BuildingName
The Description of the Project
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SPECIFICATION DIVISION 22

NUMBER SECTION DESCRIPTION

END OF CONTENTS TABLE

DIVISION 22
SECTION 220719 - MECHANICAL SYSTEMS INSULATION

REVISIONS:
JULY 2019 - : UPDATED BY THE PLUMBING COMMITTEE;COMPLY WITH ASHRAE 90.1 - 2013

NOVEMBER 2022: UPDATED INSULATION THICKNESS TABLE.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

INCLUDE PARAGRAPH 1.1.A AND B IN EVERY SPECIFICATION SECTION.

A. Drawings and general provisions of the Contract, Standard General and Supplementary General Conditions, Division 1 Specification Sections, and other applicable Specification Sections including the Related Sections listed below, apply to this Section.

B. Related Sections:

1. Section 220553 - Mechanical Identification
2. Section 221113 - Piping Materials and Methods

SPEC EDITOR: EDIT THE FOLLOWING AS REQUIRED

1.2 SUMMARY:

A. Insulate piping, ductwork and equipment unless indicated as not to be insulated.

B. Insulate branch heating or chilled water piping from the main to the coil.

C. Reinsulate items from which asbestos insulation was removed.

D. Insulate connection points between new and existing items.

E. Repair or replace insulation damaged during construction.

F. ITEMS NOT TO BE INSULATED:

SPEC EDITOR: EDIT LIST BELOW TO SUIT PROJECT

1. Equipment: hot water pumps, steam condensate pumps, feed water pump, water softener shell, vacuum pumps, hot water shot feeders, hot water expansion tanks, factory insulated equipment.
2. In hot piping: Unions, flexible connectors, control valves 2" and smaller, safety valves, discharge vent piping, vacuum breakers, thermostatic vent valves, piping within fin tube or other terminal units, and steam traps 3/4 inch and smaller, unless noted otherwise.
3. Other piping: waste and vent, compressed air, natural gas, lab vacuum, refrigerant liquid lines, vertical portion of rain water conductors, 12” of chilled beam piping at pipe condensate sensors.

4. Ductwork: indoor return and exhaust air ductwork in conditioned areas.

1.3 REFERENCES

A. Definitions

1. Insulation thermal conductivity: No greater than value listed, in Btu-inch/hour-square foot-degrees F at 100 degrees F mean temperature.
2. Water Vapor Permeance (ASTM E97 or E96, Procedure A): No more than value listed, in perms. Water vapor permeability (ASTM C355): No greater than value listed, in perm-inch.
3. Puncture resistance (ASTM D781): No less than value listed.
4. Flame spread classification (ASTM E84, NFPA 255): No greater than value listed. Smoke density classification (ASTM E84, NFPA 255): No greater than value listed. Composite listing includes insulation, jacket, and adhesive.
5. Density no less than value listed, in pounds per cubic foot.
6. Condition area: Areas that are mechanically maintained between 65F and 80F and relative humidity less than 60% at all times. The following spaces are normally considered conditioned area: spaces above ceilings, heated penthouse, mechanical and electrical rooms.

INCLUDE 1.4.A IN EVERY SPEC SECTION, BUT EDIT AS APPROPRIATE FOR THAT SPEC SECTION, E.G. STRIKE "WIRING DIAGRAMS" IF NOT APPLICABLE TO THE SECTION.

1.4 SUBMITTALS

A. Product Data: Include manufacturer, catalog number, catalog illustrations, rated capacities, performance characteristics, weights, conductor insulation and jacket dimensions, component sizes, rough-in requirements, materials of construction, accessories, operating and maintenance clearance requirements. Additionally include:

1. Shop Drawings
2. Installation, Operation and Maintenance Manuals
3. Test and Evaluation Reports
4. Source Quality Control Submittals
5. Site Quality Control Submittals
6. Certificates
7. Manufacturer Reports
8. Special Procedure Submittals
9. Qualification Statements
10. Warranty Documentation
11. Record Documentation

SPEC EDITOR: REVISE 1.5 AS REQUIRED; INCLUDE ITEMS CONTAINING ASBESTOS IN DIVISION 02 OR ON PLANS.

1.5 ASBESTOS ABATEMENT:

A. All asbestos within the contract bounds shall be removed per the requirements described in Division 02. Refer to drawings for items containing asbestos insulation. Reinsulate all piping, ductwork and equipment from which asbestos has been removed.

1.6 QUALITY ASSURANCE

A. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.

B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft-training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

WHEN FIRE-PERFORMANCE CHARACTERISTICS ARE IMPORTANT REQUIREMENTS, VERIFY SURFACE-BURNING CHARACTERISTICS OF INSULATION MATERIALS BY AN INDEPENDENT TESTING AGENCY AND REQUIRE TEST REPORT SUBMITTALS.

C. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing 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 agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

D. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the specified quality assurance standards; latest editions, unless noted otherwise.

1. Reference Standards: ASHRAE 90.1-2013.

TYPICALLY 1.7.A SHOULD BE INCLUDED IN EVERY SPEC SECTION.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials and equipment raised off the floor on pallets and protected with coverings to prevent damage due to weather and construction activities. Store in areas that prevent damage due to freezing and extreme temperatures or sunlight. Arrange coverings to provide air circulation to avoid damage from condensation or chemical build-up. Protect from damage, dirt and debris at all times.

B. Shipping and Handling Requirements

C. Packaging and Protection

D. On-site Storage & Staging

E. Packaging Waste Management

BELOW IS U-M STANDARD WARRANTY LANGUAGE. ALL WARRANTIES ARE TO START FROM THE DATE OF SUBSTANTIAL COMPLETION. DO NOT USE TERMS LIKE "UPON OWNER ACCEPTANCE" OR "18 MONTHS FROM SHIPMENT OR 1 YEAR FROM STARTUP, WHICHEVER OCCURS FIRST", ETC.

1.8 WARRANTY

A. Provide a complete warranty for parts and labor for a minimum of one year from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. Insulate pipe, duct and equipment to meet the thicknesses and conductivities indicated.

2.2 PIPING INSULATION THICKNESS TABLE:

A. Minimum insulation thickness in inches, shall comply with the table below for the associated piping system and pipe sizes.

Piping System Fluid	Temp. Range Deg. F	Conductivity BTU·in./ (h·ft2·°F)	Thickness in Inches For Pipe Sizes Through Size Listed				
			1"	1.5"	4"	8"	above
MPS (60#)	251-350	0.29-0.32	3.0	4.0	4.5	4.5	4.5
(above to include MPS condensate)							
LPS (15#)	201-250	0.27-0.30	2.5	2.5	2.5	3.0	3.0
(above to include LPS condensate)							
Hot Water	141-200	0.25-0.29	1.5	1.5	2.0	2.0	2.0
Hot Water	105-140	0.22-0.28	1.0	1.0	1.5	1.5	1.5
(above includes hot water potable and hot water heating)							
Cold Water potable	Any	0.21-0.27	0.5	0.5	1.0	1.0	1.0
Storm	Any	0.21-0.27	0.5	0.5	1.0	1.0	1.0
Chilled Water	40-60	0.20-0.26	0.5	1.0	1.0	1.0	1.0
Chilled Water	<40	0.20-0.26	0.5	1.0	1.0	1.0	1.5
Ref. Suct.	Any		1.0	1.0	1.5	N/A	N/A
Energy Recovery	Any		1.0	1.0	1.0	1.0	1.0
Free Cooling Cond. Water	Any		1.0	1.0	1.0	1.0	1.0

(U-M HAS NOT YET ADOPTED ASHRAE 90.1-2019, HOWEVER THE ABOVE SCHEDULE HAS BEEN UPDATED TO MATCH ASHRAE 90.1-2019 RECOMMENDATIONS.)

B. For heat traced piping use insulation ¼" diameter larger to allow room for installation of cable.

2.3 PIPING INSULATION:

THESE PRODUCTS ARE SUITABLE FOR TEMPERATURES OF APPROXIMATELY 0 TO 180F.

A. Fiberglass insulation with factory-applied vapor barrier jacket with self-sealing laps. ASTM C547 Class 1 insulation. Vapor barrier jacket: laminated white kraft paper, aluminum foil, glass fiber reinforcement.

Approved Manufacturers: Johns-Manville, Knauf, Owens/Corning

B. Fiberglass insulation with factory-applied vapor barrier jacket with self-sealing laps. ASTM C547 Class 1 insulation. Vapor barrier jacket: smooth, durable, cleanable polymer film or polypropylene-coated.

Approved Manufacturers: Johns-Manville, Knauf, Owens/Corning

C. At fittings and flanges, insulate with wrapped fiberglass insulation of same thickness as adjacent pipe, and cover with pre-molded PVC jackets. Seal edge of jacket with self-sealing vapor barrier tape.

Approved Jacket Manufacturers: Zeston, Ceel-Co-, Proto

D. For valves, strainers, suction diffusers and other accessories that require maintenance: In hot piping, insulate similar to fittings and flanges. In cold piping, insulate with closed cell elastomeric insulation, installed to be removable for maintenance access.

E. Insulate piping systems outside buildings with fiberglass Insulation. Apply insulation 1/2" thicker than listed in table, and weatherproof the insulation with PVC insulation jacketing.

Approved Jacket Manufacturers: Zeston, Ceel-Co, Proto

F. As a Contractor's Option insulate hot water, cold water, chilled water, refrigerant, piping systems with flexible closed cell elastomeric insulation, ASTM C534, conductivity of 0..254 @90F, water vapor permeability of 0.05. In thickness 1" and less, composite flame spread/ smoke density of 25/50.

Approved Manufacturers: Armacell - AP Armaflex; Rubatex - R-180-FS, IMCOA.

1. Seal all butt joints and seams by joining cut edges with adhesive as supplied by the insulation manufacturer.
2. For exterior piping, coat insulation with glass mesh and two finish coats compatible with insulation. Manufacturer: Armstrong Armacell- Armaflex WB.

2.4 PIPING INSULATION SPECIALTIES:

SPEC EDITOR: ALUMINUM JACKETS ARE NOT GENERALLY RECOMMENDED, BECAUSE OF DAMAGE AND FAILURES WE'VE EXPERIENCED LATELY.

A. Expansion Joints Insulation: Expansion joints shall be insulated with prefabricated insulation blankets, installed in a manner to allow for the repacking of the joints without removing blanket. Hold blankets in place with permanently attached Velcro fasteners.

B. Aluminum Jackets: Where indicated on drawings, provide 0.016" thick alloy 3003 aluminum jacketing with longitudinal lock seam and butt strap circumferential joints.

Approved Manufacturers: Childers-Lock-on and Pabco-Surfeit.

SPEC EDITOR: CONSIDER ADDING A NOTE ON THE DRAWINGS FOR INSULATED JACKETS ON STEAM TRAP ASSEMBLIES AND UNIONS. JACKET SHALL OVERLAP THE UNION ON EACH SIDE AND LABEL THE UNIONS.

C. Removable Insulation Jackets: Where indicated on drawings, provide removable insulation jackets with fiberglass insulation, flexible fabric jacket and velcro fasteners.

Approved Manufacturer: ESI, Insulation Technologies Inc.

2.5 TUNNEL PIPING INSULATION

A. Additionally provide dimpled aluminum jacketing.

2.6 DUCTWORK INSULATION - INDOOR, EXPOSED:

SPEC EDITOR: RIGID INSULATION IS AVAILABLE IN DENSITIES OF 1.6, 2.25, 3.0, 4.25 AND 6.0. R VALUE AND COST INCREASE WITH DENSITY. INSULATION THICKNESS WAS INCREASED TO IMPROVE FIT OVER FLANGED CONNECTIONS, MAY BE REDUCED TO 1" FOR SLIP AND DRIVE DUCT.

A. In mechanical equipment rooms and all other areas where visible without removing ceilings or opening access panels, insulate ductwork with 1-1/2" thick rigid, fiberglass insulation board with factory-applied vapor barrier. Insulation: ASTM C612 Class 2, conductivity of 0.26, density of 3.0. Vapor barrier: laminated white kraft paper, aluminum foil, glass fiber reinforcement, permeance of 0.02, and puncture resistance of 50 units. Composite flame spread/ smoke density of 25/50.

Approved Manufacturers: CertainTeed, Johns Mansville, Knauf, Owens/Corning

2.7 DUCTWORK INSULATION - INDOOR, CONCEALED:

A. In ceiling spaces, building shafts, and other locations where not visible, insulate ductwork with 1-1/2" thick, blanket-type, fiberglass insulation with factory-applied vapor barrier, and 2" stapling and taping flange along one edge. Insulation: ASTM C553, density of 0.75, conductivity of 0.23 @75F. Vapor barrier: laminated white kraft paper, aluminum foil, glass fiber reinforcement, permeance of 0.02, and puncture resistance of 50 units. Composite flame spread/ smoke density of 25/50.

Approved Manufacturers: CertainTeed, Johns Mansville, Knauf, Owens/Corning.

2.8 DUCTWORK INSULATION - OUTDOOR:

SPEC EDITOR: PLANT HAS BEEN EXPERIMENTING WITH USING EPDM ROOFING AS A WRAPPING MATERIAL FOR EXTERIOR DUCTWORK. PRELIMINARY RESULTS LOOK PROMISING. CONSIDER ADDING PLANT WORK ORDER TO BUDGET TO COVER THIS.

A. Insulate exterior ductwork with 2.0" thick flexible closed cell elastomeric insulation, ASTM C534, conductivity of 0.30, water vapor permeability of 0.20. Composite flame spread/ smoke density of 25/50.

Approved Manufacturers: Armacell, Rubatex.

1. Seal all butt joints and seams by joining cut edges with adhesive as supplied by the insulation manufacturer.
2. Wrap insulation with glass mesh and coat with two finish coats compatible with insulation.
   Manufacturer: Armacell-Armaflex WB.

3. Taper insulation to prevent ponding.

2.9 SEALING MASTICS FOR PIPE AND DUCT INSULATION

A. Provide mastics to seal insulation joints and to provide a continuous vapor barrier. The permeance of the mastic shall be equal to or less than the permeance of the vapor barrier of the insulation it is applied to. The ASTM E84 flame spread and smoke density classification shall not exceed 25/50. Mastics shall be mercury and asbestos free, selected for the temperature range of the service, and selected for uses recommended by the manufacturer. Mastics used outdoors shall be outdoor rated, waterproof, and U.V. resistant.

Approved Manufacturers: Subject to compliance with the above requirements, provide mastics manufactured by Childers, Foster, Vimasco, Mon-Eco Industries.

2.10 HOT EQUIPMENT INSULATION:

A. Insulate all equipment with surface temperature over 100F, using rigid fiberglass insulation board. Insulation: ASTM C612 Class 2, conductivity of 0.23 @75F, density of 6.0. Vapor barrier: laminated white kraft paper, aluminum foil, glass fiber reinforcement, permeance of 0.2, and puncture resistance of 50 units. Composite flame spread/ smoke density of 25/50.

Approved Manufacturers: CertainTeed, Johns Mansville, Knauf Owens/Corning

B. Apply insulation in thickness as follows: 1-1/2" for operating temperature up to 150F, 2" for operating temperature of 150F to 200F, 3" for operating temperature over 200F.

C. Cut, score, or miter insulation to fit contour of equipment and secure with galvanized steel bands or wire, or weld pins. Stagger joints where possible and fill voids with insulating cement. Apply 1" galvanized wire mesh over entire exterior surface and finish with two coats of insulating cement toweled to a hard finish.

2.11 COLD EQUIPMENT INSULATION:

A. Insulate all equipment with surface temperature below 60F with 1" thick, flexible, closed cell, elastomeric foam insulation sheet, ASTM C534, conductivity of 0.30, permeance of 0.20, composite flame spread/ smoke density of 25/50.

Manufacturers: Armacell, Rubatex.

B. Apply elastomeric foam insulation sheet with contact adhesive.

Approved Manufacturers: Armacell, Rubatex. Seal all butt joints with adhesive.

PART 3 - EXECUTION

3.1 INSULATION INSTALLATION

A. All systems shall be tested and approved before being insulated.

B. The insulation shall be applied over clean, dry surface.

C. Insulate all valves, flanges, couplings and fittings. Valve and flange insulation shall be removable and reinstallable.

D. Full lengths of insulation shall be used except at end of straight sections and as required to accommodate fittings. Insulation shall be applied with the joints tightly fitted together. Cracks or voids shall be filled with insulation. Manufacturer's recommended installation procedures shall be strictly adhered to.

E. The edges and seams at all visible locations shall be finished in a neat and workmanlike manner.

F. All exposed ductwork insulation shall be applied with edges butted. Insulation shall be impaled over stick clips or pins welded to the duct, and secured with speed clips. Spacing of pins shall be as required to hold insulation firmly in place but not less than one pin per square foot. All joints and penetrations of the vapor barrier shall be sealed with a 3" wide strip of the same material, supplied with vapor barrier adhesive to both surfaces as recommended by adhesive manufacturers.

G. Blanket insulation shall be tightly sealed at all joints and seams. Insulation shall be cut longer than ductwork perimeter to allow maximum thickness on all areas and avoid excessive compression. All joints shall be over lapped at least 2" and stapled in place. The stapled seams shall be sealed with a minimum 3" wide pressure sensitive tape designed for use with the duct insulation. All breaks in the vapor barrier facing shall also be sealed with the tape. The underside of ductwork 18" or greater in width, and vertical surfaces 48" or greater shall have the insulation additionally secured with mechanical fasteners and speed clips spaced approximately 12" on center. The protruding ends of the fasteners shall be cut off flush after the speed clips are installed, and then sealed with the same tape as specified above.

H. Finished installation shall provide a continuous and effective vapor barrier.

END OF SECTION 220719