications except DWV, where 50-50 may be used. Acid will not be allowed. Silver solder shall be used for brazing DX lines.

C. Pipe And Fittings - Exterior (Does Not Include Soil, Waste And Vent Piping).

1. Be responsible for contacting the local utility companies and include in the base bid all costs incurred with tap-on fees, service taps, piping to property line, meters, meter pits and pressure reducing equipment as required by the local utility companies.

2. Furnish and install sewer piping from the building to points shown on the Drawings. Piping shall be polyvinyl chloride SDR of 35. Piping shall be suitable for forced main service.

3. Furnish and install a new water service from the building to the point shown on the Drawings. Piping shall be Type K copper with wrought copper solder joint fittings or Class 200 PVC pressure piping with an S.D.R. of 21.

4. Furnish and install all water main piping from the building to the points shown on the Drawings. Piping shall be cement lined, Class 250 cast iron pipe with Tyton joints or Johns-Manville "Blue-Brute", PVC water main with ring-tite joints, Class 150 made to cast iron pipe outside diameter and meeting the requirements of SDR 17 with fitting the same as cast iron pipe.

5. Furnish and install other piping as indicated on the drawings.

D. Soil, Waste And Vent Piping

1. Pipe and Fittings (Above Slab)

a. All soil, waste and vent piping 3" and larger shall be standard weight cast iron and shall conform to the latest ASTM Standard Specifications for standard weight fittings. All joints shall be neoprene joints. All plumbing "trees" and piping made with neoprene joints shall be supported in a "plumb" and properly graded manner.

b. Waste and vent piping 2½" and smaller shall be DWV hard copper, hubless cast iron or galvanized piping. Fittings for copper vent piping shall be wrought copper and for copper waste piping shall be cast brass drainage type. If cast iron piping is installed, all joints may be leaded or neoprene.

c. Where allowed by building and plumbing code polyvinyl chloride piping or ABS may be used.

d. Space above ceilings is a return air plenum, contractor shall protect non flammable piping as required for use in a plenum space.

2. Pipe and Fittings (Below Slab or Grade)

a. All sanitary waste and vent piping below slab shall be standard weight cast iron pipe with neoprene joints, polyvinyl chloride or ABS.
b. Trap & first 10 feet of pipe at dishwasher shall be cast iron.

2.2 FLANGES, UNIONS, AND COUPLINGS

A. Pipe Size 3 inches and Under:
1. Ferrous pipe: Class 150 malleable iron threaded unions.
2. Copper tube and pipe: Class 150 bronze unions with soldered joints.

B. Pipe Size Over 1 inch:
1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
2. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Grooved and Shouldered Pipe End Couplings:
1. Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
2. Sealing gasket: "C" shape composition-sealing gasket.

D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.3 GATE VALVES

A. Sizes 2" and smaller shall be Nibco Bronze No. T-134, Crane Brass, No. 431UB, Milwaukee 1151 or approved equal, screwed, solid wedge disc, tapered seat, rising brass stem, union bonnet working pressure 150 PSI steam.

B. Sizes 2½" and larger shall be Nibco No. F-617-0, Crane IBBM, No. 465 1/2, Milwaukee F2885 or approved equal, iron body bronze mounted, flanged with flanged bonnet and yoke, rising bronze stem, brass seat and disc, working pressure 125 PSI steam.

2.4 GLOBE VALVES

A. Sizes 2" and smaller shall be Nibco Bronze No. T-235-Y, Crane Brass, No. 7, Milwaukee 590 or approved equal, screwed renewable composition disc, rising brass stem, working pressure 150 PSI steam.

B. Sizes 2½" and larger shall be Nibco Bronze, No. F-918-B, Crane IBBM, No. 351, Milwaukee F2981 or approved equal flanged with flanged bonnet and yoke, rising bronze stem, brass seat and disc, working pressure 125 PSI steam.

2.5 CHECK VALVES (HORIZONTAL)

A. Sizes 2" and smaller shall be Nibco Bronze, No. T-433-B, Crane Brass No. 137, Milwaukee 510 or approved equal, screwed with screwed cap, swing check, renewable bronze disc, working pressure 150 PSI steam.

B. Sizes 2½" and larger shall be Nibco, No. F-918-B, Crane IBBM, No. 373, Milwaukee F2974 or approved equal, swing check, flanged with flanged cap, bronze seat and disc, working pressure 125 PSI steam.

2.6 BALANCING VALVES

A. Sizes 2" and smaller shall be Powell, Figure 2200 or approved equal, 175 PSI WOG, screwed, lubricated plug cock.

B. Size 2½" and larger shall be Powell, Figure 2201 or approved equal, 175 PSIG WOG flanged, lubricated plug cock.

C. Valves, as manufactured by Crane, Keystone, Homestead or equal will be acceptable.

2.7 RELIEF VALVES

A. Refer to individual articles on heaters or boilers.

2.8 BUTTERFLY VALVES

A. Dezurik, Figure No. 632-LD, Crane, Milwaukee, Keystone, Nibco or approved equal, lug style, semi-steel body, bronzed discs with stainless steel shafts, bronze bushings and infinite position adjustment lever on valves 4" and smaller and enclosed handwheel actuators on all valves 6" and larger.

2.9 BALL VALVES (WATER)

A. Milwaukee Model BA-100 Apollo, Nibco or equal bronze body and bonnet, chrome plated brass ball, glass-reinforced teflon seat, blowout proof stem, 600 PSI WOG, 150 PSI WSP, screwed, lever operated with extended neck to match insulation thickness, CV of 24 for ¾" size, 34 for 1" size.

2.10 EXTERIOR VALVES AND ACCESSORIES

A. Valve - Mueller, Cat. No. A-2480-20, mechanical joint of sizes as required on Drawings.

B. Valve Boxes - Mueller, Cat. No. H-10365, flange base. Provide extension piece as required.

C. Furnish a valve-operating wrench with socket to fit valves above. Length of wrench to be as required and shall be equal to Mueller, No. A-24610.

D. Valves, as manufactured by Milwaukee, Kennedy, Traverse City or equal will be accepted.

2.11 BACKFLOW PREVENTER

A. See schedule on drawings.

2.12 CHECK VALVES (VERTICAL)

A. Mueller, Fig. No. 107M-A-P, Williams-Hager, Nibco or approved equal, 250 PSI ANSI B16.1 globe type, silent check valve, flanged ends, cast iron body with bronze trim.

2.13 UNIONS

A. Unions shall be installed at all locations shown on the Drawings and as required for the isolation of all screwed valves and connections to screwed equipment.

B. Unions in steel piping 2" and smaller shall be ground joint, malleable iron, screwed; 250 PSI working pressure for high pressure steam and return lines and chilled water lines, and 125 PSI working pressure for all other applications.

C. Unions in piping 2½" and larger shall be flanged type with gaskets designed for the working pressure of the unions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.
C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION
A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain maximum headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

H. Provide access doors where valves and fittings are not exposed.

I. Establish elevations of buried piping outside the building to ensure not less than 3 feet of cover.

J. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.

K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

L. Provide support for utility meters in accordance with requirements of utility companies.

M. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.

N. Install bell and spigot pipe with bell end upstream.

O. Install valves with stems upright or horizontal, not inverted.

P. Pipe vents from gas pressure reducing valves to outdoors and terminate in weatherproof hood.

Q. Sleeve pipes passing through partitions, walls and floors.

R. Trap and first 10 feet of pipe at dishwasher shall be cast iron.

3.4 INSTALLATION PROCEDURES

A. All piping furnished and installed under this Contract and shown on the Drawings shall be new and conform to the applicable specifications of ASA, as applied to the class, weight and type of piping installed.

B. All underground piping shall be installed at the elevations given on the Drawings or on details pertaining to the installation in question. All piping shall be installed with an even grade between elevations given and in accordance with articles in these Specifications, which apply to this work.

C. All piping located in pipe chases, furred walls, and ceilings shall be tested for leaks before being concealed or covered in any manner.

D. All waste and vent piping and roof leaders, condensate drain piping, shall pitch minimum of 1/8" per foot.

E. Where construction does not permit pitching, all piping other than waste, vent and roof leader piping may be installed dead level. Provide drain valves at low point.

F. No pressure piping shall be installed in or under concrete floor slab. No "Bull Head" Tees will be allowed.

G. High point in all recirculated water systems shall be provided with manual air vent valves and/or automatic air vents. Automatic air vents shall be piped to the outside of the building or to an approved drain.

H. Use dielectric insulating unions wherever adjoining materials being connected are of dissimilar material such as connections between copper and steel piping.

3.5 PIPE LAYING AND BEDDING

A. Provide firm bed for each pipe so that pipe is supported uniformly along barrel and does not rest on bell or joint when brought to grade. Set each length to grade and line before making joint.

B. Thoroughly inspect and fit pipes before lowering into trenches. Clean interior of joints before joint material is placed.

C. Lay to uniform grade between elevations shown or to pitch indicated. Use Engineer's level and transit along with adequately spaced and supported batter boards to establish horizontal and vertical control. Lay bell and spigot pipe with bells upstream.

D. For each pipe which passes under a footing or grade beam, provide steel pipe sleeve, with at least two (2) inches clearance around pipe and extending eighteen (18) inches beyond each side of footing or grade beam. Before backfilling, pack space between pipe and sleeve for a depth of two (2) inches at each end of sleeve with oakum or yarn to prevent the entrance of dirt. If pipe is installed before footing or grade is constructed, place compacted backfill around sleeve. If pipe is installed after building work is constructed, backfill with concrete to a thickness of at least six (6) inches around sleeve and up to the footing or grade beam.

E. Close open ends of piping during construction to prevent earth entering lines. Close ends of lines and unused openings in fittings.

F. Provide concrete thrust blocks for water piping as indicated or required to resist any thrust that may be encountered.

3.6 APPLICATION

A. Use grooved mechanical couplings and fasteners only in accessible locations.

B. Install unions downstream of valves and at equipment or apparatus connections.

C. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

D. Install gate, ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.

E. Install globe ball or butterfly valves for throttling, bypass, or manual flow control services.

F. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.

G. Provide spring loaded check valves on discharge of water pumps.

H. Provide plug valves in natural gas systems for shut-off service.

I. Provide flow controls in water recirculating systems where indicated.

3.7 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed and clean.

B. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residuals.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.8 SERVICE CONNECTIONS

A. Connect to existing sanitary connection. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved reduced pressure water meter with by-pass valves and sand strainer.

1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Caulk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.

END OF SECTION

SECTION 15260 – MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Flexible elastomeric.
b. Mineral fiber.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

D. Flexible Elastomeric (aka "armaflex"): Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Aeroflex USA Inc.; Aerocel.
    b. Armacell LLC; AP Armaflex.
    c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
    d. or Equal

E. Mineral-Fiber Blanket Insulation (aka "duct-wrap"): Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corp.; Duct Wrap.
    b. Johns Manville; Microlite.
    c. Knauf Insulation; Duct Wrap.
    d. Manson Insulation Inc.; Alley Wrap.
    e. Owens Corning; All-Service Duct Wrap.
    f. or Equal

F. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Fibrex Insulations Inc.; Coreplus 1200.
    b. Johns Manville; Micro-Lok.
    c. Knauf Insulation; 1000 Pipe Insulation.
    d. Manson Insulation Inc.; Alley-K.
    e. Owens Corning; Fiberglas Pipe Insulation.

2. Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
2. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.3 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

K. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

3.4 PENETRATIONS

A. Refer to drawings for details showing insulation requirements at penetrations.

3.5 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

1. **Attachment of insulation using tape only is not acceptable.**

B. Omit insulation on valves, filter-dryers, or any other piping specialty that needs to remain accessible for service or maintenance. Also omit insulation where necessary for connected system to operate correctly.

3.6 MINERAL-FIBER INSULATION BLANKET INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts (except top side) and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions larger than 18 inches, place pins 16 o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
b. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
c. Do not over-compress insulation during installation.
d. Impale insulation over pins and attach speed washers.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 PRE-FORMED MINERAL-FIBER PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch , and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 INSULATION SCHEDULE

Application	Material	Thickness
Domestic Cold Water (All Sizes)	Mineral-Fiber Pipe Insulation Or Flexible Elastomeric	1 inch 3/4"
Domestic Hot Water (All Sizes)	Mineral-Fiber Pipe Insulation Or Flexible Elastomeric	1 inch 3/4"
Supply Ductwork (All Sizes)	Mineral-Fiber Blanket	2 inches
Return Ductwork (All Sizes)	Mineral-Fiber Blanket	2 inches
Refrigerant Piping (All Sizes)	Flexible Elastomeric	3/4 inch

END OF SECTION 15260

SECTION 15430 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Floor drains.

B. Cleanouts.

C. Hose bibs.

D. Hydrants.

E. Water hammer arrestors.

1.2 RELATED SECTIONS

A. Division 15 - Piping & Valves.

B. Division 15 - Plumbing Fixtures.

C. Division 15 - Plumbing Equipment.

D. Division 16 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

1.3 REFERENCES

A. ASME A112.21.1 - Floor Drains.

B. ASME A112.26.1 - Water Hammer Arrestors.

C. ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.

D. ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.

E. DI G-101 - Testing and Rating Procedure for Grease Interceptors with Appendix of Sizing and Installation Data.

F. DI WH-201 - Water Hammer Arrestors.

1.4 SUBMITTALS FOR REVIEW

A. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.

B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

1.5 SUBMITTALS FOR INFORMATION

A. Certificates: Certify that grease and oil interceptors meet or exceed specified requirements.

B. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

A. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, and water hammer arrestors.

B. Operation Data: Indicate frequency of treatment required for interceptors.

C. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Accept specialties on site in original factory packaging. Inspect for damage.

1.8 EXTRA MATERIALS

A. Supply two loose keys for outside hose bibs.

PART 2 - PRODUCTS

2.1 WATER HAMMER ARRESTORS

A. ANSI A112.26.1; stainless steel or copper construction, bellows type sized in accordance with PDI WH-201, precharged suitable for operation in temperature range 34 to 250 degrees F and maximum 250 psi working pressure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibs.

F. Pipe relief from backflow preventer to nearest drain.

G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water as indicated, with a minimum of two sets in the building.

H. Install trap primers for all floor drains not installed in toilet rooms.

END OF SECTION

SECTION 15440 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Water closets.

B. Urinals.

C. Lavatories.

D. Sinks.

E. Service sinks.

F. Electric water coolers.

1.2 RELATED SECTIONS

A. Division 15 - Supports and Anchors.

B. Division 15 - Piping & Valves.

C. Division 15 - Plumbing Specialties.

D. Division 15 - Plumbing Equipment.

E. Division 16 - Equipment Wiring Systems: Electrical characteristics and wiring connections

1.3 REFERENCES

A. ARI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.

B. ASME A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use.

C. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.

D. ASME A112.19.2 - Vitreous China Plumbing Fixtures.

E. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).

F. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.

G. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

A. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

A. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

B. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.7 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., or a testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Accept fixtures on site in factory packaging. Inspect for damage.

B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.9 WARRANTY

A. Provide five year manufacturer warranty for electric water cooler.

1.10 EXTRA MATERIALS

A. Supply two sets of faucet washers, flush valve service kits, and toilet seats minimum, and two additional for each five fixtures.

PART 2 - PRODUCTS

2.1 See Schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall supports and wall carriers as indicated.

E. Seal fixtures to wall and floor surfaces with sealant, color to match fixture.

F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended to hold fixture in place.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.5 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

A. Clean plumbing fixtures and equipment.

3.7 PROTECTION OF FINISHED WORK

A. Do not permit use of fixtures until acceptance of project.

3.8 SCHEDULES

A. Fixture Rough-In

	Hot	Cold	Waste	Vent
Water Closet (Flush Valve)		1 inch	4 inch	2 inch
Urinal: (Flush Valve)		3/4 inch	2 inch	1-1/2 in
Lavatory:	1/2 inch	1/2 inch	1-1/2 in	1-1/4 in
Sink:	1/2 inch	1/2 inch	1-1/2 in	1-1/4 in
Service Sink:	1/2 inch	1/2 inch	3 inch	1-1/2 in
Drinking Fountain		1/2 inch	1-1/4 in	1-1/4 in

END OF SECTION

SECTION 15462 - ELECTRIC WATER HEATERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 0 and 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes electric water heaters and accessories.

B. Related Section: Division 15 Section "Plumbing Specialties" contains requirements that relate to this Section.

1.03 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate dimensions, finishes and coatings, required clearances, methods of assembly of components, and piping and wiring connections.

C. Shop Drawings showing layout of each unit, including tanks, pumps, controls, related accessories, and piping.

D. Setting Drawings with templates and directions for installing foundation bolts, anchor bolts, and other anchorages.

E. Wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to water heaters. Include ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between factory-installed and field-installed wiring.

F. Product certificates signed by manufacturers of water heaters certifying that their products comply with specified requirements.

G. Field quality-control installation reports.

H. Maintenance data for water heaters to include in operation and maintenance manuals specified in Division 1. Include startup instructions.

1.04 OPERATING AND MAINTENANCE MANUALS

A. Three sets of O&M instructions and manuals shall be submitted in loose-leaf 3-ring cardboard reinforced vinyl binders to the Engineer in accordance with the General Conditions.

B. Contained in each binder shall also be vendors, warranty information, vendor phone numbers, list of materials, and materials parts list.

C. O & M Manuals shall be available to the Owner prior to equipment training commences.

D. General and Supplemental General Conditions shall supercede this paragraph where conflicts occur.

E. O & M manuals shall be submitted on CD disk in PDF format along with the required paper copies. Contractor shall send same PDF format information to Facility Management System Contractor to incorporate into the operating system software.

1.05 QUALITY ASSURANCE

A. ASHRAE Standard: Comply with performance efficiencies prescribed in ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

B. ASHRAE Standard: Comply with performance efficiencies prescribed in ASHRAE 90.2, "Energy Efficient Design of New Low-Rise Residential Buildings."

C. NFPA Standard: Comply with NFPA 70, "National Electrical Code," for electrical components.

D. Listing and Labeling: Provide electrically operated water heaters, controls, and components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

E. Product Options: Drawings indicate size, profiles, connections, dimensional requirements, and characteristics of water heaters and accessories and are based on specific types and models indicated. Other manufacturers' water heaters and accessories with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

1.06 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of Contract Documents.

B. Special Warranty: Submit a written warranty executed by manufacturer agreeing to repair or replace water heaters and accessories that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, tanks and elements. This warranty is in addition to, and not a limitation of, other rights Owner may have against Contractor under Contract Documents.

C. Warranty Period: 5 years after date of Substantial Completion.

1.07 EQUIPMENT STARTUP AND STARTUP REPORTS

A. Field Testing and Adjustment: It is required that the equipment specified in this section of the specifications be started up by a certified representative of the equipment manufacturer. Startup shall consist of testing and adjusting the equipment to ensure it is properly operating per Drawings, Specifications, and Accepted Shop Drawing parameters. Minimum startup time the representative shall be on site is one day, not including travel time. The Architect/Engineer shall be notified one week prior any scheduled startup date. Any costs involved with starting up the equipment shall be included in the bid price regardless of problems encountered.

B. Startup Report: A written report shall be created that documents all procedures used in starting up and running the piece of equipment. The report shall certify that the equipment is running in accordance with the accepted shop drawing parameters for capacity, performance, and energy usage. Report shall include the name of the manufacturer's representative starting up the equipment, date equipment was started, problems encountered and actions taken to correct problems. Report shall include acceptance of all external connections to the piece of equipment and that the equipment was installed in accordance with manufacturer's documented installation instructions.

C. Startup date shall not be confused with warranty start date, or substantial completion dates. Warranty equipment begins on the substantial completion date per Division 1 of these Specifications.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Domestic Electric Hot Water Heaters:

   a. See Schedule in Plumbing Drawings.

2. Thermal Expansion Absorbers

   a. Furnish and install as shown on Drawings Amtrol, Bell & Gossett, Armstrong or Taco thermal expansion absorbers with polypropylene liner, heavy-duty butyl diaphragm and outer steel shell constructed per ASME Code Section VIII.

   b. See Schedule in Plumbing Drawings

   c.

PART 3 - EXECUTION

3.01 CONCRETE BASES

A. Install concrete bases of dimensions indicated for water heaters and accessories. Refer to Division 3 Section "Cast-in-Place Concrete" and Division 15 Section "Basic Mechanical Materials and Methods."

3.02 WATER HEATER INSTALLATION

A. General: Install water heaters on concrete bases. Set and connect units according to manufacturer's written instructions. Install units plumb, level, and firmly anchored in locations indicated. Maintain manufacturer's recommended clearances. Install so controls and devices are accessible for service.

B. Anchor water heaters and storage tanks to substrate.

C. Install seismic restraints as indicated.

E. Install temperature and pressure relief valves in top portion of storage water heater tanks and hot-water storage tanks. Use relief valves with sensing elements that extend into tanks. Extend relief valve outlet with water piping in continuous downward pitch and discharge to closest floor drain.

F. Install pressure relief valves in hot-water-outlet piping for water heaters without storage. Extend relief valve outlet with water piping in continuous downward pitch and discharge to closest floor drain.

G. Install vacuum relief valves in cold-water-inlet piping.

H. Install vacuum relief valves in water heaters and hot-water storage tanks that have copper lining.

I. Install water heater drain piping as indirect waste to spill into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 15 Section "Plumbing Specialties" for drain valves.

J. Install thermometers on water heater inlet and outlet piping. Thermometers are specified in Division 15 Section "Meters and Gages."

M. Install piping adjacent to water heaters to allow service and maintenance.

N. Arrange for field-applied insulation on equipment and piping not furnished with factory-applied insulation.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Connect hot- and cold-water piping to units with shutoff valves and unions. Connect hot-water circulating piping to unit with shutoff valve, check valve, and union.

2. Make connections with dielectric fittings where piping is made of dissimilar metals. Dielectric fittings are specified in Division 15 Section "Basic Mechanical Materials and Methods."

B. Electrical Connections: Power wiring and disconnect switches are specified in Division 16 Sections. Arrange wiring to allow unit servicing.

C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 COMMISSIONING

A. Perform the following final checks before startup:

1. Fill water heaters with water.

2. Check that piping system tests are complete.

3. Check for piping connection leaks.

4. Check for clear relief valve inlets, outlets, and drain piping.

5. Check operation of pumps and circulators.

6. Test operation of safety controls, relief valves, and devices.

B. Perform the following startup procedures:

1. Energize electric circuits.

2. Adjust operating controls.

3. Adjust hot-water-outlet temperature settings to 110 F.

END OF SECTION

SECTION 15621 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Fixed-plate total heat exchangers.
   2. Packaged energy recovery units.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: For air-to-air energy recovery equipment. Include plans, elevations, sections, details, and attachments to other work.

   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Field quality-control reports.

D. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ARI Compliance: Capacity ratings for air-to-air energy recovery equipment shall comply with ARI 1060, "Rating Air-to-Air Energy Recovery Equipment."

C. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

D. UL Compliance: Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."

1.6 COORDINATION

A. Coordinate layout and installation of air-to-air energy recovery equipment and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Packaged Energy Recovery Units: Two years.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: Three set(s) of each type of filter specified.

PART 2 - PRODUCTS

2.1 FIXED-PLATE TOTAL HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide RenewAire or comparable product by one of the following:

1. Mitsubishi Electric Sales Canada Inc.
2. RenewAire LLC.
3. Micrometl.
4. Venmar.
5.

C. Casing: Galvanized steel.

D. Plates: Evenly spaced and sealed and arranged for counter airflow.

1. Plate Material: Chemically treated paper with selective hydroscopicity and moisture permeability, and gas barrier properties.

E. Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
4. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

2.2 CONTROLS

A. Unit shall be on when lights form designated light switch are on.

2.3 CAPACITIES AND CHARACTERISTICS

A. See Schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fixed-plate heat exchangers so supply and exhaust airstreams flow in opposite directions.

1. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to heat exchanger. Access doors and panels are specified in Division 23 Section "Air Duct Accessories."

B. Install units with clearances for service and maintenance.

C. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for ductwork specified in Division 23 Section "Metal Ducts."

C. Install piping adjacent to machine to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Adjust seals and purge.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Set initial temperature and humidity set points.
5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 15621

SECTION 238126 - DUEL FUEL SPLIT-SYSTEMS (HEAT PUMP + GAS FURNACE)

PART 1 - GENERAL

1.1 RELATE D DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Split-system heat pump units.
2. Evaporator (cooling coil)
3. Condensing gas furnaces

B. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

C. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1-2007 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.5 COORDINATION

A. Where condensing units are located on grade, coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

B. Where condensing units are located on roof, coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 07 Section "Roof Accessories."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: **Five** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Air Conditioning; Div. of Carrier Corporation.
2. Lennox Industries Inc.
3. Trane Company (The); Unitary Products Group.
4. York International Corp.
5. Or Equal

2.2 AIR-COOLED, 15 SEER HEAT PUMPS (OUTDOOR UNIT)

A. Casing: Steel, finished with baked enamel in standard color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

1. Compressor Type: Scroll
2. Refrigerant: R-410A

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal-overload protection.

G. Mounting Base: Concrete with cast-in place anchors, or poly ethylene base.

H. Minimum Energy Efficiency: **15 SEER**

2.3 GAS-FIRED FURNACES, CONDENSING

A. General Requirements for Gas-Fired, Condensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.47/CSA 2.3, "Gas-Fired Central Furnaces," and with NFPA 54. Minimum 95% efficiency.

B. Cabinet: Steel or Galvanized steel.

1. Cabinet interior around heat exchanger shall be factory-installed insulation.
2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
3. Factory paint external cabinets in manufacturer's standard color.

C. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.

1. Fan Motors: Permanent split-capacitor (PSC).

2. Special Motor Features: Multi-tapped, multispeed with internal thermal protection and permanent lubrication.

D. Type of Gas: Natural.

E. Heat Exchanger:

1. Primary: Aluminized steel.
2. Secondary: Stainless steel.

F. Burner:

1. Gas Valve: 100 percent safety [**two-stage**] [**modulating**] main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.

G. Gas-Burner Safety Controls:

1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.

H. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.

I. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; terminals for connection to accessories.

J. Accessories:

1. Combination Combustion-Air Intake and Vent: PVC plastic fitting to combine combustion-air inlet and vent through outside wall or roof as indicated on plans.

2. PVC Plastic Vent Materials:

a. PVC Plastic Pipe: Schedule 40, complying with ASTM D 1785.
b. PVC Plastic Fittings: Schedule 40, complying with ASTM D 2466, socket type.
c. PVC Solvent Cement: ASTM D 2564.

2.4 COOLING COILS

A. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

1. Coil shall be sized to match outdoor heat pump and indoor fan characteristics.

2.5 ACCESSORIES

A. Thermostat: Low voltage 7-day programmable thermostat.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

1. Minimum Insulation Thickness: 1/2 inch thick.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Where units are noted on the drawings to be installed on concrete pad, install heat pump on 4-inch-thick, reinforced concrete base; 4 inches larger on each side than unit.

D. Where units are noted to be installed on manufactured mounting base, install heat pumps on polyethylene mounting base.

E. Install roof-mounting compressor-condenser components on equipment supports specified in Division 07 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

F. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

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

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

C. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and/or return ducts to air handler with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 15623

SECTION 15738 - SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes split-system heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Units shall be designed to operate with HCFC-free refrigerants.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Air Conditioning; Div. of Carrier Corporation.
2. Trane Company
3. York International Corp.
4. McQuay
5. Mitsubishi
6. Sanyo
7. LG

2.2 CONCEALED EVAPORATOR-FAN COMPONENTS

A. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.

1. Insulation: Faced, glass-fiber duct liner.
2. Drain Pans: Galvanized steel, with connection for drain; insulated.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

D. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

E. Fan Motors: Comply with requirements in Division 15 Section "Motors."

1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

F. Wiring Terminations: Connect motor to chassis wiring with plug connection.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

1. Compressor Type: Scroll.
2. Refrigerant Charge: R-410A

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Aluminum-propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal-overload protection.

G. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Install piping adjacent to unit to allow service and maintenance.

B. Ground equipment according to Division 16 Section "Grounding and Bonding."

C. Electrical Connections: Comply with requirements in Division 16 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 15738

SECTION 233423 – EXHAUST FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Ceiling-mounting ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Fan speed controllers.
7. Wiring Diagrams: Power, signal, and control wiring.

B. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

PART 2 - PRODUCTS

2.1 CEILING-MOUNTING VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Broan Mfg. Co., Inc.
2. Carnes Company HVAC.
3. Dayton Electric Manufacturing Co.; a division of W. W. Grainger, Inc.
4. Greenheck.
5. JencoFan; Div. of Breidert Air Products.
6. Loren Cook Company.
7. Penn Ventilation.

B. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.

C. Housing: Steel, lined with acoustical insulation.

D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

E. Grille: Plastic, stainless steel, aluminum, or painted aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories: As noted on the Drawings

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

C. Install units with clearances for service and maintenance.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete.
3. Verify that cleaning and adjusting are complete.
4. Adjust damper linkages for proper damper operation.
5. Remove and replace malfunctioning units and retest as specified above.

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

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

END OF SECTION 15625

SECTION 15890 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealants.
5. Hangers and supports.

B. Related Sections:

1. Division 15 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Fittings
4. Reinforcement and spacing
5. Seam and joint construction.
6. Penetrations through fire-rated and other partitions.
7. Hangers and supports, including methods for duct and building attachment and vibration isolation.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

D. Tie Rods: Galvanized steel, 1/4-inchminimum diameter for lengths 36 inchesor less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANTS

A. General Sealant Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. VOC content of 250 g/L or less.
9. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
10. Service: Indoor or outdoor.
11. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 DUCT SEALING

A. Seal **all** longitudinal and transverse joints.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

C. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 15 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

END OF SECTION 15890

SECTION 15910 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Air turning devices/extractors.

B. Backdraft dampers.

C. Smoke dampers.

D. Duct access doors.

E. Duct test holes.

F. Fire dampers.

G. Flexible duct connections.

H. Volume control dampers.

1.2 RELATED SECTIONS

A. Division 15 - Ductwork.

B. Division 16 - Equipment Wiring Systems.

1.3 REFERENCES

A. IMC - International Mechanical Code

B. NFPA 70 - National Electrical Code.

C. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

D. UL 33 - Heat Responsive Links for Fire-Protection Service.

E. UL 555 - Fire Dampers and Ceiling Dampers.

F. UL 555S - Leakage Rated Dampers for Use in Smoke Control Systems.

1.4 SUBMITTALS

A. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers and duct access doors.

B. Manufacturer's Installation Instructions: Indicate for fire dampers and combination fire and smoke dampers.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.6 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., or a testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

1.8 EXTRA MATERIALS

A. Provide two of each size and type of fusible link.

PART 2 - PRODUCTS

2.1 AIR TURNING DEVICES/EXTRACTORS

A. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.2 BACKDRAFT DAMPERS.

A. Gravity Backdraft Dampers, size 18X18 or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturers standard construction.

B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: 16 gage thick galvanized steel, with blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.3 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.4 FIRE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

B. Ceiling Dampers: Galvanized steel, 22 gage frame and 16 gage flap, two layers .125 inch ceramic fiber on top side, and one layer on bottom side for round flaps, with locking clip.

C. Horizontal Dampers: Galvanized steel, 22 gage frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.

D. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations and closure under air flow conditions. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.

E. Multiple Blade Dampers: 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x ½ inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

F. Fusible Links: UL 33, separate at 160 0r 212 degrees F with adjustable link straps for combination fire/balancing dampers.

2.5 FLEXIBLE DUCT CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

B. Connector: Fabric crimped into metal edging strip.
   1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz.
   2. Net Fabric Width: Approximately 6 inches wide.
   3. Metal: 3 inches wide, 24 gage thick galvanized steel.

2.6 SMOKE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 5555, and as indicated.

B. Dampers: UL Class 1 curtain or multiple blade type fire damper, normally open automatically operated by electric actuator.

C. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.7 VOLUME CONTROL DAMPERS.

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

B. Splitter Dampers:
   1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
   2. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.

3. Operator: Minimum ¼ inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
4. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.

C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

D. End Bearings: Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

E. Quadrants:
1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches provide regulator at both ends.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, BOCA-NMC, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 15890 for duct construction and pressure class.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated. Review locations prior to fabrication.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. Provide fire dampers , combination fire and smoke dampers and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components , and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

F. Install smoke dampers and combination smoke and fire dampers in accordance with IMC - International Medical Code and the Kentucky Building Code.

G. Demonstrate re-setting of fire dampers to Owner's representative.

H. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and supported by vibration isolators.

I. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

J. Use splitter dampers only where indicated.

K. Provide balancing dampers on high velocity systems where indicated.

L. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION

SECTION 15940 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Diffusers.

B. Registers/grilles.

1.2 REFERENCES

A. ADC 1062 - Certification, Rating and Test Manual.

B. AMCA 500 - Test Method for Louvers, Dampers and Shutters.

C. ARI 650 - Air Outlets and Inlets.

D. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.

E. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

F. NFPA 70 - National Electrical Code.

G. IMC - International Mechanical Code.

1.3 SUBMITTALS

A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.4 PROJECT RECORD DOCUMENTS

A. Record actual locations of air outlets and inlets.

1.5 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.

B. Test and rate louver performance in accordance with AMCA 500.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Titus.
B. Tuttle and Bailey.
C. Anemostat.
D. Naylor.
E. Price.
F. York.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09900.

END OF SECTION

SECTION 15990 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

B. Measurement of final operating condition of HVAC systems.

1.2 REFERENCES

A. AABC - National Standards for Total System Balance.

B. ADC - Test Code for Grilles, Registers, and Diffusers.

C. ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.

D. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

E. SMACNA - HVAC Systems Testing, Adjusting, and Balancing.

1.3 SUBMITTALS

A. Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.

B. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

C. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.

D. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.

E. Provide reports in 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

F. Include detailed procedures, agenda, sample report prior to commencing system balance.

G. Test Reports: Indicate data on AABC National Standards for Total System Balance forms, or forms prepared following ASHRAE 111, NEBB forms, forms containing information indicated in Schedules.

1.4 QUALITY ASSURANCE

A. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.5 QUALIFICATIONS

A. Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum three years documented experience.

B. Perform Work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor.

1.6 PRE-BALANCING CONFERENCE

A. Convene one week prior to commencing work of this section.

1.7 SEQUENCING

A. Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

1.8 SCHEDULING

A. Schedule and provide assistance in final adjustment and test of system with Fire Authority.

PART 2 - PRODUCTS

2.1 Not used

PART 3 - EXECUTION

3.1 AGENCIES

A. Thermal Balance.
B. Ebco.
C. Prefered Air Balance.

3.2 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. Fans are rotating correctly.

7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.

C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

B. Provide additional balancing devices as required.

3.4 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.5 ADJUSTING

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

F. Check and adjust systems approximately six months after final acceptance and submit report.

3.6 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities .

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately .050 positive static pressure near the building entries.

M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

N. On fan powered VAV boxes, adjust air flow switches for proper operation.

3.7 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing

1. Split System Heat Pump/Furnaces.

2. Exhaust Fans.
3. Air Inlets and Outlets.
4. Energy Recovery Units.

B. Report Forms
   1. Title Page:
      a. Name of Testing, Adjusting, and Balancing Agency
      b. Address of Testing, Adjusting, and Balancing Agency
      c. Telephone number of Testing, Adjusting, and Balancing Agency
      d. Project name
      e. Project location
      f. Project Architect
      g. Project Engineer
      h. Project Contractor
      i. Project altitude
      j. Report date
   2. Summary Comments:
      a. Design versus final performance
      b. Notable characteristics of system
      c. Description of systems operation sequence
      d. Summary of outdoor and exhaust flows to indicate amount of building pressurization
      e. Nomenclature used throughout report
      f. Test conditions
   3. Instrument List:
      a. Instrument
      b. Manufacturer
      c. Model number
      d. Serial number
      e. Range
      f. Calibration date
   4. Electric Motors:
      a. Manufacturer
      b. Model/Frame
      c. HP/BHP
      d. Phase, voltage, amperage; nameplate, actual, no load RPM
      e. Service factor
      f. Starter size, rating, heater elements
      g. Sheave Make/Size/Bore
   5. V-Belt Drive:
      a. Identification/location
      b. Required driven RPM
      c. Driven sheave, diameter and RPM
      d. Belt, size and quantity
      e. Motor sheave diameter and RPM
      f. Center to center distance, maximum, minimum, and actual
   6. Roof Top Units:
      a. Identification/number

b. Location
c. Service
d. Manufacturer
e. Air flow, design and actual
f. Entering air DB temperature, design and actual
g. Entering air WB temperature, design and actual
h. Leaving air DB temperature, design and actual
i. Leaving air WB temperature, design and actual
j. Air pressure drop, design and actual

7. Exhaust Fan Data and Energy Recovery Unit:
   a. Location
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Air flow, specified and actual
   f. Total static pressure (total external), specified and actual
   g. Inlet pressure
   h. Discharge pressure
   i. Sheave Make/Size/Bore
   j. Number of Belts/Make/Size
   k. Fan RPM
   l. Air temperature in and out of each side of Energy Recovery Unit.

8. Duct Traverse:
   a. System zone/branch
   b. Duct size
   c. Area
   d. Design velocity
   e. Design air flow
   f. Test velocity
   g. Test air flow
   h. Duct static pressure
   i. Air temperature
   j. Air correction factor

9. Air Distribution Test Sheet:
   a. Air terminal number
   b. Room number/location
   c. Terminal type
   d. Terminal size
   e. Area factor
   f. Design velocity
   g. Design air flow
   h. Test (final) velocity
   i. Test (final) air flow
   j. Percent of design air flow

END OF SECTION