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SECTION 23 07 00

HVAC INSULATION

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

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

B. All criteria establish within Specification 23 00 00 shall apply to this section unless specifically noted otherwise.

C. Examine all Drawings and all Sections of the Specifications for requirements and provisions affecting the Work of this Section.

1.1 SUMMARY

A. Related Sections include the following:

1. All the requirements of Part 1 paragraphs of Section 23 00 00 apply to this section.
2. The requirements of the following Part 3 paragraphs of Section 23 00 00 apply to this section:

    a. Field Painting and Coating
    b. Identification

B. Section includes labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Pipe insulation for the following piping systems including fittings, valves and strainers:

    a. Condensate drain piping outdoors.
    b. Any other piping indicated as insulated in the specifications and/or on the drawings.

1.2 ACTION SUBMITTALS

A. Provide original file copies only, scanned file copies are not acceptable. All submittals shall be submitted in hardcopy and editable and searchable electronic format.

B. Qualification Data: For qualified Installer.

C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

D. Product Data: Include manufacturer's technical literature for each type of product indicated and which system(s) the product is to be applied. Include thermal conductivity (after compression), water-vapor permeance, thickness, and jackets (both factory- and field-applied if any).

E. Shop Drawings: Provide the following:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, flanges, dampers, valves, strainers, pumps, and specialties for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.
5. Detail attachment and covering of heat tracing inside insulation.
6. Detail insulation application at pipe expansion joints for each type of insulation.
7. Detail removable insulation at piping specialties.
8. Detail removable insulation at equipment connections.
9. Detail field application for each equipment type.
10. Detail application of field-applied jackets.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Manual Data: For all equipment.

B. All product warranties which shall cover materials and labor for a minimum of 1 year from the date of acceptance.

C. All documentation required for project completion, including contractor’s project completion certificate in accordance with MA code 780CMR 107.6.3 indicating that the installation is in accordance with the approved construction documents and all applicable local, state and federal statutes and regulations. All pertinent deviations shall be specifically noted in the certificate.

1.4 QUALITY ASSURANCE

A. 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.

B. 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.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Insulation materials shall be protected during delivery, storage on site, and use from water, crushing, or other damaging conditions. Any damaged insulation shall be replaced with new.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230000.

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing where applicable.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 PIPE INSULATION

A. General

1. Insulation shall be CertainTeed, Knauf, Johns Manville, Owens Corning, Armacell, K-Flex USA, or Halstead Nomaco. Install insulation, mastics, adhesives, coatings, covers, weather protection and other work exactly as required by manufacturer's recommendations. Materials shall meet requirements of Adhesive and Sealant Council Standards.
2. All mastics, adhesives, and coatings shall have low to no VOCs and be water based wherever possible.
3. Products shall not contain asbestos, lead, mercury, or mercury compounds.
4. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
5. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
6. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
7. Apply insulation after systems have been tested, proved tight and approved by Engineer. Remove dirt, scale, oil, rust and other foreign matter prior to installation of insulation.
8. Leaks in vapor barrier or voids in insulation will not be accepted.

9. ASTM E 84 minimum fire hazard ratings shall be no higher than 25 flame spread, 50 fuel contributed and 50 smoke developed for indoor applications.
10. Where pipes are insulated, flexible connections to pipes shall be insulated.
11. Insulate flanges and couplings with same material and thickness as pipe.
12. Insulation shall be continuous through wall and ceiling openings and in sleeves.
13. Transmission rates of vapor barriers shall not exceed 0.02 perms.
14. Provide pipe, valve, and fitting insulation of type(s) indicated in these specifications and with the minimum insulation thicknesses scheduled on the drawings for all listed piping services and temperature ranges.

B. Provide the following products depending on temperature of each piping system. Insulation shall be marked to show the locations of all unions, break flanges, strainers, check and balancing valves.

1. For piping with a service temperature between 40°F and 600°F such as chilled water, hot water, dual temperature water, make-up and feed water, blow-down, all outdoor condenser water piping, all indoor condenser water supply piping from the towers to the free cooling heat exchanger, condensate drain, glycol heat recovery (with down to 0°F minimum winter temperature), boiler feed water, heated oil, water defrost piping in refrigerated rooms, steam, and steam condensate, provide glass fiber insulation equal to JM Micro-Lok. Insulation shall be rigid molded and noncombustible, meeting ASTM C 547, Type I. K-factor shall be 0.23 at 75°F mean temperature. All purpose vapor retardant jacket shall be JM AP-T PLUS. Jacket shall be white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self-sealing longitudinal laps and butt strips or AP Jacket with outward clinch expanding staples (coated with vapor barrier mastic for all chilled water, dual temperature water and glycol heat recovery systems). A breather mastic for applications above ambient pipe service temperatures (fittings, tees, valves, etc.) shall be water based Foster 46-50 or Childers CP-10 / CP-11. A rigid, non-compressible insulation, equal to Pittsburg-Corning FoamGlas or KingspanTarec Kooltherm shall be used at all pipe hangers and supports for all steel chilled water piping where the pipe is supported by hangers, anchors, and guide with a minimum length of eighteen (18) inches.
2. For all refrigerant suction and cold chilled water/brine solutions (below 60°F) and all outdoor refrigerant liquid and hot gas piping with a service temperature between -40°F and 200°F, provide PBDE (polybrominated diphenyl esthers) free elastomeric foam insulation equal to Armacell AP/Armaflex (up to 1” thick) or AP/Armaflex/FS (over one (1) inch thick). This insulation type may also be used for condensate drain and chilled water and low temperature heating systems (up to 200 degrees F) piping and fittings that are not heat traced. If used in computer room plena or over stainless steel pipe or fittings, the material shall be chlorine free equal to Armacell NH/Armaflex. Insulation shall be flexible, cellular elastomeric, meeting ASTM C 534, Type I. K-factor shall be 0.27 at 75°F mean temperature. Insulation shall be rated for no more than 25/50-flame spread/smoke developed rating. Provide waterproof vapor retardant adhesive as needed for installation. Provide 2 coats of waterproof Foster 30-64 Elastomeric Foam Coating, or equal UV protective coating for all outdoor insulation that is not jacketed (allowed up to one (1) inch pipe diameter).

C. Field Applied Piping and Fitting Jackets

1. Provide covers for insulation of all pipe fittings (i.e. elbows, tees, end caps, reducers, unions, flanges, mechanical joints), strainers and valves with surface temperatures between –20°F and 150°F (all water, low pressure steam and condensate systems with glass fiber insulation and over one (1) inch foam insulation on refrigerant piping). Provide easily removable sections for cleaning and maintenance of unions, balancing valves, and strainers. Fitting covers shall be 30-mil thick white PVC equal to JM Zeston 2000 molded high impact, UV resistant covers. Attach with water-resistant pressure sensitive color matching vinyl tape to maintain vapor barrier. Insulate all fittings per manufacturer's recommendations to prevent surface temperature from exceeding the 150°F limit.

2. Other than where foam type insulation is used on up to one (1) inch outdoor pipe, with 2 coats of UV protection, protect all piping insulation that passes through walls and floors, and all outdoor pipe insulation with 0.016 inch thick smooth or embossed aluminum sheet jacket or 0.01 inch thick smooth or corrugated type 304 stainless steel or 30 mil thick Zeston 2000 perma-weld high impact UV resistant PVC jacket with perma-weld fitting covers. Seams shall be on the bottom half of the pipe arranged to shed water. Provide minimum two (2) inch overlap for all longitudinal and transverse joints. All seams of outdoor jacket shall be filled with waterproof adhesive. Provide one (1) inch wide draw bands (same material as jacket) on twelve (12) inch centers.

D. Apply insulation after systems have been tested, proved tight and approved by Engineer. Remove dirt, scale, oil, rust and foreign matter prior to installation of insulation.

E. No leaks in vapor barrier or voids in insulation will be accepted.

F. Insulation and vapor barrier on piping which passes through walls or partitions shall pass continuously through sleeve, except that piping between floors and through fire walls or smoke partitions shall have space allowed for application of approved packing between sleeves and piping, to provide fire stop as required by NFPA. Seal ends to provide continuous vapor barrier where insulation is interrupted.

G. Provide insulation with factory applied vapor barrier jacket on all outdoor cooling tower drain and makeup, drain, hot and cold water piping, unless noted otherwise.

H. Cooling coil condensate drain piping other than PVC piping and outdoor cooling tower drain piping shall have ½" thick foam type insulation.

I. Insulation for prefabricated piping is specified in Pre-insulated Piping Paragraphs of specification section 23 20 00 and not included with this section.

J. Provide longitudinal lap and 6" wide vapor barrier joint seal strips secured with approved adhesive.

K. Seal ends of pipe insulation and seal insulation to pipe with approved fire retardant vapor barrier, at flanges, valves and fittings and at intervals of no more than 21 feet on continuous runs of piping.

L. Secure covers on concealed pipe with metal bands at least 3/4" wide and no more than 18" apart, spaced to hold ends and centers of each section.

M. Insulation on outdoor piping shall be twice the thickness listed in Table A above, but not more than 6". Waterproof with 0.016" thick aluminum jacket with 2" transverse and longitudinal lapped seams oriented to shed water. Fill seams with weatherproof adhesive. Secure jacket with 1" wide aluminum draw bands on 12" centers.

N. Insulate outdoor condensate systems only if heat traced.

O. Insulation on Fittings, Valves and Flanges

1. Fittings, valves and flanges shall be insulated with precut, factory supplied fibrous glass, by CertainTeed, Knauf, Owens Corning or Manville.
2. Fittings, valves and flanges shall be insulated with same material and to same thickness as adjoining pipe insulation.
3. Pipe fittings shall be pre tested, clean and dry before insulation.
4. Installation of insulation on fittings shall be as follows, in order:
    a. Wrap insulation around fitting and tuck ends into fitting throat.
    b. Edges of adjacent insulation shall be tufted and tucked in, to fully insulate fitting to thickness of adjacent pipe insulation. Use two or more thicknesses if necessary.
    c. If two layers of insulation are used on fittings, wrap and secure first layer with twine before applying second layer.
    d. Top layer of insulation shall be covered with one piece, PVC, Zeston molded fitting cover. Secure cover with stainless steel tack fasteners inserted into jacket throat overlap seam.
    e. Tape joints with pressure sensitive vapor barrier tape; tape shall extend 2" on either side of joint.
5. Prior to taping of joints on chilled water lines, apply vapor barrier mastic (brushed on) to fitting cover, throat overlap and edges. Also apply vapor barrier mastic to pipe insulation jacket ends.
6. For strainers and other valves or fittings which need maintenance, provide preformed removable insulation sections or pre-manufactured removable insulation jackets.

P. Refrigeration Line Insulation

1. Suction lines, hot gas bypass lines, and outdoor liquid lines shall be insulated to the thickness listed in Table A with rigid closed cell foam insulation having an ASTM E 84 fire hazard ratings of 25 flame spread, 50 smoke developed and 50 fuel contributed for up to 2” thickness by Armacell Rigid Armaflex or equal by Manville, Owens Corning, K-Flex USA (Insul-Tube), or Halstead/Nomaco, providing they meet all requirements including surface burning limits, with maximum K factor of 0.25 at 75 degrees F mean temperature.
2. Installation shall meet manufacturer's recommendations. Seal butt joints with insulation manufacturers approved adhesive.
3. Outside above ground insulation shall be protected with two coats of approved vinyl lacquer coating over woven glass mesh adhered to insulation with Insulcolor or approved equal lagging adhesive, as recommended by manufacturer.

PART 3 - EXECUTION

3.0 EXAMINATION

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

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.1 PREPARATION

A. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature over 250 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature under 50 deg F or over and 250 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. These requirements generally apply to all insulation materials and installation except where more stringent requirements are specified in various Part 2 equipment insulation material paragraphs.

B. Environmental Requirements: Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

C. Quality Assurance: Insulation materials must be asbestos free, UL listed, and manufactured at facilities certified and registered to conform to ISO 9000 Quality Standard. All insulating products and jackets shall carry flame spread and smoke developed ratings as listed in Part 2 for the location as tested in accordance with ASTM E 84.

D. Workmanship: All insulation shall be installed by a licensed applicator and applied in accordance with the manufacturer’s recommendations. All work shall comply with all applicable federal, state, and local codes including, but not limited to, OSHA. All work shall conform to industry and trade accepted standards for

commercial and industrial insulations. Verify that piping, heat trace, and ductwork has been tested (including applicable pressure/leakage tests) before applying insulation materials. Surfaces to be insulated shall be cleaned free of dirt, scale, moisture, oil and grease. No vapor barrier leaks or insulation voids will be accepted. Continue insulation vapor barrier through penetrations except where prohibited by code. All fire rated walls and penetrations shall be sealed with fire stopping. Locate insulation and cover seams in least visible locations. Neatly finish insulation at supports, protrusions, and interruptions. For all systems requiring a vapor barrier seal all terminations including fittings, wall penetrations, and supports with vapor barrier mastic such as Foster 30-65, Childers CP-35 or approved equal. In addition, in brine or chilled water pipe systems vapor seal pipe terminations every four (4) pipe sections, using Foster 30-65, Childers CP-35 or approved equal. Bevel and seal ends of insulation at equipment, flanges, and unions. Where insulation is used over stainless surfaces, the material shall be chlorine free.

E. Delivery and Storage of Materials

1. Deliver all materials to the job site and protect the insulation against dirt, water, chemical and mechanical damage before, during and after installation. Do not install damaged insulation and remove it from the job site.
2. Deliver insulation, coverings, cements, adhesives coatings etc. to the site in factory-fabricated containers with the manufacturer's stamp or label affixed showing fire hazard ratings of the products, name of manufacturer and brand.
3. Installed insulation that has not been weatherproofed shall be protected from inclement weather by an approved waterproof sheeting installed by the Contractor. Any water-damaged insulation shall be removed and replaced by the Contractor at no additional cost.

F. Piping, including piped equipment:

1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
2. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
3. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

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

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

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

J. Keep insulation materials dry during application and finishing.

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

L. Install insulation with least number of joints practical.

M. Where vapor barrier is indicated (minimum of all cooling piping, outdoor air ducts, as well as exhaust ducts from humidified spaces located outdoors), seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

N. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

O. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 3 inches o.c.
4. For below ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with at least 2 layers of continuous tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

P. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.

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

R. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

S. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate ductwork damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping" to maintain firestopping and with appropriate fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 INSTALLATION OF FIBERGLASS OR MINERAL-FIBER PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Fittings and Elbows:

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

3.5 PIPE FINISHES

A. Uninsulated outdoor bare steel pipe and all pipe insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint pipe or jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets unless specifically called for on the drawings or elsewhere specifications.

END OF SECTION 23 07 00