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MECHANICAL SPECIFICATIONS

DIVISION 15 - MECHANICAL

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MECHANICAL SPECIFICATION

**SECTION 15005
CUTTING AND PATCHING**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Each contractor shall provide all cutting, fitting and patching as required to complete the work or to provide penetrations for installation of piping and ductwork related to the installation of the air handling units related to the new heat pumps.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS

- A. Comply with specifications and standards for each product involved.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect existing condition, including work subject to damage or moving during cutting and patching.
- B. Report unsatisfactory conditions to the Owner's Representative. Do not proceed until directed.

3.2 FIELD QUALITY CONTROL

- A. Comply with manufacturer's recommendations and requirements for each product involved.

3.3 PERFORMANCE

- A. Do not cut or alter another contractor's work without written consent of the Owner's Representative.
- B. Execute cutting by methods which will prevent damage to other work.
- C. Execute fitting and adjustments of products to provide a finished installation to comply with specified products, functions, tolerances and finished.

END OF SECTION 15005

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SECTION 15050
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe hangers and supports.
 - 2. Pipe sleeves.
 - 3. Soldering procedures and techniques.
 - 4. Equipment pads.
 - 5. Mechanical identification.
 - 6. Motors.
- B. Related Sections:
 - 1. Temperature controls
 - 2. Testing, adjusting, and balancing:
 - 3. Mechanical insulation:
 - 4. Hydronic piping systems:
 - 5. Electrical wiring and connections: Division 16

1.2 REFERENCES

- A. ANSI A13.1-1981(1985) -- Scheme for the Identification of Piping Systems; 1981 (Reapproved 1985).
- B. ASTM A 53-93a -- Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless; 1993.
- C. ASTM C 94-94 -- Standard Specification for Ready-Mixed Concrete; 1994.
- D. CDA 404/0-R -- Copper Brass Bronze Product Handbook - Copper Tube for Plumbing, Heating, Air Conditioning and Refrigeration; Copper Development Association, Inc.; 1980.
- E. MSS SP-58 -- Pipe Hangers and Supports--Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 1993.
- F. MSS SP-69 -- Pipe Hangers and Supports--Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 1991.
- G. MSS SP-89 -- Pipe Hangers and Supports--Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 1991.

1.3 DESIGN REQUIREMENTS - PIPE HANGERS AND SUPPORTS

- A. Conform to MSS SP-69.
- B. Calculate weight balance to determine required supporting force at each spring hanger location.
- C. Calculate weight balance to determine pipe weight load at each equipment connection.

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- D. Design hangers to support piping under all conditions of operation.
- E. Design hangers to allow for piping expansion and contraction.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Submit product data for each product specified in this section.
- B. Shop Drawings:
 - 1. Submit shop drawings which indicate the location and size of products specified in this section.
- C. Quality Control Submittals: Submit the following:
 - 1. Manufacturer qualification statement, for information.
 - 2. Installer qualification statement, for information.
- D. Coordination Drawings:
 - 1. Prior to distribution of coordination drawings to affected installers, submit coordination drawings specified under "Coordination," for information.
- E. Warranty: Submit signed copy of written warranty.
- F. Coordination Drawings:
 - 1. Prior to distribution of coordination drawings to affected installers, submit coordination drawings specified under "Coordination," for information.

1.5 COORDINATION

- A. Coordination Drawings:
 - 1. Prepare coordination drawings and distribute to affected installers.
 - 2. Indicate:
 - a. Indicate hanger and support locations.
 - b. Project conditions.
 - c. Field measurements.
 - d. Required clearances.
 - e. Recommendations for avoidance of possible interferences.
 - 3. Drawing scale: 1/4 inch equals 1 foot.
 - 4. Use reproducible copy of drawings.

1.6 QUALITY ASSURANCE

- A. Pipe Hangers and Supports: Conform to requirements for each piping system specified in other sections.
- B. Manufacturer Qualifications: A company manufacturing products in this section and whose products have performed in a satisfactory manner under comparable conditions for a period of 5 years.
- C. Installer Qualifications: A company installing products in this section and whose installations have performed in a satisfactory manner under comparable conditions for a period of 5 years.

1.7 PROJECT CONDITIONS

- A. Determine working clearance around and between construction elements such as beams,
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- columns, walls, and ceilings.
- B. Locations of pipe indicated on drawings are approximate unless dimensioned. Determine exact location before roughing in supports and hangers.
- C. Field Measurements: Field-measure related work to ensure proper fit and clearance.

1.8 WARRANTY

- A. Submit a written warranty for each product requiring the following:
 - 1. Manufacturer shall warrant all parts and labor for a period of 1 year starting from the date of substantial completion.
 - 2. Compressors and associated parts shall have 5 yr warranty as offered and provided by the respective parts.

PART 2 - PRODUCTS

2.1 PIPE HANGERS

- A. Manufacturers: Provide products complying with requirements of the contract documents and made by one of the following:
 - 1. Carpenter and Paterson, Inc.
 - 2. Grinnell Corporation.
 - 3. B-Line Systems, Inc.
 - 4. Unistrut
- B. Component Materials and Manufacture: Conform to MSS SP-58.
- C. Selection: Conform to MSS SP-69.
- D. Fabrication: Shop-fabricate supports for 2-1/2-inch pipe and larger in accordance with MSS SP-89.

2.2 PIPE SLEEVES

- A. Material:
 - 1. Galvanized steel pipe; Schedule 40; Conforming to ASTM A 53.
- B. Applications:
 - 1. Provide pipe sleeves at the following locations:
 - 2. Masonry walls and Floor slab penetrations

2.3 SOLDER MATERIALS

- A. Federal law prohibits the use of solders containing lead in potable water systems. Select solder as recommended by the Copper Tube Handbook (CDA 404/0-R) for specific job conditions.

2.4 EQUIPMENT PADS

- A. Description:
 - 1. Pad thickness: 4 inches minimum.
 - 2. Beveled edges height: 1 inch
 - 3. Reinforcing spacing: 9 inches, both ways
 - 4. Size pad to fit equipment, and dowel to the floor.
- B. Provide anchor bolts.

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- C. Material:
 - 1. Concrete conforming to ASTM C 94.
 - 2. Strength: 3000 psi.
- D. Provide concrete equipment pad for all base-mounted equipment.
- E. Refer to Division 3 for equipment grouting.

2.5 MECHANICAL IDENTIFICATION PRODUCTS

- A. Product Applications:
 - 1. Pipe 1 inch and smaller: Use valve tags.
 - 2. Pipe larger than 1 inch.
 - a. Snap-on plastic markers.
 - b. Adhesive labels.
 - c. Painted legend using stenciled letters.
 - 3. Pipe identification may be omitted from:
 - a. Sanitary drain piping.
 - b. Storm piping.
 - c. Equipment drains.
 - d. Inaccessible piping.
 - 4. Valve tags:
 - a. Identify each valve with a valve tag.
 - 5. Equipment:
 - a. Engraved plastic nameplates.
 - b. Adhesive labels.
 - c. Painted legend using stenciled letters.
- B. Snap-on Plastic Markers:
 - 1. Legend: Preprinted under clear, outdoor-grade acrylic plastic cover, reading forward and reverse. Include flow direction arrows.
 - 2. Fastener: Manufacturer's standard.
- C. Valve Tags:
 - 1. Material: Stamped aluminum.
 - 2. Size: 1-1/2 inches.
 - 3. Shape: Round.
 - 4. Legend - top line: System abbreviation, 1/4 inch high.
 - 5. Legend - second line: Valve tag number as indicated on drawings, 1/2 inch high.
 - 6. Provide mounting hole at top of tag.
 - 7. Fasteners:
 - a. Brass jack chain.
 - b. Nickel bead chain.
- D. Engraved Plastic Nameplates:
 - 1. Description: 3-ply plastic nameplate with contrasting letter color.
 - 2. Fasteners: Noncorrosive screws or rivets.
- E. Adhesive Labels:
 - 1. Description: Pressure-sensitive vinyl with permanent adhesive.
 - 2. Banding tape: Vinyl with permanent adhesive. Include preprinted directional arrows in contrasting color.
- F. Marking Paint:
 - 1. Quality: Permanent, nonfading, nonpeeling, exterior type stenciling enamel for spray or brush application.

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2. Compatibility: Provide paint compatible with substrate and undercoatings.
 - G. Legends and Colors:
 1. Pipe identification legend text: Indicate piping system using full name or standard abbreviation as indicated on drawings.
 2. Pipe identification legend size: Conform to ANSI A13.1.
 3. Pipe identification colors: Conform to ANSI A13.1.
 4. Duct identification legend text: Indicate system using full name or standard abbreviation as indicated on drawings.
 5. Duct identification colors: As scheduled.
 6. Equipment identification legend text: Indicate system using full name or standard abbreviation and equipment tag number as indicated on drawings.
 7. Equipment identification legend size: 1/2 inch, minimum.
 8. Equipment identification colors: As scheduled.
- 2.6 MOTORS:
- A. Provide energy efficient motors.
 - B. 1/2-horsepower and Smaller: Single phase.
 - C. Larger than 1/2-horsepower: 3-phase.
 - D. Provide motors with nameplate ratings to match electrical circuit characteristics shown on drawings.
 - E. Nameplate ratings:
 1. 200 volts for 208 volt circuits.
 2. 230 volts for 240 volt circuits.
- 2.7 FIELD MOUNTED STARTERS:
- A. Provide starters with nameplate ratings to match electrical circuit characteristics shown on drawings.
 - B. Nameplate Ratings:
 1. 200 volts for 208 volt circuits.
 2. 230 volts for 240 volt circuits.
 - C. Furnish starters for all motors supplied with mechanical equipment.
 1. Exception: Starters indicated in motor control centers are furnished by Division 16.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces intended to support products.
- B. Verify that each product conforms to regulatory requirements and to specification requirements.

3.2 PREPARATION

- A. Clean surfaces to receive work.
- B. Protect surrounding elements from work of this section.

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3.3 INSTALLATION

- A. Soldering: Conform to the procedures and techniques for soldering described in the Copper Tube Handbook (CDA 404/0-R).
- B. Keep a copy of the Copper Tube Handbook on the construction site for the duration of the work.
- C. Equipment Pads:
 - 1. Equipment pads shall be true and level.
- D. Motors: Mount and align motors to operate equipment without vibration, noise, or damage.
- E. Starters: Mount starters true and level in locations shown on drawings.

3.4 BUILDING ATTACHMENTS AND FASTENERS

- A. Install products in accordance with manufacturer's instructions.
- B. Do not cut or drill structural elements.

3.5 PIPE HANGERS AND SUPPORTS

- A. Fabricate and install piping supports in accordance with MSS SP-89.
- B. Keep a copy of "Pipe Hangers and Supports--Selection and Application" (MSS SP-69) on the construction site for the duration of the work.
- C. Provide supplementary steel where required for pipe supports.
- D. Install hangers and supports to prevent transmittal of movement and loading to connected equipment.
 - 1. Install hangers and supports to achieve required pipe slopes.
 - 2. Provide means for vertical adjustment on rigid hangers.

3.6 IDENTIFICATION

- A. Install products in accordance with manufacturer's instructions.
- B. Identify piping systems in accordance with ANSI A13.1, using products specified in this section.
 - 1. Locate labels within 10 feet on each side of wall.
 - 2. Locate labels every 50 feet on continuous horizontal runs.
 - 3. Locate label at each change of direction and fitting.
- C. Interface stencil marker painting with finish painting specified in Division 9.

3.7 ADJUSTING

- A. Adjust hangers to distribute loads equally to attachments.
- B. Adjust hangers to achieve proper piping slope.

END OF SECTION 15050

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SECTION 15060

PIPING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. The Contract Documents apply to this section.
- B. Drawings show approximate general routing of principal service lines, however, execution of the work shall be coordinated more precisely as described in "Execution" of this section.

1.02 SCOPE

- A. Includes all new piping as required for connecting the potable water heating and the heat pump systems
- B. Includes all connections and alterations to existing pipings as required.

1.03 RELATED SECTIONS

- A. Refer to section 1 5050 Basic Material
- B. Refer to section 1 5 050 for pipe hangers and supports.
- C. Refer to section 15242 for vibration isolation.

PART 2 - PRODUCTS

2.01 COPPER PIPING

- A. Copper tubing shall be hard drawn, type as noted, conforming to ASTM Specification noted, and joined by method noted, and shall be used for the following:
 - 1. Domestic hot and cold water piping - no-lead solder - type "L", ASTM B-88.
 - 2. Refrigerant piping - silver solder, type "ACR", ASTM B-280.
 - 3. Soil, waste and vent piping above-grade, except for urinal drains - type "DWV", ASTM B-306 - no-lead solder.

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4. Drains from piping, pumps, relief valves, etc. - type "DWV", ASTM B-306 - no-lead solder.
 5. Condenser water supply and return - type "L", ASTM B-88 - no-lead solder.
 6. Heat pump supply and return piping - type "L", ASTM B-88, no-lead solder.
 7. Cooling coil condensate drain piping - type "DMV", ASTM B-306- no-lead solder.
- B. Flux used for soldering of copper piping shall conform to ASTM specification B813.
 - C. The soldering of copper piping shall be performed in conformance with the requirements of ASTM B828.
 - D. Solder metal shall conform to the requirements of ASTM B32.
 - E. Copper piping as specified may be used at the contractor's option for heating hot water, chilled water, heat pump loop, condenser water supply and return piping, laboratory gas and vacuum piping, and remote radiator coolant piping.
 - F. All copper piping 3-inches and larger on pressure systems shall be connected with braze joints.

PART 3 EXECUTION 3.01

3.01 SOLDERED AND BRAZED JOINTS

- A. Soldered joints for the assembly of copper tubing lines shall be made with a non-corrosive flux and solder as noted for the service. Ends of tubing shall be cut square and all burrs and fins shall be removed. The surfaces of the tubing and fitting to be soldered shall be abrasively cleaned, and the tubing shall be inserted into the fitting to its full depth. After the joint has been made, all excess flux and solder shall be wiped off.

3.05 DRAINAGE PIPING, GENERALLY

- A. Sanitary drainage and vent piping shall be installed in all respects in accordance with the applicable laws and regulations of the local authority. Any changes which must be made to conform to such laws and regulations shall be made by the contractor under this specification, as approved by the Owner's Agent and without cost to the Owner.
- B. All fixtures and equipment requiring drainage and vents shall be connected to the drainage and vent systems, whether such fixtures or equipment are specified herein or in other specifications, or provided by the Owner.
- B. Except as otherwise indicated on the drawings drain piping shall be installed with a fall of 1/4- inch per foot.

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- D. Traps shall be provided for all floor drains, fixtures, and other connections requiring same. All traps shall be provided with cleanouts which shall be made accessible.
- E. All parts of the drainage system shall be vented as required by the laws regulating sanitary drainage.
- F. Provide 6-pound lead flashings for vent lines through roofs, all soldered and made watertight. Flashings shall extend 9-inches into the roofing and shall be turned down 2-inches inside the vent pipe.
- G. Provide fresh air intake connections for house traps of the sizes indicated on the drawings and conforming to code requirements.
- H. Provide cleanouts (prior to dropping below grade) at foot of all sanitary stacks, vent, waste, and storm water risers, and at each change of direction, at the ends of branch runs, in straight runs as required by code and where indicated. Terminate as specified under "Cleanouts".
- I. Provide house sewers to conduct the sanitary and storm drainage from the building to the public sewer system, including all piping, trenching, shoring and/or pumping as required, backfilling, final connection to the city sewers, street openings and repaving as required to make the system complete.]
- J. Make the connection to the city sewers, open the street and repave in accordance with the requirements of the municipal authorities having jurisdiction.]
- K. Commence the sewer pipe installation at the connection to the municipal sewer with all spigot ends pointing in the direction of flow. Lay all pipes with ends abutting and in a true line, carefully centered to form a sewer with a uniform invert.]

3.27 FLUSHING

- A. All new systems of copper piping shall be initially flushed with hot water to remove excess traces of flux within the piping. „
- B. Refer to IMC and IPC requirements for flushing as required by code of these for flushing and sterilization requirements of all new piping systems.

END OF SECTION 15060

SECTION 15242
VIBRATION ISOLATION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Vibration isolation.

1.2 RELATED WORK

- A. Division 15 – Heat Pumps.
- B. Division 15 – Plumbing, and Mechanical Equipment
- C. Division 15 – Heat Pump Condensers.
- D. Division 15 – HP Air Handling Units with Coils.

1.2 REFERENCES

- A. ASHRAE - Guide to Average Noise Criteria Curves.

1.3 QUALITY ASSURANCE

- A. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition.

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division 1.
- B. Indicate vibration isolator locations, with static and dynamic load on each, on shop drawings and described on product data.
- C. Submit schedule of equipment served and isolation type for approval.
- D. Submit manufacturer's installation instructions under provisions of Division 1.

1.5 CERTIFICATES

- A. Submit manufacturer's certificate under provisions of Division 1 that isolators are properly installed and properly adjusted to meet or exceed specified requirements.

PART 2 PRODUCTS

2.1 ACCEPTABLE 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:

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1. Vibration Eliminator Co.
2. Korfund Dynamics Corp.
3. Amber/Booth Co.

2.2 VIBRATION ISOLATORS

- A. Type 1: Closed spring mounts with one or more steel springs, leveling bolt, neoprene pad on base plate.
- B. Type 2: Rubber-in-shear hangers, suitable for attachment to threaded rod.
- C. Type 3: Rubber waffle pads, 30 durometer, minimum 1/2 inch thick, maximum loading 40 psi. Use neoprene in oily or exterior locations.

2.3 FABRICATION

- A. Provide pairs of neoprene side snubbers or restraining springs where side torque or thrust may develop.
- B. Color code spring mounts.
- C. Select springs to operate at 2/3 maximum compression strain, with 1/4 inch ribbed neoprene pads.

PART 3. EXECUTION

3.1 INSTALLATION

- A. Install vibration isolators for motor driven equipment, including series powered fan boxes.
- B. Provide spring isolators on piping connected to isolated equipment as follows: Up to 4 inch diameter, first three points of support, 5 inch diameter and over, first 5 points of support. Static deflection of first point shall be twice deflection of isolated equipment.

3.2 Installation Schedule (Follow equipment Manufacturer's recommendations for vibration isolation.)

ISOLATED EQUIPMENT

Pump
Air Handling Unit

ISOLATOR TYPE

Type 3
Type 1

END OF SECTION

**SECTION 15250
MECHANICAL INSULATION**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe system insulation.
 - 2. Duct system insulation.
- B. Related Sections:
 - 1. Duct
 - 2. Hydronic piping systems:
 - 3. Fire stopping and smoke stopping:

1.2 REFERENCES

- A. ASTM C 533-85 (90) -- Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 1985 (Reapproved 1990).
- B. ASTM C 534-88 -- Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 1988.
- C. ASTM C 547-77 -- Standard Specification for Mineral Fiber Preformed Pipe Insulation; 1977.
- D. ASTM C 553-92 -- Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 1992.
- E. ASTM C 612-93 -- Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 1993.
- F. ASTM E 84-91a -- Standard Test Method for Surface Burning Characteristics of Building Materials; 2010.
- G. ASTM E 96-93 -- Standard Test Methods for Water Vapor Transmission of Materials; 1993.
- H. National Commercial and Industrial Insulation Standards; Midwest Insulation Contractors Association; 1988.
- I. NFPA 255-1990 -- Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 1990.
- J. UL 723 -- Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; 1983 (Revised 1987).

1.3 PERFORMANCE REQUIREMENTS

- A. Flame Spread and Smoke Developed Ratings for Insulation and Ancillary Materials: Rated in accordance with ASTM E 84, NFPA 255, or UL 723. Affix manufacturer's stamp or label showing fire/smoke indexes on shipping containers or insulation.
 - 1. Indoor mechanical insulation and ancillary materials:
 - 2. Outdoor mechanical insulation and ancillary materials:

1.4 SUBMITTAL

- A. Product Data: Submit for each type of mechanical insulation and accessory.
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1.5 QUALITY ASSURANCE

- A. Conform to "National Commercial and Industrial Insulation Standards" by the Midwest Insulation Contractors Association.
- B. Manufacturer Qualifications: A company manufacturing insulation products which have performed in a satisfactory manner under comparable conditions for a period of 5 years.

PART 2 - PRODUCTS

2.1 INSULATION MANUFACTURERS

- A. Fiberglass Insulation:
 - 1. Products of the following manufacturers, provided they comply with requirements of the contract documents, will be among those considered acceptable.
- B. Flexible Elastomeric Insulation:
 - 1. Products of the following manufacturers, provided they comply with requirements of the contract documents, will be among those considered acceptable.
- C. Calcium Silicate Insulation:
 - 1. Products of the following manufacturers, provided they comply with requirements of the contract documents, will be among those considered acceptable.

2.2 PIPING INSULATION APPLICATIONS

- A. Dual temperature piping (40 to 250 degrees F).
 - 1. Insulation materials: 1" fiberglass for piping up to 1" diameter, 1 1/2" fiberglass for piping larger than 1" diameter.
- B. Potable water piping.
 - 1. Insulation materials: 1/2" fiberglass for all cold water piping, 1" fiberglass for hot water supply or return piping up to 2" diameter, 1 1/2" fiberglass for piping larger than 2" diameter.

2.3 DUCT INSULATION APPLICATIONS

- A. Supply duct.
 - 1. Insulation material: 1" fiberglass.

2.4 EQUIPMENT INSULATION APPLICATIONS

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect substrates to receive mechanical insulation. Correct any unsatisfactory conditions before installing mechanical insulation.

3.2 PREPARATION

- A. Remove dirt, dust, and moisture from surfaces before insulating.
- B. Provide positive ventilation in enclosed areas where volatile materials are used to apply insulation.

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3.3 INSTALLATION

- A. Insulate piping systems after leak test results have been accepted.
- B. Install insulation to attain a smooth and uniform surface. Abut insulation at joints. Do not fill gaps in joints with joint mastic or sealer. Remove and reinstall insulation with tight fitting joints.
- C. Maintain vapor retarder on insulation.
- D. Insulation shall be continuous on insulated piping and duct which penetrates walls and floors.
- E. Exceptions: Some fire stopping/smoke stopping assemblies require a break in the insulation. Coordinate with installer of fire stopping/smoke stopping and maintain the insulation vapor retarder at breaks.
- F. Do not install insulation on hot, wet, or dirty surfaces.

3.4 PIPE INSULATION

- A. Piping Systems Requiring Insulation:
 - 1. Potable water piping.- Hot and Cold
- B. Insulate valves, fittings, and similar items with the same material and thickness of insulation as applied to adjoining pipe run. Install factory-molded, precut, or job-fabricated insulation segments.
 - 1. Cover insulation with PVC covers and seal to maintain vapor retarder.
- C. Abut pipe insulation and pipe hanger insulation inserts.
- D. Seal joints with vapor retarder tape.
- E. Unions and Strainers: Use removable insulation segments. Arrange segments to permit access to strainer removal cap or plug and unions by slitting tape at the joints.
- F. Omit insulation from the following:
 - 1. Flanges on hot piping.
 - 2. Expansion joints.
 - 3. Fire protection piping.

3.5 DUCT INSULATION

- A. Insulate the following duct:
 - 1. Supply and return duct.

3.6 EQUIPMENT INSULATION

- A. Insulate equipment listed in Part 2 under EQUIPMENT INSULATION APPLICATIONS.
- B. Apply insulation in removable segments on equipment access doors and other elements which require frequent removal for service.

3.7 INTERFACE WITH OTHER PRODUCTS

- A. Equipment specifications, elsewhere in Division 15.
- B. Pipe supports, elsewhere in Division 15.

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- C. Duct specifications, elsewhere in Division 15.
- D. Fire stopping and smoke stopping specified as shown on drawing

3.8 EXISTING INSULATION

- A. Repair or replace existing mechanical insulation which is damaged. Match thickness and material of existing mechanical insulation. Maintain vapor retarder between new and existing insulation.

3.9 PROTECTION

- A. Instruct other installers of methods required to protect mechanical insulation from damage.

3.10 CLEANING

- A. Clean insulation surfaces to achieve a new appearance.
- B. Clean insulation, using materials and methods recommended by manufacturer.

END OF SECTION 15250

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**SECTION 15410
PLUMBING PIPING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Potable Water System.
 - A. Pipe and fittings.
 - B. Specialties.
 - C. Shut off and Isolation Valves
 - D. Drains.
 - C. . Pipe, fittings and accessories.
- B. Related Sections:
 - 1. Pipe insulation: Elsewhere in Division 15

1.2 REFERENCES

- A. ASME B16.15-1985 -- Cast Bronze Threaded Fittings, Classes 125 and 250; the American Society of Mechanical Engineers; 1985.
- B. ASME B16.18-1984 -- Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2010 or as applicable by the City of Wilmington Codes.
- C. ASME B16.26-1988 -- Cast Copper Alloy Fittings for Flared Copper Tubes; The American Society of Mechanical Engineers; 2010.

1.3 DEFINITIONS

- A. Water Distribution System: The system includes potable water piping (hot and cold) through-out the site, the building and associated plumbing products inside building.

1.4 SUBMITTALS

- A. Product Data: Submit for each product specified in this section.
- B. Shop Drawings: Prepare and submit shop drawings showing layout of plumbing system components. Include component sizes, rough-in requirements, service sizes and all other information necessary to demonstrate compliance with requirements of contract documents.
- C. Test Reports:
 - 1. Comply with requirements of applicable code.
- D. Qualifications Statements: Submit statements indicating compliance with qualifications requirements specified under "Quality Assurance."
- E. Manufacturer's Instructions:
 - 1. Submit for each product specified in this section.
 - 2. Include installation procedures.
 - 3. Include instructions for examination, preparation, and protection of adjacent work.

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- F. Operation and Maintenance:
 - 1. Submit maintenance and operating data for each product specified in this section.
 - 2. Include the following information:
 - a. Instructions for starting and operating equipment.
 - b. Operating limits which, if exceeded, may result in hazardous or unsafe conditions.
 - c. Cleaning, preventive maintenance, and lubrication schedule and procedures.
 - d. List of special tools, maintenance materials, and replacement parts.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A company manufacturing products specified in this section which have performed in a satisfactory manner under comparable conditions for a period of 5 years.
- B. Installer Qualifications: A company installing products specified in this section and whose installations have performed in a satisfactory manner for a period of 5 years.
- C. Regulatory Requirements: Conform to National plumbing code and 1996 BOCA code.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping:
 - 1. All materials shall be protected from damage by factory packing. Label packing, indicating contents.
 - 2. Handle all products in a manner to prevent damage. Follow manufacturer's recommendations.
 - 3. Cap ends of pipes and tubes at the factory. Maintain end caps until pipe or tube is installed.
 - a. Exception: End caps are not required for hub-and-spigot pipes.
- B. Acceptance at Site:
 - 1. Reject any damaged materials upon arrival.
 - 2. Store all materials above grade and in a manner to prevent damage.

1.7 PROJECT CONDITIONS

- A. Location and arrangement of plumbing materials are indicated on drawings. Install as indicated. Obtain approval of the architect for any significant deviation from the system design or from the intent of the design, before installation is executed.

1.8 COORDINATION

- A. Use manufacturer's instructions and data to determine rough-in requirements and locations of products connected to piping.
 - 1. Provide coordination drawings for each plumbing piping system.

1.9 SEQUENCING AND SCHEDULING

- A. Coordinate work of this section with work of other sections as necessary.

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PART 2 - PRODUCTS

2.1 MATERIALS - GENERAL

- A. Do not use plumbing products manufactured from metal alloys containing more than 6 percent lead in potable water piping system.

2.2 HOT WATER SYSTEM

- A. Design Pressure: 85 psig
- B. Pipe and Fitting Materials - Within Building or Above Grade:
 - 1. Copper tube: Conform to ASTM B 88, Type L.
 - a. Application: Piping 4-inch and smaller
 - b. Temper: All tubes; annealed.
 - c. Joints: Soldered, mechanically coupled, or brazed.
 - d. Fittings:
 - 1. soldered, or brazed joint, wrought copper fittings: Conform to ANSI B16.22.
 - 2. Threaded cast bronze fittings: Conform to ASME B16.15.
- C. Pipe and Fitting Materials - Underground or Below Slab:
 - 1. Copper tube: Conform to ASTM B 88, Type K.
 - a. Application: Piping 3-inches and smaller.
 - b. Temper: All tubes; annealed.
 - c. Joints:
 - 1. Tubes 1-inch and smaller: Soldered.
 - 2. Tubes larger than 1-inch: Soldered or brazed.
 - d. Fittings:
 - 1. Threaded, soldered, or brazed joint, wrought copper fittings: Conform to ASME B16.22.
 - 2. Threaded cast bronze fittings: Conform to ASME B16.15.
- D. Isolation and Shut off Valves
 - 1. Contractor shall provide isolation and shut off valves for all plumbing equipment. These include but not limited to Hot water heater, etc.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which plumbing piping is to be installed.
- B. Verify placement of fixtures and equipment to determine locations of rough-in connections.
- C. Correct any unsatisfactory conditions before beginning installing piping products of this section. Commencement of installation indicates acceptance of conditions.

3.2 PREPARATION

- A. Pipe and Fittings:
 - 1. Preparation of pipe and tubes: Ream and deburr.
 - 2. Clean all debris from pipe (inside and outside) and fittings (inside and outside) before installation.

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3.3 INSTALLATION

A. General Piping Requirements:

1. Install piping as indicated on the drawings. Avoid interferences with other work.
2. Install fittings at all branch connections and changes in direction.
3. Fire stop/smoke stop all pipe penetrations through fire/smoke barriers in accordance with requirements of the fire stopping and smoke stopping section in Division 7.

B. Joints:

1. Copper tubing:

- a. Bending: Conform to bending procedures and techniques described in the Copper Tube Handbook (CDA 404/O-R).
- b. Brazing: Conform to soldering procedures and techniques described in the Copper Tube Handbook (CDA 404/O-R).
- c. Keep a copy of the Copper Tube Handbook (CDA 404/O-R) on construction site for duration of the work.
- d. Mechanical couplings: Conform to manufacturer's recommended installation procedures and techniques.

3.4 CLEANING

A. Water Distribution System:

- 2 Clean and disinfect water distribution system to meet regulatory requirements.

3.5 PROTECTION

- #### A.
- Plug all piping system openings whenever installation is temporarily interrupted or halted for the day.

END OF SECTION 15410

SECTION 15486

AIR COOLED HEAT PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies the following configurations of electrically operated Heat Pumps"

1. Heat pump.
2. Concealed air cooled heat pumps up to that 21 kW (6 tons).

B. Definitions:

1. Energy Efficiency Ratio (EER): The ratio of net cooling capacity is Btu/h to total rate of electricity input in watts under designated operating conditions.
2. Coefficient of Performance (COP) - Cooling: The ratio of the rate of heat removed to the rate of energy input in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.
3. Coefficient of Performance (COP) - Heating: The ratio of the rate of heat delivered to the rate of energy input is consistent units for a complete heat pump system, including the compressor and, if applicable, auxiliary heat under designated operating conditions.
4. Unitary Heat Pump: One or more factory made assemblies that normally include an indoor conditioning coil, compressor(s) and an outdoor refrigerant-to-air coil or refrigerant-to-water heat exchanger. These units provide both heating and cooling functions.

1.2 RELATED WORK

- A. Section 1, GENERAL REQUIREMENTS: For pre-test requirements.
- B. Section 15, Basic Mechanical Material and Methods.
- D. Section 15, REFRIGERANT PIPING: Requirements for field refrigerant piping.
- E. Section 15. HYDRONIC PIPING Requirements for piping for split systems and expansion tanks.
- F. Section 15, HVAC DUCTS AND CASINGS: Requirements for sheet metal ductwork.

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- G. Section 15, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Requirements for controls and Thermostats.
- H. Section 15. TESTING, ADJUSTING, AND BALANCING FOR HVAC: Requirements for testing, adjusting and balancing of HVAC system.

1.3 QUALITY ASSURANCE:

- A. Refer to specification Section 15. Mechanical Materials and Method
- B. Comply with ASHRAE Standard 15, Safety Code for Mechanical Refrigeration.
- C. Comply with ASHRAE 90.1-2004.

1.4 SUBMITTALS

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and AND SAMPLES.
- B. Manufacturer's Literature and Data.
 - 1. Heat Pumps:
 - c. Vertical type.
- C. Certification: Submit, simultaneously with shop drawings, a proof of certification that this product has been certified by ARI.
- D. Performance Rating: Submit catalog selection data showing equipment ratings and compliance with required cooling and heating capacities EER and COP values as applicable.

1.5 APPLICABLE PUBLICATIONS:

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Federal Specification (Fed. Spec.):
 - A-A-50502-90 Air-conditioner (UNITARY HEAT PUMP), AIR TO AIR (3000 TO 300,000 BTUH)
- C. Air-Conditioning and Refrigeration Institute (ARI) Standards:
 - ARI-DCPP Directory of Certified Product Performance - Applied Directory of Certified Products
 - 210/240-06 Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment
 - 270-95 Sound Rating of Outdoor Unitary Equipment
 - 310/380-04 Standard for Packaged Terminal Air-Conditioners and Heat Pumps (CSA-C744-04)

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- 320-98 Heat Pumps
- D. Air Movement and Control Association (AMCA):
- 210-99 Laboratory Methods of Testing Fans for Aerodynamic Performance Rating (ANSI)
- 410-96 Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans
- E. American National Standards Institute (ANSI):
- S12.51-02 Acoustics - Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Method for Reverberation Rooms (same as ISO 3741:1999)
- F. American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc (ASHRAE):
- 2004 Handbook HVAC Systems and Equipment
- G. American Society of Testing and Materials (ASTM):
- B117-03 Standard Practice for Operating Salt Spray (Fog) Apparatus
- H. National Electrical Manufacturer's Association (NEMA):
- MG 1-06 Motors and Generators (ANSI)
- ICS 1-00 (R2005) Industrial Controls and Systems: General Requirements
- I. National Fire Protection Association (NFPA):
- 90A-02 Standard for the Installation of Air-Conditioning and Ventilating Systems
- J. Underwriters Laboratory (UL):1995-05 Heating and Cooling Equipment

PART 2- PRODUCTS

2.1 GENERAL REQUIREMENTS FOR WATER SOURCE HEAT PUMPS

- A. System Characteristics of a split System heat pumps: The system consists of individual unit connected to exterior Heat pump condensers.

2.2 HEAT PUMP

- A. Description: air cooled heat pump with temperature controls; and shall be factory assembled, tested, and rated according to ARI-

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- ISO-13256-1. Unit shall be console, vertical, horizontal type, with ducted free air delivery. Comply with ARI 320.
- B. Cabinet: Manufacturer's standard galvanized steel for ducted models and galvanized steel with baked enamel finish. Unit shall have access panels and flanged duct connections. Cabinet shall be factory insulated with fiber glass duct liner, minimum 13 mm (1/2-inch) thick and complying with UL 181. Units shall have knockouts for electrical, piping, and condensate drain connections.
- C. Fan: Direct driven, centrifugal, with permanently lubricated multi-speed motor resiliently mounted in fan inlet
- D. Compressor: Hermetic, rotary, scroll, compressor installed on vibration isolators; with a slide-out chassis and housed in an acoustically treated enclosure. Unit shall have factory-installed safeties, anti-recycle timer, high-pressure cutout, low-pressure cutout or loss-of-charge switch, internal thermal-overload protection, and freeze stat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below 2 deg C (35 deg F). **Condensate overflow switch shall stop compressor with high condensate level in condensate drain pan. Compressor lockout circuit shall be capable of being reset at either remote thermostat or circuit breaker.**
- E. Refrigerant Piping Materials: ASTM B 743 copper tube with wrought-copper fittings and brazed joints.
- F. Pipe Insulation: Refrigerant minimum 10-mm (3/8-inch) thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-development indexes according to ASTM E 84.
- G. Refrigerant Metering Device: Capillary tube, Thermal expansion valve to allow specified operation with entering-water temperatures from minus 25 to 125 deg F.
- H. **Condensate Drainage: Plastic or stainless-steel drain pan with condensate drain piping projecting through unit cabinet and complying with ASHRAE 62.1-2004.**
- I. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

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- J. Sound Attenuation Package: Minimum 1-mm (0.06-inch) thick compressor enclosure and front panel. Minimum 2-mm (0.12-inch) thick foam gasket around the compressor and perimeter of end panel, sound attenuating blanket over compressor and hot-gas muffler.
- K. General Motor Requirements: Comply with requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT. Motor shall be multispeed, permanently lubricated, // permanent split capacitor ECM.
- L. Air-to-Refrigerant Heat Exchanger:
1. Coaxial heat exchangers with copper, water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube shall be leak tested to 450 psig on refrigerant side and 400 psig on water side. Heat exchanger shall be factory mounted in unit on resilient rubber vibration isolators.
 2. Stainless-Steel, Brazed-Plate Heat Exchanger: Factory mount heat exchanger in unit on resilient rubber vibration isolators and leak tested to 450 psig for refrigerant side and 400 psig for water side.
heater is less than 125 deg F.
- M. Motorized Water Valve: Stop water flow through the unit when compressor is off.
- N. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 450 psig.
- O. Refrigerant Circuit Components: Sealed refrigerant circuit charged with R-410A refrigerant
1. Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.
 2. Charging Connections: Service fittings on suction and liquid for charging and testing.
 3. Reversing Valve: Pilot-operated sliding-type valve designed to be fail-safe in heating position with replaceable magnetic coil.
 4. Refrigerant Metering: Extended temperature range device or a bi-directional thermal expansion valve.

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- P. Electric Heating Coil: Helix-wound, nickel-chromium wire-heating elements in ceramic insulators mounted on steel supports.
Energize on call for heating when entering-water-loop temperature is less than 60 deg F
- Q. Hot-Gas Reheat: Reheat valve shall be a pilot-operated, sliding-type valve with replaceable magnetic coil to divert refrigerant hot gas to reheat coil when remote humidistat calls for dehumidification.
- R. Hot-Gas Bypass: Include constant pressure expansion valve, solenoid valve, and controls to maintain continuous refrigeration system operation at 10 percent of full load on lead compressor.
- S. Filters: Disposable, glass-fiber, flat type, 25 mm (1 inch) thick, treated with adhesive, and having a minimum of 80 percent arrestance according to ASHRAE 52.1 and a MERV rating of 5 according to ASHRAE 52.2. Disposable, pleated type, 1 inch thick and with a minimum of 90 percent arrestance according to ASHRAE 52.1 and a MERV rating of 7 according to ASHRAE 52.2.
- T. Comply with requirements in Section 15, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC for control equipment and sequence of operation are specified.
- U. Controls:
1. Basic Unit Controls:
 - a. Low- and high-voltage protection.
 - b. Overcurrent protection for compressor and fan motor.
 - c. Random time delay, three to ten seconds, start on power up.
 - d. Time delay override for servicing.
 - e. Control voltage transformer.
 2. **Thermostat: Wall-mounted thermostat heat-cool-off switch, fan on-auto switch, manual automatic changeover, temperature set point, Deg F indication.**
 3. Terminal Controller:
 - a. Scheduled operation for occupied and unoccupied periods on 7 / 365 -day clock with minimum 4 programmable periods per day, override period Remote control panel to contain programmable timer and LED for fault condition.
 - b. Compressor-disable relay shall stop compressor operation for demand limiting or switch to unoccupied operation.

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- c. Unit shall automatic restart after five minutes if fault clears and lockout after three attempts to restart following fault.
- d. Indicate fault for service technician Return-air temperature high-limit (firestat).
- e. Stop unit on high temperature.
- f. Backup for volatile memory.
- g. Differential pressure switch shall indicate fan status.
- h. Fan failure alarm.
- i. Differential pressure switch shall indicate filter status.
- j. Dirty filter alarm.

4. Comply with requirements in Section 15. DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC for BAS interfaces requirements. Interface relay for scheduled operation. Interface relay shall provide indication of fault at central workstation. Interface shall be BAC-net or Lonworks for central BAS workstation for the following functions. Set-point adjustment for set points identified in this Section start/stop and operating status of heat-pump unit Data inquiry shall include supply air, room air temperature and humidity, and entering-water temperature. Occupied and unoccupied schedules

V Electrical Connection: Control box with single electrical connection factory installed and tested with fused disconnect

W. Hangers shall have vibration isolators for horizontal type heat pumps.

Part 3- execution

3.1 INSTALLATION

A. Floor-Mounted Units: Support on neoprene pads with minimum 0.125-inch static deflection. Secure units to anchor bolts installed in concrete bases.

B. Suspended Units: Suspend from structure with threaded steel rods and minimum 0.25-inch static deflection rubber-in-shear vibration isolators and seismic restraints.2 Seismic Bracing:

Where applicable provide Seismic bracing as required under specification Section:

SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

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3.3 CONNECTIONS

- A. Connect supply and return hydronic piping to heat pump with unions and shutoff valves.
- B. Connect heat-pump condensate drain pan to indirect waste connection with condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.
- C. Connect supply- and return-air ducts to water-source heat pumps with flexible duct connectors. Comply with requirements in Section 15 METAL DUCT.
- D. Install electrical devices furnished by manufacturer but not specified to be factory mounted.
- E. Install piping adjacent to machine to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

- B. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing water-source heat pumps and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

3.5 INSTRUCTIONS

- A. Provide services of manufacturer's technical representative for four hours to instruct owner's personnel in operation and maintenance of the heat pumps and related systems

E N D OF SECTION 15486

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**SECTION 15891
METAL DUCT**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal duct.
 - 2. Balancing Dampers
- B. Related Sections:
 - 1. Paint.
 - 2. Basic mechanical materials and methods.
 - 3. Mechanical insulation.
 - 4. Air terminal units.
 - 5. Controls.
 - 6. Electrical wiring and wiring connections: Division 16

1.2 REFERENCES

- A. ASTM A 527/A 527M-90 -- Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality; 2010
- B. ASTM C 916-85 (2010) -- Standard Specification for Adhesives for Duct Thermal Insulation; 1985 (Reapproved 2010).
- C. ASTM C 1071-2010 -- Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material); 2010.
- D. HVAC Duct Construction Standards, Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA); 2010.
- E. NFPA 90A -- Standard for the Installation of Air Conditioning and Ventilating Systems; National Fire Protection Association; 2010.
- F. UL 181 -- Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.; 1994 (8th edition dated November 29, 1994).

1.3 SUBMITTALS

- A. Shop drawings for each product specified in this section that is not a standard product of the manufacturer.
- B. Shop drawings for shop-fabricated duct and fittings.
 - 1. Indicate duct sizes, static pressure ratings, locations, elevations, slopes of horizontal runs, wall and floor penetrations, reinforcing methods, and connection details.
 - 2. Indicate interface and spatial relationship between duct, proximate equipment, and building elements.
 - 3. Indicate modifications proposed to conform to local shop practice and to meet project conditions. Show that free area and rigidity are not reduced from that specified.
- C. Product data for each product specified in this section.
- D. Fabricator qualification statement, for information.

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- E. Coordination drawings, for information.

1.4 FIELD SAMPLE

- A. Furnish sample of lined duct to demonstrate attachment and fastening of liner.
- B. Include at least 2 connecting sections.

1.5 QUALITY ASSURANCE

- A. Conform to NFPA 90A.
- B. Conform to the requirements of the following standards that do not conflict with regulatory requirements or requirements of the contract documents; keep one copy at project site:
 - 1. SMACNA "HVAC Duct Construction Standards, Metal and Flexible."

1.6 QUALIFICATIONS

- A. Fabricator Qualifications: A company fabricating products of this section for a period of 5 years.
- B. Installer Qualifications: A company installing products of this section and whose installations have performed in a satisfactory manner under comparable conditions for a period of 5 years.

1.7 PROJECT CONDITIONS

- A. Review drawings to determine project conditions.
 - 1. Determine working clearance around and between equipment..
 - 2. Determine working clearance around piping and other mechanical work.
 - 3. Determine working clearance required around lighting fixtures, and other electrical work.
 - 4. Determine clearance required to allow proper maintenance of equipment.
 - 5. Determine spaces reserved for electrical connections.
- B. Locations of equipment and air terminal units indicated on drawings are approximate unless dimensioned. Determine exact location before roughing in duct and duct connections.

1.8 FIELD MEASUREMENTS

- A. Field-measure related work to ensure proper fit and clearance.
- B. Field-measure existing work to ensure proper fit and clearance.

1.9 COORDINATION

- A. Use manufacturer's instructions and data to determine rough-in requirements and locations of products connected to ducts.
- B. Prepare coordination drawings and distribute to affected installers of related work.
 - 1. Use reproducible copy of duct shop drawings.
 - 2. Indicate product locations, project conditions, and field measurements.
 - 3. Indicate proposed infringements into required clearance space of other work.
 - 4. Indicate clearance required around each location of installed products for installation, ventilation, access, operation, and maintenance.
 - 5. Indicate required separation of product from pipes, heat generating sources
 - 6. Indicate requirements for access openings in building finishes.

PART 2 - PRODUCTS

2.1 METAL DUCT MATERIALS

- A. Galvanized Sheet Metal: ASTM A 527.
 - 1. Finish: Provide mill phosphatized finish, suitable for painting.

2.2 METAL DUCT SHOP FABRICATION

- A. Fabricate and support duct using tools, techniques, and materials required by SMACNA "HVAC Duct Construction Standards, Metal and Flexible."
- B. Install duct liner where indicated on drawings. Duct dimensions shown are clear inside with liner in place.
- C. Duct sealing is required for the following duct static pressure classes:
 - 1. 1/2 inch w.g., Seal Class C.
 - 2. 1 inch w.g., Seal Class C.
 - 3. 2 inches w.g., Seal Class C.
 - 4. 3 inches w.g., Seal Class B.
 - 5. 4 inches w.g., Seal Class A.
 - 6. 6 inches w.g., Seal Class A.
 - 7. 10 inches w.g., Seal Class A.
- D. Seal duct in accordance with duct sealing described in SMACNA "HVAC Duct Construction Standards, Metal and Flexible."

2.3 DUCT STATIC PRESSURE CLASS

- A. Supply Duct Static Pressure Class:
 - 1. 3 inch w.g. between supply fan and air terminal units.
- B. Supply Duct Pressure Mode: Positive.
- C. Return Duct Static Pressure Class:
 - 1. 1" w.g. for return duct connected to Air Handling Units, and all fan coil units, where applicable.
- D. Return Duct Pressure Mode: Negative.
- E. Exhaust Duct Static Pressure Class:
 - 1. 1 inch w.g. for all exhausts fans.
- F. Exhaust Duct Pressure Mode:
 - 1. Negative upstream of exhaust fan.
 - 2. Positive downstream of exhaust fan.
- G. Outside Air Duct Static Pressure Class:
 - 1. 1 inch w.g. for AHU-1 and all fan coil units.
- H. Outside Air Duct Pressure Mode: Negative.

2.4 CONTROL, BALANCING, AND BACKDRAFT DAMPERS

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- A. Provide control, balancing, and back draft dampers as indicated on drawings.

2.5 CONTROL DAMPERS

- A. Description:
 - 1. Frame material:
 - a. Aluminum.
 - 2. Blade type:
 - a. Aluminum airfoil.
 - 3. Blade edge seal material:
 - a. Extruded vinyl.
 - 4. Opposed blade operation.
 - 5. Operator type:
 - a. Pneumatic.

2.6 MAINTENANCE MATERIALS AND TOOLS

- A. Spare filter: one of each type and size.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in compliance with manufacturer's instructions.
- B. Fabricate duct in field to accommodate changes and to complete system. Use methods of construction and sealing specified for shop fabrication.
- C. Install metal duct in accordance with SMACNA "HVAC Duct Construction Standards, Metal and Flexible."
- D. Modify size, shape, and routing of duct to meet project conditions.
- E. Install accessories specified in this section.
- F. Provide manual dampers for balancing system at each branch takeoff.
- G. Install duct test holes as required.
- H. Temporary Closure: Close ends of duct using suitable materials and methods to minimize collecting construction debris in installed duct.

3.2 COMMISSIONING

- A. Verify tightness of mechanical joints.
- B. Remove baffles and temporary closures.
- C. Verify proper operation of control actuators.
- D. Verify that moving parts are properly lubricated.

3.3 FIELD QUALITY CONTROL

- A. Inspect installed products to observe damage.
- B. Test and demonstration as required by the governing authority.
- C. Visually inspect duct which is not leakage tested, to verify duct construction requirements.
- D. Testing, Adjusting, and Balancing:
 - 1. Secure all manual dampers at full open position.
 - 2. Set splitters straight with main duct.
 - 3. Complete and clean the duct systems to prepare for testing, adjusting, and balancing work.

3.4 CLEANING

- A. Clean using materials and methods recommended by product manufacturer.
- B. Remove dust and debris from inside ducts and fittings.
- C. Clean finishes to remove dust and dirt.
- D. Touch up scratches in unfinished surfaces to restore corrosion resistance.
- E. Touch up scratches in finished surfaces to restore finish.

3.5 INSTRUCTION OF OWNER'S PERSONNEL

- A. Provide instruction to the owner's designated personnel.
- B. Conduct walking tour of the project. Briefly identify location and describe function, operation, and maintenance of each product.
- C. Demonstrate each distinct adjustment, troubleshooting, servicing, and maintenance procedure.

3.6 PROTECTION

- A. Do not use duct provided under this section for temporary heating and ventilating during construction.

END OF SECTION 15891

**SECTION 15940
AIR OUTLETS AND INLETS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Air diffusers and accessories.
 - 2. Grilles and accessories.
 - 3. Registers and accessories.
- B. Related Sections:
 - 1. Metal Duct.
 - 2. Hydronic piping systems.
 - 3. Mechanical insulation
 - 4. Temperature controls.
 - 5. Basic mechanical materials and methods.
 - 6. Testing, adjusting, and balancing

1.2 REFERENCES

- A. ARI Standard 880-89 -- Standard for Air Terminals; Air-Conditioning and Refrigeration Institute; 1989.
- B. NFPA 90A -- Standard for the Installation of Air Conditioning and Ventilating Systems; National Fire Protection Association; 1993.

1.3 SUBMITTALS

- A. Product Data - Air Outlets and Inlets:
 - 1. Performance data for each distinct type and size.
 - 2. Installation instructions.
- B. Contract Closeout Submittals:
 - 1. Operation and maintenance data:
 - a. Parts list.
 - b. "Troubleshooting" guide.
 - 2. Warranty: Manufacturer's standard warranty information.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: A company manufacturing products of this section which have performed in a satisfactory manner under comparable conditions for a period of 5 years.
- B. Installers' Qualifications: A company installing products of this section whose installations have performed in a satisfactory manner under comparable conditions for a period of 5 years.
- C. Regulatory Requirements:
 - 1. Conform to NFPA 90A.
- D. Certifications and Tests:
 - 1. ARI compliance:
 - a. Test air terminal units in accordance with ARI Standard 880, Appendix A.

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1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Protect air inlets and outlets with factory packing designed to prevent damage and contamination. Label exterior of the factory packaging identifying air inlet and outlet types.
- B. Acceptance at Site: Reject any damaged materials upon arrival.
- C. Storage and Protection:
 - 1. Store air inlets and outlets in factory packaging in an area (indoors) protected from weather and construction traffic.
 - 2. If indoor storage is unavailable and outdoor storage is necessary, store air terminals above grade and protect with waterproof cover or wrap.

PART 2 - PRODUCTS

2.1 AIR OUTLET AND AIR INLET MANUFACTURERS

- A. Provide product complying with requirements of the contract documents and made by one of the following:
 - 1. Krueger Division/Philips Industries, Inc.
 - 2. Air Devices Division/Hart & Cooley.
 - 3. Titus, Inc.
 - 4. Hart and Cooley, Inc. Division/Eagle Industries.
 - 5. Tuttle and Bailey

2.2 AIR INLETS AND OUTLETS

- A. Description:
 - 1. Material: Steel or aluminum.
 - 2. Type, capacity, and size of air inlets and outlets are indicated on the drawings.
 - 3. Provide the required accessories manufactured by the air inlet or outlet manufacturer.

2.3 DIFFUSER - D

- A. Manufacturer and Model Number: Tuttle and Bailey,
- B. Other manufacturers' products will be considered.

2.4 GRILLE - GR

- A. Manufacturer and Model Number: Tuttle and Bailey
- B. Other manufacturers' products will be considered.

2.5 REGISTER - R

- A. Manufacturer and Model Number: Tuttle and Bailey.
- B. Other manufacturers' products will be considered.

PART 3 - EXECUTION

3.1 EXAMINATION

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- A. Verification of Conditions:
 - 1. Examine conditions and areas where air outlets and air inlets will be installed. Correct any unsatisfactory conditions before installing air inlets and outlets.

3.2 INSTALLATION

- A. Locate all diffusers, registers, and grilles in accordance with duct shop drawings.
- B. Install air inlets and outlets in compliance with manufacturer's recommendations.

3.3 ADJUSTING

- A. Provide the owner with 5 operating keys for each type of air inlet or outlet device which requires them.

3.4 PAINTING

- A. Paint the interior of ducts matte black behind grilles and registers where it is visible.

3.5 CLEANING

- A. Clean the faces of all air inlets and outlets. Replace or repair any damaged faces.

END OF SECTION 15940

**SECTION 15975
CONTROL SYSTEMS EQUIPMENT**

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 control equipment for Air Cooled Heat Pumps HVAC systems and components, including control components for terminal heating and cooling units that are not supplied with factory-wired controls.

1.3 SYSTEM DESCRIPTION

- A. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories connected to controllers to operate mechanical systems according to sequences of operation indicated or specified.

1.4 SEQUENCE OF OPERATION

1.5 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified. Include manufacturer's technical Product Data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, installation instructions, and startup instructions.
- C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Submit damper leakage and flow characteristics, plus size schedule for controlled dampers.
- D. Shop Drawings containing the following information for each control system:
 - 1. Schematic flow diagram showing fans, pumps, coils, dampers, valves, and control devices.
 - 2. Each control device labeled with setting or adjustable range of control.
 - 3. Diagrams for all required electrical wiring. Clearly differentiate between factory-installed and field-installed wiring.
 - 4. Details of control panel faces, including controls, instruments, and labeling.
 - 5. Written description of sequence of operation.
 - 6. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
- E. Wiring diagrams detailing wiring for power, signal, and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.
- F. Samples of each type of furnished thermostat cover according to requirements of Division 1.
- G. Maintenance data for control systems equipment to include in the operation and maintenance

manual specified in Division 1. Include the following:

1. Interconnection wiring diagrams with identified and numbered system components and devices.
2. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
3. Calibration records and list of set points.

H. Field Test Reports: Procedure and certification of pneumatic control piping system.

I. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain Heating/Air conditioning control from single source if possible.

B. Installer Qualifications: Engage an experienced Installer specializing in control system installations.

C. Manufacturer Qualifications: Engage a firm experienced in manufacturing control systems similar to those indicated for this Project and that have a record of successful in-service performance.

D. Startup Personnel Qualifications: Engage specially trained personnel in direct employ of manufacturer of primary temperature control system.

E. Comply with NFPA 90A.

F. Comply with NFPA 70.

G. Coordinate equipment selection with Division 16 Section "Fire Alarm Systems" to achieve compatibility with equipment that interfaces with that system.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store equipment and materials inside and protected from weather.

PART 2 - PRODUCTS

2.1 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:

1. Carrier
2. Trane
3. Bryant

B. APARTMENT THERMOSTAT

1. T2000 ZONE THERMOSTAT Provide a T2000 Auto Change Over thermostat or equal to control Heat pump through heating and cooling cycles. The T2000 thermostat shall send heating or cooling calls to the System Controller. Each thermostat shall send heating or cooling calls to the System Controller. There shall be a three degree dead band between the heating and cooling set points. Each thermostat shall be provided with two on/off switches. One switch will control heating calls to the System Controller. The other switch will control cooling calls to the System Controller. The switches may be manually set for auto operation,

cooling only, heating only or zone off. Red heating and green cooling signal lights shall be integral parts of the thermostat. The thermostat is to be compatible with auto change over Controllers. The T2000 thermostat shall have remote sensor capability.

2.3 THERMOSTATS

- A. Combination Thermostat and Fan Switches: Line-voltage thermostat with 2-, 3-, or 4-position, push-button or lever-operated, fan switch.
 - 1. Label switches "FAN ON-OFF," "FAN HIGH-LOW-OFF," "FAN HIGH-MED-LOW-OFF." Provide unit for mounting on 2-gang switch box.
- B. Low-Voltage, ON-OFF Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater.
- C. Line-Voltage, ON-OFF Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual ON-OFF-AUTO selector switch; UL listed for electrical rating.
 - 1. Equip thermostats, which control electric, heating loads directly, with OFF position on dial wired to break ungrounded conductors.
 - 2. Dead Band: Maximum 2 deg F (1 deg C).
- D. Fire-Protection Thermostats: UL listed with fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature, with the following:
 - 1. Reset: Manual.Reset: Automatic with control circuit arranged to require manual reset at central control panel, with pilot light and reset switch on panel labeled to indicate operation.
- E. Room Thermostat Construction: Manufacturer's standard locking covers.
- F. Room Thermostat Accessories: As follows:
 - 1. Insulating Bases: For thermostats located on exterior wall.
 - 2. Thermostat Guards: Locking transparent-plastic mounted on separate base.
 - 3. Adjusting Key: As required for device.
 - 4. Aspirating Boxes: Where indicated for thermostats requiring flush installation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation. Verify that field end devices, wiring, and pneumatic tubing are installed before proceeding with installation.

3.2 INSTALLATION

- A. Install equipment as indicated to comply with manufacturer's written instructions.
- B. Verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate 60 inches (1524 mm) above floor.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

- C. Install labels and nameplates to identify control components according to Division 15 Sections specifying mechanical identification.
- D. Install refrigerant instrument wells, valves, and other accessories according to Division 15 Section "Refrigerant Piping."
- E. Install duct volume-control dampers according to Division 15 Sections specifying air ducts.
- F. Install optical-fiber cable according to Division 16 Section "Control/Signal Transmission Media."

3.3 ELECTRICAL WIRING AND CONNECTIONS

- A. Install raceways, boxes, and cabinets according to Division 16 Section "Raceways, Boxes, and Cabinets."
- B. Install building wire and cable according to Division 16 Section "Wires and Cables."
- C. Install signal and communication cable according to Division 16 Section "Control/Signal Transmission Media."
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Install concealed cable in raceway.
 - 4. Bundle and harness multiconductor instrument cable in place of single cables where a number of cables follow a common path.
 - 5. Fasten flexible conductors, bridging cabinets and doors, neatly along hinge side; protect against abrasion. Tie and support conductors neatly.
 - 6. Number-code or color-code conductors, except local individual room controls, for future identification and servicing of control system.
- D. Connect electrical components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.
- E. Connect manual reset limit controls independent of manual control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- F. Connect HAND-OFF-AUTO selector switches to override automatic interlock controls when switch is in HAND position.

3.4 COMMISSIONING

- A. Manufacturer's Field Services: Provide the services of a factory-authorized service representative to start control systems.
- B. Test and adjust controls and safeties.
- C. Replace damaged or malfunctioning controls and equipment.
- D. Start, test, and adjust control systems.
- E. Demonstrate compliance with requirements.

- F. Adjust, calibrate, and fine tune circuits and equipment to achieve proper operation.

3.5 DEMONSTRATION

- A. Manufacturer's Field Services: Provide the services of a factory-authorized service representative to demonstrate and train Owner's maintenance personnel as specified below.
 - 1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 - 2. Schedule training with Owner with at least 7 days' notice.

END OF SECTION 15975

SECTION 15990 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Testing, adjusting, and balancing (TAB) requirements for:
 - 1. Supply air systems.
 - 2. Return air systems.
 - 3. Potable water systems.
- B. Related Sections:
 - 1. Temperature control.
 - 2. Basic mechanical materials and methods.
 - 3. Duct.
 - 4. Hydronic piping systems.

1.2 REFERENCES

- A. National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems; Associated Air Balance Council; 2009.

1.3 SUBMITTALS

- A. Name of the TAB Agency.
- B. Detailed Procedures.
- C. Agenda.

1.4 QUALITY ASSURANCE

- A. Conform to AABC National Standards for Total Systems.
- B. Agency Employer: The Contractor shall purchase the services of an independent TAB agency.
- C. Agency Qualifications: A company which has performed a test and balance under comparable conditions at a similar facility with satisfactory results within the last 5 years.
- D. Provide the owner with an AABC "National Project Performance Guarantee."
 - 1. Submit copies to the contractor and the architect.

1.5 PROJECT CONDITIONS

- A. Review drawings to determine project conditions.
- B. Determine access requirements.
- C. Locations of equipment on the drawings are approximate unless dimensioned.

PART 2 - PRODUCTS

2.1 PROGRESS REPORTS

- A. Report progress of the job: Inspect all mechanical systems and list:
 - 1. Deficiencies.
 - 2. Items not installed.

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3. Items installed, but not operable.
- B. Report Description:
 1. Typed or legibly hand written.
 2. Bound.
 3. List initial readings.
 4. List final readings when available.
- C. Number of Copies: Three for the contractor; one for the architect.

2.2 FINAL REPORTS

- A. Verify and report performance of automatic controls system with cooperation from the control installer.
- B. Inspect all mechanical systems and report:
 1. Deficiencies.
 2. Items not installed.
 3. Items installed, but not operable.
- C. Report Description:
 1. Typed.
 2. Bound.
 3. List initial readings.
 4. List final readings.
 5. List excesses and deficiencies.
 6. List dates and times of all tests.
 7. List the name plate data of installed equipment. Include:
 - a. Manufacturer.
 - b. Size.
 - c. Model number.
 - d. Serial number.
 - e. Motor horsepower.
 - f. Revolutions per minute.
 - g. Voltage.
 - h. Full load amperes.
 - i. Sheave sizes.
 - j. Belt sizes.
 - k. Starter heater sizes.
 - l. Starter rating.
 - m. Starter fuse sizes.
 8. Air measurements during heating mode and during cooling mode:
 - a. Air flow and air velocities for:
 1. Supply air systems.
 2. Return air systems.
 3. Exhaust air systems.
 4. Outside air systems.
 - b. Static pressures, velocity pressures, and total pressures for all branches and mains.
 - c. Pressure drops across all filters and all coils.
 - d. Dry bulb temperatures entering and leaving coils.
 - e. Humidities entering and leaving coils.
 9. Water measurements:
 - a. Flow rates at domestic water heaters.
 - b. Total flow rates for the following systems:
 1. Heating water system.
 - c. Head pressures.
 - d. Head pressure drops across equipment.
 - e. Heat transfer rates in Btu per hour.

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1. Predict performance of equipment at design conditions based on measured heat transfer rates.
- D. Number of Copies: Four delivered to the contractor; one delivered to the architect; two delivered to the owner.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that all systems are fully operational.
1. Report any unsatisfactory conditions to the contractor and the architect in writing.
 2. Begin testing, adjusting, and balancing work after all systems are fully operational.

3.2 SYSTEM OPERATION

- A. Contractor Responsibilities: Operate the systems at all times during testing, adjusting, and balancing work.
1. Perform start-up, adjustment, and commissioning of all mechanical systems, including but not limited to the following:
 - a. Assembly of all parts.
 - b. Alignment of drives.
 - c. Tightening sheaves on shafts.
 - d. Checking motors for proper rotation.
 1. Correction of incorrect rotation.
 - e. Providing properly sized starter overload heaters.
 - f. Removal of dirt and blockage.
 - g. Adjust automatic controls.
 - h. Commission systems.

3.3 TESTING, ADJUSTING, AND BALANCING

- A. Marking of Adjustable Devices:
1. Permanently mark all adjustable device settings. Include:
 - a. Valves.
 2. Set, lock, and mark balancing devices with memory stops.
- B. HP and Hot Water Electric
1. Check and record full load amperes.
 2. Report any motors which are overloaded, defective, or operating within their service safety factor.
- C.. Air Flow Measurements:
1. Main ducts:
 - a. Use Pitot tube and a calibrated inclined manometer to measure pressures.
 - b. Calculate air flow based on measured pressures.
 2. Ducts with velocities below 700 feet per minute:
 - a. Use Pitot tube and a standard hook gage to measure pressures.
 - b. Calculate air flow based on measured pressures.
- D. Diffusers, Registers, and Grilles:
1. Measure and record initial and final device air flow.
 2. Measure and record initial and final device air velocity.
 3. Adjust all diffusers, registers and grilles to minimize drafts.
 4. Set slot diffusers as follows:
 - a. Interior spaces: Horizontal throw; 180 degrees apart.
 - b. Perimeter spaces:

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1. 2-slot diffusers:
 - a. Set one slot with horizontal throw toward perimeter.
 - b. Set one slot with horizontal throw toward interior.
2. 3-slot diffusers:
 - a.
 - b.
3. 4-slot diffusers:
 - a. Set one slot with horizontal throw toward perimeter.
 - b. Set one slot with vertical throw.
 - c. Set two slots with horizontal throw toward interior.
5. Adjust the air flow within the tolerances listed below and to minimize drafts:
 - a. Individual space tolerance: 5 to 10 percent of specified air flow.
 - b. Individual device tolerance:
 1. One device in space: Minus 5 to plus 10 percent of specified air flow.
 2. Two devices in space: Plus or minus 10 percent of the specified air flow.
 3. Three devices or more in space: Plus or minus 15 percent of the specified air flow.
6. Identify each device by listing its:
 - a. Location and area.
 - b. Size.
 - c. Type.
 - d. Manufacturer.
7. Use manufacturer's ratings to complete required calculations.

END OF SECTION 15990