SECTION 23 07 00

HVAC INSULATION

**BASED ON DFD MASTER SPECIFICATION DATED 3/27/2024**

This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.

# P A R T 1 - G E N E R A L

SCOPE

This section includes insulation specifications for heating, ventilating and air conditioning piping, ductwork and equipment. Included are the following topics:

PART 1 - GENERAL

Scope

Related Work

Reference

Reference Standards

Quality Assurance

Description

Definitions

Shop Drawings

Operation and Maintenance Data

Environmental Requirements

PART 2 - PRODUCTS

Materials

Insulation Types

Adhesives, Mastics, Sealants, and Reinforcing Materials

Jackets

Insulation Inserts and Pipe Shields

Expansion Joint and Valve Insulation Blankets

Accessories

PART 3 - EXECUTION

Examination

Installation

Protective Jacket Installation

Piping, Valve and Fitting Insulation

Piping Protective Jackets

Removable Insulation Blankets

Pipe Insulation Schedule

Duct Insulation

Ductwork Protective Coverings

Duct Insulation Schedule

Equipment Insulation

Equipment Insulation Schedule

Construction Verification Items

RELATED WORK

Section 01 91 01 or 01 91 02 – Commissioning Process

Section 23 05 00 - Common Work Results for HVAC

Section 23 08 00 - Commissioning of HVAC

Section 23 11 00 - Facility Fuel Piping

Section 23 21 13 - Hydronic PipingSection 23 22 13 - Steam and Condensate Heating PipingSection 23 24 00 - Internal-Combustion Engine PipingSection 23 83 16 - Radiant-Heating Hydronic Piping

Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

Section 23 31 00 - HVAC Ducts and Casings

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

ASTM B209 Aluminum and Aluminum Alloy Sheet and Plate

ASTM C165 Test Method for Compressive Properties of Thermal Insulations

ASTM C177 Heat Flux and Thermal Transmission Properties

ASTM C195 Mineral Fiber Thermal Insulation Cement

ASTM C240 Cellular Glass Insulation Block

ASTM C302 Density of Preformed Pipe Insulation

ASTM C272 Water Absorption of Core Materials for Sandwich Constructions

ASTM C303 Density of Preformed Block Insulation

ASTM C355 Test Methods for Test for Water Vapor Transmission of Thick Materials

ASTM C449 Mineral Fiber Hydraulic Setting Thermal Insulation Cement

ASTM C518 Heat Flux and Thermal Transmission Properties

ASTM C533 Calcium Silicate Block and Pipe Thermal Insulation

ASTM C534 Preformed Flexible Elastomeric Thermal Insulation

ASTM C547 Mineral Fiber Preformed Pipe Insulation

ASTM C552 Cellular Glass Block and Pipe Thermal Insulation

ASTM C553 Mineral Fiber Blanket and Felt Insulation

ASTM C578 Preformed, Block Type Cellular Polystyrene Thermal Insulation

ASTM C591 Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation

ASTM C610 Expanded Perlite Block and Thermal Pipe Insulation

ASTM C612 Mineral Fiber Block and Board Thermal Insulation

ASTM C921 Properties of Jacketing Materials for Thermal Insulation

ASTM C1136 Flexible Low Permeance Vapor Retarders for Thermal Insulation

ASTM C1728 Standard for Aerogel Insulation

ASTM D412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension

ASTM D1000 Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications

ASTM D1621 Standard Test Method for Compressive Properties Of Rigid Cellular Plastics

ASTM D1622 Standard Test Method for Apparent Density of Rigid Cellular Plastics

ASTM D1940 Method of Test for Porosity of Rigid Cellular Plastics

ASTM D2126 Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging

ASTM D2240 Standard Test Method for Rubber Property—Durometer Hardness

ASTM D5590 Test Method for Determining the Resistance of Coatings to Fungal Defacement

ASTM E84 Surface Burning Characteristics of Building Materials

ASTM E814 Standard Test Method for Fire Tests of Penetration Firestop Systems

ASTM E2336 Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems

MICA National Commercial & Industrial Insulation Standards

NFPA 225 Surface Burning Characteristics of Building Materials

UL 723 Surface Burning Characteristics of Building Materials

QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions

Label all insulating products delivered to the construction site with the manufacturer's name and description of materials.

Insulation systems shall be applied by experienced contractors. Within the past five (5) years, the contractor shall be able to document the successful completion of a minimum of three (3) projects of at least 50% of the size and similar scope of the work specified in this section.

The following paragraph applies to fluid-applied ductwork insulation only.

Fluid-applied ductwork insulation is a roofing product that shall be applied only by qualified contractors. Contractor shall be recognized by the manufacturer of the Polyurea 2-part liquid membrane system as an “approved” or “authorized” applicator. Only manufacturer recognized, qualified and authorized Contractor’s whose labor and material are fully covered, without exception, by the manufacturer’s warranty, as required by this section, will be allowed to perform the work. Manufacturer must submit letterhead document verifying the Contractor as an authorized applicator of their product and able to receive the specified warranty.

DESCRIPTION

Furnish and install all insulating materials and accessories as specified or as required for a complete installation. The following types of insulation are specified in this section:

1. Pipe Insulation
2. Duct Insulation
3. Equipment Insulation

Install all insulation in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions. Exceptions to these standards will only be accepted where specifically modified in these specifications, or where prior written approval has been obtained from the DFD Project Representative.

DEFINITIONS

Concealed: shafts, furred spaces, space above finished ceilings, utility tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

SHOP DRAWINGS

Refer to division 1, General Conditions, Submittals.

Submit a schedule of all insulating materials to be used on the project, including adhesives, fastening methods, fitting materials along with material safety data sheets and intended use of each material. Include manufacturer's technical data sheets indicating density, thermal characteristics, jacket type, and manufacturer's installation instructions. Include copies of the MICA plates that are applicable to this project.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

Delete the following if there are no additional requirements.

In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

1. [A/E and commissioning provider to define detailed operation and maintenance data requirements for equipment specifications added to this section.]

ENVIRONMENTAL REQUIREMENTS

Do not store insulation materials on grade or where they are at risk of becoming wet. Do not install insulation products that have been exposed to water.

Protect installed insulation work with plastic sheeting to prevent water damage.

# P A R T 2 - P R O D U C T S

MATERIALS

Manufacturers: Armacell, CertainTeed, Manson, Childers, Dow, Extol, Fibrex, Halstead, Foster, Imcoa, ITW, Johns Manville, Knauf Insulation, Owens-Corning, Pittsburgh Corning, VentureTape or approved equal.

Materials or accessories containing asbestos will not be accepted.

Use composite insulation systems (insulation, jackets, sealants, mastics, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less, with the following exceptions:

Pipe insulation which is not located in an air plenum may have a flame spread rating not over 25 and a smoke developed rating no higher than 450 when tested in accordance with UL 723 and ASTM E84.

INSULATION TYPES

Insulating materials shall be fire retardant, moisture and mildew resistant, and vermin proof. Insulation shall be suitable to receive jackets, adhesives and coatings as indicated.

FLEXIBLE FIBERGLASS INSULATION:

Minimum nominal density of 0.75 lbs. per cu. ft., and thermal conductivity of not more than 0.30 at 75 degrees F mean temperature, rated for maximum service temperature of 250 degrees F.

Knauf Insulation – Duct Wrap;

Owens Corning – SoftR

Johns Manville – Microlite EQ

RIGID FIBERGLASS INSULATION:

Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75 degrees F mean temperature, 0.25 at 125 degrees F, 0.27 at 150 degrees F, 0.29 at 200 degrees F, 0.32 at 250 degrees F, minimum compressive strength of 25 PSF at 10% deformation, rated for maximum service temperature of 450 degrees F.

Knauf – Earthwool insulation Board

Johns Manville – 814 Spin-Glas;

Owens Corning Fiberglas type 703

SEMI-RIGID FIBERGLASS INSULATION:

Minimum nominal density of 3 lbs. per cu. ft., thermal conductivity of not more than 0.28 at 75 degrees F mean temperature, minimum compressive strength of 25 PSF at 10% deformation, rated for service temperature range of 0 degrees F to 450 degrees F. Insulation fibers perpendicular to jacket and scored for wrapping cylindrical surfaces.

Owens Corning Fiberglas 703

CALCIUM SILICATE INSULATION:

Rigid hydrous calcium silicate, ASTM C533, Type I, minimum dry density of 12.5 lbs. per cu. ft., thermal conductivity of not more than 0.44 at 300 degrees F mean temperature, maximum water absorption of 90% by volume, minimum compressive strength 140 psi at 5% deformation, rated for service temperature range of 0 degrees F to 1,200 degrees F. Material to be visually coded or marked to indicate it is asbestos free.

HIGH TEMPERATURE CALCIUM SILICATE INSULATION:

Rigid hydrous calcium silicate, ASTM C533, Type II, minimum dry density of 12.5 lbs. per cu. ft., thermal conductivity of not more than 0.44 at 300 degrees F mean temperature, maximum water absorption of 90% by volume, minimum compressive strength 140 psi at 5% deformation, rated for service temperature range of 0 degrees F to 1,800 degrees F. Material to be visually coded or marked to indicate it is asbestos free.

ELASTOMERIC INSULATION:

Flexible closed cell, minimum nominal density of 5.5 lbs. per cu. ft., thermal conductivity of not more than 0.28 at 75 degrees F mean temperature, minimum compressive strength of 4.5 psi at 25% deformation, maximum water vapor permeability of 0.08 perm inch, maximum water absorption of 6% by weight, rated for service temperature range of -20 degrees F to 220 degrees F on piping and 180 degrees F where adhered to equipment.

Armaflex AP

Aerocel - SSPT

K-Flex – Insul-lock DS

POLYOLEFIN INSULATION:

Flexible closed cell, minimum nominal density of 1.5 lbs. per cu. ft., thermal conductivity of not more than 0.25 at 75 degrees F mean temperature, minimum compressive strength of 5 psi at 25% deformation, maximum water vapor permeability of 0.0 perm inch, maximum water absorption of 0% by weight and volume, rated for service temperature range of -165 degrees F to 210 degrees F.

For use on Chilled water only and in sheet form only

Normaco – Therma-cel, Nomalock, Imcosheet

This paragraph describes Imcoa insulation which is suitable for interior/exterior use or direct burial.

PHENOLIC INSULATION:

Rigid closed cell, minimum nominal density of 2.2 lbs. per cu. ft., thermal conductivity of not more than 0.13 at 75 degrees F mean temperature, minimum compressive strength of 31 psi parallel and 18 psi perpendicular, maximum water vapor permeability 0.117 perm inch, maximum water absorption of 0.5% by volume, rated for service temperature range of -290 degrees F to 250 degrees F.

Trymer Supercel

EXTRUDED POLYSTYRENE INSULATION:

Rigid closed cell, minimum nominal density of 1.6 lbs. per cu. ft., thermal conductivity of not more than 0.26 at 75 degrees F mean temperature, minimum compressive strength of 20 psi, maximum water vapor permeability of 1.5 perm inch, maximum water absorption of 0.5 % by volume (ASTM C272), rated for service temperature range of -290 degrees F to 165 degrees F.

Owens Corning – Foamular Thermapink

Dow – Styrofoam

ITW Insulation Systems – For Piping

POLYISOCYANURATE INSULATION:

Rigid closed cell polyisocyanurate, minimum nominal density of 2.0 lbs. per cu. ft., thermal conductivity of not more than 0.19 at 75 degrees F mean temperature aged 180 days, minimum compressive strength of 24 psi parallel and 13 psi perpendicular, maximum water vapor permeability of 4 perm inch, maximum water absorption of 2% by volume, rated for service temperature range of -290 degrees F to 300 degrees F.

ITW – Trymer 2000 XP (Pipe)

The paragraph below describes FoamGlas insulation for use in direct burial applications. Before using review with DFD Project Manager.

CELLULAR GLASS INSULATION:

Rigid closed cell, minimum nominal density of 7.5 lbs. per cu. ft., thermal conductivity of not more than 0.28 at 50 degrees F mean temperature, 0.29 at 75 degrees F mean temperature, 0.38 at 200 degrees F mean temperature, minimum compressive strength of 90 psi, maximum water vapor permeability of 0.0 perm inch, maximum water absorption of 0.2% by volume, rated for service temperature range of -450 degrees F to 900 degrees F.

Pittsburg Corning - Foamglas

MINERAL WOOL INSULATION:

Rigid preformed mineral wool, minimum nominal density of 8 lbs. per cu. ft., thermal conductivity of not more than 0.24 at 75 degrees F mean temperature, 0.30 at 200 degrees F, 0.38 at 300 degrees F, minimum compressive strength of 3 psi, maximum wicking of 1%, maximum water adsorption of 1% by volume, rated for service temperature range of -120 degrees F to 1200 degrees F.

Pipe insulation shall be pre-formed in two (2) half cylinder sections. Cut V-groove sheet insulation is not acceptable. Provide three (3) stainless steel bands for each section of insulation.

Roxul – ProRox PS 960, SL 960

Calsilite – MinWool 1200 Pipe

The paragraph below describes Pyrogel XT insulation which is suitable for use in existing conduits under certain conditions. Before using review with DFD Project Manager.

This insulation is only allowed with WRITTEN APPROVAL from DFD Project Manager. This insulation has a history of off gassing ammonia once heated by the steam pipe.

AEROGEL INSULATION:

Flexible sheet with a minimum nominal density of 11 lbs. per cu. ft., thermal conductivity of not more than 0.146 at 100 degrees F mean temperature, 0.19 at 200 degrees F, 0.22 at 250 degrees F, material shall be hydrophobic, and rated for service temperature range of -40 degrees F to 1200 degrees F.

FIREPROOFING INSULATION:

Mineral wool with nominal density of 8 lbs. per cu. ft., flame spread index of 25, fuel contribution index of 0, and smoke developed index of 0, thermal conductivity of not more than 0.23 at 75 degrees F mean temperature, rated for service temperature range of -120 degrees F to 1200 degrees F. Use rigid or semi-rigid board for duct insulations.

Foil-scrim-polyethylene vapor retarding jacket, factory applied to insulation, maximum permeance of .02 perms.

FIRE RATED INSULATION:

Noncombustible, non-asbestos, non-ceramic fiber, high temperature blanket or board fireproofing insulation, constructed of calcium silicate or calcium/magnesium/silica amorphous wool with 2-hour ***(1-hour, 3-hour)*** ASTM E814 “F” and “T” fire ratings, UL or equivalent third party listed, labeled and specifically evaluated for such purpose in accordance with ASTM E2336. Foil-scrim-polyethylene fiberglass reinforced factory applied jacket.

Grease ducts (Type I kitchen hood serving appliances that produce grease vapors or smoke) must be enclosed from the point of penetration of a ceiling, wall or floor to the outlet terminal in a 2-hour rated enclosure vented to the outside and constructed with 6”-12” clearance to the duct. The preceding paragraph describes a code exception for fire-stop insulation with an equal or greater fire rating (A/E to verify and specify hourly rating) than the assembly penetrated. DFD prefers the use of rated enclosures which are lower in cost than fire-stop insulation.

FLUID-APPLIED DUCTWORK INSULATION (FDI):

Pre-approved Manufacturers: Technical Roofing Solutions, Inc.; Volatile Free Inc.; BASF Corp.; Gaco Western Inc. or equal. (Manufacturers must be approved prior to bid opening.)

Coatings shall be U.L. Listed to retain existing system UL ratings when applied as specified in this project.

Silicone enhanced water-borne single component waterproofing elastomeric coating with excellent strength and weathering characteristics.

Final finish coating color shall match existing fluid applied ductwork insulation color or as indicated by A/E.

Performance Values:

|  |  |  |
| --- | --- | --- |
| **PHYSICAL PROPERTY** | **ASTM TEST METHOD** | **TYPICAL VALUE** |
| Tensile Strength | D 412 | 225 psi |
| Elongation | D 412 | 200% |
| Shore A Hardness (inst-5 sec.) | D 2240 | 65Shore A |
| Tack-Free Time |  | 10 to 30 Seconds |
| Service Temperature |  | -40°F to 300°F |
| Application Temperature |  | 40°F to 150°F |
| Tear Resistance | D 264 Die C | 65 Pli |
| Spread of Flame | ASTM E-84 | <75 (Smoke<450) |

Approved Spray Polyurethane Foam (SPF) used for thermal insulation.

Performance Values:

|  |  |  |
| --- | --- | --- |
| **PHYSICAL PROPERTY** | **ASTM TEST METHOD** | **TYPICAL VALUE** |
| Density (nominal) | ASTM D-1622 | 2.5 pcf |
| Compressive Strength (min) (parallel to rise) | ASTM D-1621 | 40 psi |
| K Factor (Initial) | ASTM C-177 | 0.15 btu.in/ft2.hr. °F |
| Closed Cell Content | ASTM D-1940 | 90% |
| Dimensional Stability (aged 28 days, % volume change) | ASTM D-2126 | <2.5 @ 158oF/98% RH |
| Moisture (Perm/Inch) | ASTM C-355 | 0.8 |
| Spread of Flame\* (2 inch thick sample) | ASTM E-84 | <75 (Smoke<450) |

Final coating shall be a silicone enhanced water-borne elastomeric compatible, fire retardant coating (Flame spread <25 Smoke <50).

Water-Based Epoxy Primer: A two-component, water-based, multi-purpose, easy spreading epoxy primer.

Urethane, high build mastic for applications where high performance, all temperature flexibility, and strength is required.

Urethane-based, low solids, fast drying, penetrating, rust and general-purpose primer.

Highly concentrated, low-sudsing biodegradable cleaner used to remove grease and grime.

Hydrocarbon modified, moisture-cured, urethane coating for use over asphalt products and as a basecoat /primer for silicone enhanced water-borne elastomeric coating.

Other products required by coating manufacturer.

Fluid-Applied Ductwork Insulation Guarantee:

*State of Wisconsin Guarantee*: Provide written guarantee warranting installation required under contract, to be watertight and free from defects in materials or workmanship for period, as stipulated in guarantee form. *A copy of the required guarantee form is appended hereto.*

Liquid Coating Manufacturer’s Warranty:

Provide written manufacturer’s (NDL) no-dollar-limit warranty covering installation required under contract, to be watertight and free from defects in materials and workmanship of the silicone enhanced water-borne elastomeric coating and other system components supplied by the manufacturer for a period of fifteen (15) years from date of installation.

Completed project requires installation inspection and approval by the manufacture of the silicone enhanced water-borne elastomeric coating.

Note: Warranty may not contain clause(s) voiding warranty due to contractor solvency, improper workmanship, contractor error, or contractor failure to follow manufacturer specification(s) and requirements to obtain the warranty requested by this project.

(Contractors Performance-Payment Bond is only required to apply to this trade section during the construction period and the first year of the guarantee period. Said Bond shall not apply to any extended guarantee period beyond the first year. Such extended guarantees are limited to the applicable Contractor and manufacturer as herein specified.)

Fluid-applied ductwork insulation should only be considered for projects with large amounts of ductwork exposed to the weather. The A/E shall consult the DFD HVAC representative prior to inclusion on any project.

ADHESIVES, MASTIC, SEALANTS, AND REINFORCING MATERIALS

Products shall be compatible with surfaces and materials on which they are applied and shall be suitable for use at operating temperatures of systems to which they are applied.

FIBERGLASS INSULATION ADHESIVE:

Must comply with ASTM C916, Type II: Foster 85-60, Childers CP-127, Duro Dyne SSG.

VAPOR RETARDING MASTIC:

For below ambient equipment/piping use a water based mastic with a water vapor permeance of less than 0.04 perms at 40 mils dry film thickness per ASTM E 96: Childers CP-34, Foster 30-65 Vapor-Fas, , Knauf Insulation, KI-900 or KI-905, Vimasco 749.

NOTE TO Engineer, replace the line above with the line below for schools and hospitals or when higher humidity levels may be of concern, only specify the following mold resistant mastic (AF=Anti-Fungal)

For below ambient equipment/piping use water based, anti-fungal mastic that meets ASTM D 5590 with a 0 growth rating (AF) and a water vapor permeance that is less than 0.013 perms at 43 mils dry film thickness per ASTM E 96 Procedure B: Foster 30-80AF Vapor Safe Mastic or equal.

Anti-fungal mastic to be used in the following locations;

1. Exterior locations
2. Parking ramps
3. Swimming pool equipment rooms
4. Chemical storage and hazardous waste storage rooms
5. Wet wells
6. Sanitary pumping stations
7. Food service/kitchen areas
8. Walk-in coolers/freezers
9. Locker/shower rooms
10. Greenhouses
11. Meter Pits

WEATHER BARRIER BREATHER MASTIC:

For above ambient equipment/piping use water based mastic with a permeance greater than 1.0 perms at 1/16" dry film thickness per ASTM E96. Foster 46-50 Weatherite, Childers Vi-Cryl CP-10/CP-11, Vimasco WC-5, Knauf Insulation KI-700 or KI-705.

LAGGING ADHESIVE / COATINGS:

For all indoors applications used in conjunction with canvas/glass cloth: Foster 30-36, Childers CP-50A MV1, Vimasco 713.

NOTE TO Engineer, replace the line above with the line below for schools and hospitals or when higher humidity levels may be of concern, only specify the following mold resistant adhesive/coating (AF=Anti-Fungal)

For all indoor applications used in conjunction with canvas/glass cloth: the coating must be anti-fungal and shall meet ASTM D 5590 with 0 growth rating (AF): Foster 30-36 AF Seal Fas, Childers CP-137 AF Chil-Seal.

Anti-fungal adhesive/coating to be used in the following locations;

1. Exterior locations
2. Parking ramps
3. Swimming pool equipment rooms
4. Chemical storage and hazardous waste storage rooms
5. Wet wells
6. Sanitary pumping stations
7. Food service/kitchen areas
8. Walk-in coolers/freezers
9. Locker/shower rooms
10. Greenhouses
11. Meter Pits

REINFORCING MESH:

Use Foster 42-24 Mast A Fab, Childers Chil Glas #10 or Pittsburgh Corning PC 79.

METAL JACKETING SEALANT FOR ALL ALUMINUM JACKETING:

Metal jacketing sealants to be non-shrinking and permanently flexible.

Use Foster 95-44 Elastolar, Childers CP-76 Chil-Byl, Pittsburgh Corning 727.

For Polystyrene use Foster 30-45N, or Childers CP-70.

INSULATION JOINT SEALANT:

Joint sealants to be non-shrinking and permanently flexible.

Used on all below ambient piping to prevent moisture ingress.

For Cellular Glass, Polyisocyanurate, Phenolic use Foster 95-44 Elastolar, Childers CP-70 Chil-Byl, Pittsburgh Corning CW Sealant.

For Polystyrene use Foster 30-45N, Childers CP-70.

For Elastomeric use Armaflex 520 or equal.

JACKETS

PVC FITTING COVERS AND JACKETS (PFJ):

White PVC film, gloss finish one side, semi-gloss other side, FS LP-535D, Composition A, Type II, Grade GU. Ultraviolet inhibited indoor/outdoor grade to be used where exposed to high humidity, ultraviolet radiation, in kitchens or food processing areas or installed outdoors. Jacket thickness to be minimum .02” indoors/.03”outdoors for piping 12” and smaller, .03” indoors/.04” outdoors for piping 15” and larger.

PVC covers, and jackets have limited ability to resist water vapor transmission. On systems operating below 40 degrees F which use PVC covers or jackets, insulation must first be covered with low permeance vapor retarding mastic/fabric or vapor retarding tape.

ALL SERVICE JACKETS (ASJ):

Heavy duty, fire retardant material with polymer coated white kraft reinforced foil vapor retarder jacket, factory applied to insulation with a self-sealing pressure sensitive adhesive lap, maximum permeance of .02 perms and minimum beach puncture resistance of 50 units. Polymer coating – Knauf Insulation & Owens Corning

FOIL SCRIM KRAFT ALL SERVICE JACKETS (FSK):

Glass fiber reinforced foil kraft laminate, factory applied to insulation. Maximum permeance of .02 perms and minimum beach puncture resistance of 25 units.

PROTECTIVE METAL JACKETS (PMJ):

0.016 inch thick aluminum or 0.010 inch thick stainless steel with safety edge for indoor HVAC installations. 0.024 inch thick aluminum or 0.016 inch thick stainless steel with safety edge for Central Plant and Utility installations.

SELF-ADHERING JACKETS (SAJ):

5-ply, self-adhering multiple laminated waterproofing material with reflective aluminum foil, high density polymer films and cold weather acrylic adhesive providing zero (0.0) permeance. Minimum 6 mils material thickness, 25lb puncture resistance when tested in accordance with ASTM D1000 and flame spread/smoke developed rating of 10/20 when tested in accordance with UL 723. Venture Clad 1577CW & 1577CW-E

Vapor retarding tape shall be specifically designed and manufactured for use with the self-adhering jacket specified above. Tape shall be provided by the same manufacturer that provides jacketing. Vapor retarding tapes used with self-adhering jackets shall have a maximum permeance of 0.0 perms.

FABRIC REINFORCED MASTIC JACKETS (FMJ):

Glass fiber reinforcing fabric imbedded in weather barrier mastic as per manufacturer’s recommended procedure for 2 coat application.

VAPOR RETARDING JACKETS (VRJ):

3 ply composite vapor retarding jacket material with a maximum permeance of 0.0 perms. Material shall not support the growth of mold or mildew. Polyguard Zeroperm or equivalent.

Vapor retarding tape shall be specifically designed and manufactured for use with the vapor retarding jacket specified above. Tape shall be provided by the same manufacturer that provides jacketing. Vapor retarding tapes used with vapor retarding jackets shall have a maximum permeance of 0.0 perms.

INSULATION INSERTS AND PIPE SHIELDS

Manufacturers: B-Line, Pipe Shields, Value Engineered Products.

Construct inserts with calcium silicate or polyisocyanurate (service temperatures below 300 degrees F only), minimum 140 psi compressive strength. Piping 12” and larger, supplement with high density 600 psi structural calcium silicate insert. Provide galvanized steel shield. Insert and shield to be minimum 180 degree coverage on bottom supported piping and full 360 degree coverage on clamped piping. On roller mounted piping and piping designed to slide on support, provide additional load distribution steel plate.

Where contractor proposes shop/site fabricated inserts and shields, submit schedule of materials, thicknesses, gauges and lengths for each pipe size to demonstrate equivalency to pre-engineered/premanufactured product described above. On low temperature systems, high density rigid polyisocyanurate may be substituted for calcium silicate provided insert and shield length and shield gauge are increased to compensate for lower insulation compressive strength.

Precompressed 20# density molded fiberglass blocks, Hamfab or equal, of the same thickness as adjacent insulation may be substituted for calcium silicate inserts with one 1”x6” block for piping through 2-1/2” and three 1”x6” blocks for piping through 4”. Submit shield schedule to demonstrate equivalency to pre-engineered/premanufactured product described above.

Wood blocks will not be accepted.

EXPANSION JOINT AND VALVE INSULATION BLANKETS

Use this section for insulating steam expansion joints and steam valves with a removable blanket.

Manufacturers: Advance Thermal Corporation, TANI Division B.D. Schiffler, Sprinkman and Sons. Site fabricated blankets are not acceptable.

Blanket shall be 16.5 ounces per square yard PTFE (polytetrafluoroethylene) designed for wet and dry steam applications to 600ºF. Jacket shall have coated fabric on both exterior and interior. Wire mesh interior is not acceptable.

The Blankets shall be installed to shed water and have a 3-inch wide cinchable rain flap on each end.

All seams shall be sewn twice with double locked stitching. One seam shall be sewn with 3-ply Nomex and the other with 3-ply stainless steel. Hog rings and staples shall not be used.

The insulation shall be a 2-inch thick, compressed “E” glass fiber with no chemical binders, held in place with 12 gauge stainless quilt pins which do not puncture the inner surface of the blanket.

Blankets shall be designed to allow access to the expansion and ball joints packing cylinder plungers for repacking without removing the blanket.

Removable expansion joint blanket shall be constructed to allow the pipe and rigid insulation to expand/contract with the pipe. Blanket shall have a close fit without sagging or gaps.

Blanket shall allow for normal operation of the valve or joint without removing the cover.

Valve blankets shall come in two pieces and cover the valve yoke (if applicable).

Blankets shall have D-ring, hook and loop or buckle securing straps. Pins and wire or spring and ring securement is not acceptable.

Blankets shall have a stainless steel identifying plaque on the exterior identifying equipment information.

ACCESSORIES

All products shall be compatible with surfaces and materials on which they are applied and be suitable for use at operating temperatures of the systems to which they are applied.

Adhesives, sealants, and protective finishes shall be as recommended by insulation manufacturer for applications specified.

Insulation bands to be 3/4 inch wide, constructed of stainless steel. Minimum thickness to be 0.010 inch for stainless steel.

Tack fasteners to be stainless steel ring grooved shank tacks.

Staples to be clinch style.

Insulating cement to be ANSI/ASTM C195, hydraulic setting mineral wool.

Finishing cement to be ASTM C449.

Fibrous glass or canvas fabric reinforcing used with lagging adhesive shall have a minimum untreated weight of 6 oz./sq. yd.

Fungicidal water base duct liner coating (Foster 40-20 or equal) to be compatible with vapor retarding coating. This product must be EPA registered to be used inside HVAC ducts. Coating must comply with ASTM D 5590 with 0 growth rating.

# P A R T 3 - E X E C U T I O N

EXAMINATION

Verify that all piping, equipment, and ductwork are tested and approved prior to installing insulation. Do not insulate systems until testing and inspection procedures are completed.

Verify that all surfaces are clean, dry and without foreign material before applying insulation materials.

INSTALLATION

All materials shall be installed by skilled labor regularly engaged in this type of work. All materials shall be installed in strict accordance with manufacturer’s recommendations, building codes, and industry standards. Do not install products when the ambient temperature or conditions are not consistent with the manufacturer’s recommendations. Surfaces to be insulated must be clean and dry.

Locate insulation and cover seams in the least visible location. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.

Install insulation with smooth and even surfaces. Poorly fitted joints or use of filler in voids will not be accepted. Provide neatly beveled and coated terminations at all nameplates, uninsulated fittings, or at other locations where insulation terminates.

Install fabric reinforcing without wrinkles. Overlap seams a minimum of 2 inches.

Use full length material (as delivered from manufacturer) wherever possible. Scrap piecing of insulation or pieces cut undersize and stretched to fit will not be accepted.

All pipe and duct insulation shall be continuous through walls, ceiling or floor openings and through sleeves except where firestop or firesafing materials are required. Vapor retarding jacket shall be maintained continuous through all penetrations.

Provide a continuous unbroken moisture vapor retarding jacket on insulation applied to systems noted below. Attachments to cold surfaces shall be insulated and vapor sealed to prevent condensation.

Provide a complete vapor retarding jacket for insulation on the following systems:

1. Cold Water Make-Up
2. Chilled Water
3. Refrigerant
4. Glycol/Brine
5. Insulated Duct
6. Equipment, ductwork or piping with a surface temperature below 65 degrees F

PROTECTIVE JACKET INSTALLATION

PVC FITTING COVERS AND JACKETS (PFJ):

Lap seams and joints a minimum of 2 inches and continuously seal PVC with welding solvent recommended by jacket manufacturer. Secure PVC fittings with welding solvent on seams and joints. Lap slip joint ends 4" without fasteners where required to absorb expansion and contraction. For sections where vapor retarding jacket is not required, and jacket requires routine removal, tack fasteners may be used. For systems requiring a vapor retarding jacket, apply a 1-1/2” band of mastic over ends, throat, seams and penetrations.

ALL SERVICE JACKETS (ASJ) and FOIL SCRIM KRAFT JACKETS (FSK):

Install according to manufacturer’s recommendations using factory supplied lap seals and butt strip seals. In addition to factory adhesive, secure lap seals and tape with clinch type staples.

PROTECTIVE METAL JACKET (PMJ):

Lap seams a minimum of 2 inches. Secure with metal bands for end to end joints, and rivets or sheet metal screws for longitudinal joints. Rivets, screws, and bands to be constructed of the same material as the jacket. For piping with VRJ jacket provide metal bands at 12” centers, rivets and screws cannot be used. Locate longitudinal seams on the side (3:00 O’clock) for exterior applications. Seal laps with 1/8” bead of metal jacketing sealant to prevent water entry.

SELF-ADHERING JACKETS (SAJ):

Install according to manufacturer’s recommendations. Cut allowing minimum 4” overlap on ends and 6” on longitudinal joints. Align parallel to surface. Remove release paper and press flat to surface to avoid wrinkles. Rub entire surface with plastic squeegee for full adhesion and sealing at joint overlaps. On exterior applications, provide a bead of compatible caulk along exposed edges.

Piping with self-adhering (SAJ) jackets shall have elbows, fittings, valves and butt joints wrapped with 2 layers of vapor retarding tape. Piping with a PVC jacket (PFJ) installed over the self-adhering (SAJ) jacket may be provided with a single, lapped layer of vapor retarding tape for elbows, fittings and valves under the PVC jacket. Vapor retarding tape shall be compatible with the jacket material used.

FABRIC REINFORCED MASTIC JACKETS (FMJ):

Glass fiber fabric shall be fitted without wrinkles. Glass fiber fabric shall be sized immediately upon application with lagging adhesive and shall be capable of drying within 6 hrs. Apply adhesive and coating in accordance with manufacturer’s recommendations. All seams shall overlap not less than 2”.

VAPOR RETARDING JACKETS (VRJ):

Piping with vapor retarding jackets (VRJ) shall have elbows, fittings, valves and butt joints wrapped with 2 layers of vapor retarding tape. For piping without a (PFJ) jacket, wrap jacket with 1” wide vapor retarding tape at 12” centers with a 25% overlap. Piping with a PVC jacket (PFJ) installed over the vapor retarding jackets (VRJ) may be provided with a single, lapped layer of vapor retarding tape for elbows, fittings and valves under the PVC jacket. Vapor retarding tape shall be compatible with the jacket material used.

PIPING, VALVE, AND FITTING INSULATION

GENERAL:

Install insulation with butt joints and longitudinal seams closed tightly. Provide minimum 2” lap on jacket seams and 3” tape on butt joints, firmly cemented with lap adhesive unless otherwise noted. Additionally, secure with clinch style staples along seams and butt joints.

For low temperature brine systems, review the need for vapor dams located closer than 20 feet, on ‘T’s, elbows, floors, and both sides of any valves.

On systems requiring a vapor retarding jacket, seal off all raw ends of insulation and butt joints with vapor retarding mastic at intervals of not more than 20 feet on piping to create a vapor dam. Also provide a vapor dam on each side of valves, unions, and tees. Coat staples, longitudinal and transverse seams with vapor retarding mastic and on systems requiring vapor retarding jacket, coat insulated elbows, fittings, and valves with vapor retarding mastic.

Install insulation continuous through pipe hangers and supports with hangers and supports on the exterior of insulation. Where a vapor retarding jacket is not required or where roller hangers are not being used, hangers and supports may be attached directly to piping with insulation completely covering hanger or support and jacket sealed at support rod penetration. Where riser clamps are required to be attached directly to piping requiring vapor retarding jacket, extend insulation and vapor retarding jacketing/coating around riser clamp.

Where insulated piping is installed on hangers and supports, the insulation shall be installed continuous through the hangers and supports. High density inserts shall be provided as required to prevent the weight of the piping from crushing the insulation. Pipe shields are required at all support locations. The insulation shall not be notched or cut to accommodate the supporting channels.

On low temperature systems, use premanufactured insulated pipe riser clamps such as Pipe Shields E1000 and E 2000 series.

Fully insulate all reheat coil piping, fittings and valves (except for unions) up to coil connection to prevent condensation when coil is inactive during cooling season. Provide a vapor proof seal between the pipe insulation and the insulated coil casing.

INSULATION INSERTS AND PIPE SHIELDS:

Provide pipe shields at all hanger and support locations. Rigid insulation inserts shall be installed between the pipe and the insulation shields. Quantity and placement of inserts shall be according to the manufacturer’s installation instructions; however, the inserts shall be no less than 12” in length. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required for system.

Provide insulation inserts and pipe shields at all hanger and support locations. Inserts may be omitted on 3/4” and smaller copper piping provided 12” long 22 gauge pipe shields are used.

FITTINGS AND VALVES:

Fittings, valves, unions, flanges, couplings and specialties may be insulated with factory molded or built up insulation of the same thickness as adjoining insulation. Where the ambient temperature exceeds 150 degrees F, cover insulation with fabric reinforcing and mastic. Where the ambient temperatures do not exceed 150 degrees, furnish and install PVC fitting covers.

MINERAL FIBER:

Secure each 3’ section with three metal bands snip off excess and turn ends over into insulation to prevent exposed sharp edges. Stagger joints where more than one layer is used.

Blanket or batt sheet is NOT allow on valves or at fittings. Fittings shall be insulated with pre-formed sections or field fabricated gored pieces. Gore segments shall be stapled together.

Where multiple layers of insulation are used filament tape is allowed to secure the inner layer of insulation only in pits and accessible areas. In steam box conduit and other inaccessible areas the inner AND outer layer of insulation shall be secured with bands, wire and/or tape are not allowed without written DFD approval.

AEROGEL INSULATION:

Secure each 3’ or larger sections with stainless steel bands evenly spaced at 12” and at ends. For elbows use 16 gauge stainless steel or annealed copper tie wires evenly spaced. Twist wire ends, snip off excess and turn ends over into insulation. Stagger joints where more than one layer is used.

ELASTOMERIC AND POLYOLEFIN:

Where practical, slip insulation on piping during pipe installation when pipe ends are open. Miter cut fittings allowing sufficient length to prevent stretching. Completely seal seams and joints for vapor tight installation. For elastomeric insulation, apply full bed of adhesive to both surfaces. For polyolefin, seal factory preglued seams with roller and field seams and joints with full bed of hot melt polyolefin glue to both surfaces. Cover elastomeric insulation on systems operating below 40 degrees F with vapor retarding mastic.

EXTRUDED POLYSTYRENE AND POLYISOCYANURATE:

Fittings, valves, unions, flanges, couplings and specialties shall be insulated with factory molded insulation of the same thickness as adjoining insulation. Secure insulation sections with two wraps of nylon filament tape 9”-12” on center. On single insulation layer systems and on the outer layer of double insulation layer systems, apply a 1/16” thick bead of joint sealant rated for system operating temperatures to the outer edge of all longitudinal and butt insulation joints. For piping service below 20oF, use two layers of insulation with inner and outer butt and longitudinal joints staggered and offset 90 degrees. Where two layers of insulation are used, do not use sealant on the inner layer or adhere the inner layer to the outer layer. Apply vapor stop bead of joint sealant between pipe and insulation on both sides of valves, expansion/contraction joints, flanges, thermometers/gauges, attached vent and drain lines. Insulate attached non-circulated lines, control lines, vents, etc. for a minimum distance of 6” from pipe. Cover insulation with a protective jacket as specified below. Do not penetrate protective covering or insulation with mechanical fasteners.

Protective jackets should be specified for pipe insulation exposed in food handling/kitchen areas, cold rooms, wet areas, exterior installations or where insulation is subject to physical abuse. Jackets also need to be specified for insulations (other than interior elastomeric and polyolefin) where not factory installed. PVC fitting covers, and PVC jacketing must be specified with mastic covering where painted finish is required.

PIPING PROTECTIVE JACKETS

In addition to the jackets specified in the pipe insulation schedule below the following protective jackets are required:

Provide a protective PVC jacket (PFJ) for the following insulated piping:

1. Chilled water piping and valves in walk-thru tunnels and valve pits
2. Exposed piping in kitchens
3. Piping exposed in finished locations
4. Exterior refrigeration piping.

Carefully evaluate which locations are considered “finished”. This will require discussion with the Architect and DFD Project Manager.

Provide a protective PVC (PFJ) or Fabric Reinforced Mastic (FMJ) jacket for the following insulated piping:

1. All piping within mechanical rooms.

Provide a protective metal (PMJ) or self-adhering (SAJ) jacket for the following insulated piping:

1. Exterior installed refrigeration piping.

Provide a protective metal jacket (PMJ) for the following insulated piping:

1. Steam and condensate piping and fittings located in walk-thru tunnels and steam pits.

Provide a protective covering of 2 coats of vapor retarding mastic with fibrous glass or canvas fabric reinforcing (FMJ) for the following insulated piping:

Enter applications if different than those listed in pipe insulation schedule below.

Provide a protective self-adhering (SAJ) jacket for the following insulated piping:

Enter applications if different than those listed in pipe insulation schedule below.

REMOVABLE INSULATION BLANKETS: (EXPANSION SLIP JOINT AND VALVES 2-1/2” AND LARGER)

Use this section for insulating steam expansion joints and steam valves with a removable blanket.

Provide removable reusable insulated cover on new and existing expansion slip joints, ball joints and valves.

Install blankets to be field removable without tools.

Blankets shall be installed to allow the normal expansion and contraction associated with these systems, without crushing or damaging the blanket.

Expansion Joint blankets shall extend over the adjacent rigid insulation to allow for pipe expansion.

Blankets shall be installed without sagging or gaps.

Blankets shall be installed to shed water.

**Steam system will not be allowed to start up until removable jackets are installed.**

PIPE INSULATION SCHEDULE:

Provide insulation on new and existing remodeled piping system as indicated in the following schedule:

Where asbestos abatement activities require reinsulation of existing piping not remodeled, expand above description to clarify scope of insulation work.

More than one insulation type can be listed for a given service if appropriate. Where insulation conductivity significantly differs from schedule, reference current building code to determine appropriate thickness.

|  |  |  |  |
| --- | --- | --- | --- |
| **SERVICE** | **INSULATION** | **JACKET** | **INSULATION THICKNESS BY PIPE SIZE** |
| **< 1”** | **1” to****< 1-1/2”** | **1-1/2”****to < 4”** | **4” to < 8”** | **8” and Larger** |
|  |  |  |  |  |  |  |  |
| Heating Hot Water | Rigid Fiberglass | ASJ | 1.5” | 1.5” | 2” | 2” | 2” |
| Note: On 1” or smaller hot water pipe run outs to terminal unit coils the insulation thickness may be reduced to ½” on both the supply and return pipes within 4ft of the coil but not on the distribution system side of the temperature control valve. |
| Chilled Water | Polyisocyanurate / Polystyrene | VRJ or SAJ | 1.5” | 1.5” | 1.5” | 1.5” | 1.5” |
| Note: On chilled water piping locate in return air plenums use phenolic piping insulation with a flame spread/smoke development rating of ≤ 25/50. |
| Chilled Beam Piping | Rigid Fiberglass | ASJ | 1” | 1” | 1” | 1” | 1” |
| Refrigeration Suction |
| > 40oF | Elastomeric | None | 1.5” | 1.5” | 1.5” | 1.5” | 1.5” |
| 40oF to 20oF | Elastomeric | None | 1.5” | 1.5” | 1.5” | 1.5” | 1.5” |
| 20oF to -20oF | Polystyrene / Polyisocyanurate | VRJ or SAJ | 1.5” | 2” | 2” | 2” | 2.5” |
| -20oF to -60oF | Polystyrene / Polyisocyanurate | VRJ or SAJ | 2” | 2” | 2.5” | 2.5” | 3” |
| Cold Water Piping | Rigid Fiberglass | ASJ | 0.5” | 0.5” | 1” | 1” | 1” |
| Cooling CoilCondensate Drain | Rigid Fiberglass | ASJ | 0.5” | 0.5” | 1” | 1” | 1” |
| Low Pressure Steam | Rigid Fiberglass | ASJ | 2.5” | 2.5” | 2.5” | 3” | 3” |
| In Conduits | Mineral Wool | None | 2.5” | 2.5” | 2.5” | 3” | 3” |
| Low Pressure Cond. | Rigid Fiberglass | ASJ | 1.5” | 1.5” | 2” | 2” | 2” |
| In Conduits | Mineral Wool | None | 1.5” | 1.5” | 2” | 2” | 2” |
| High Pressure Steam(15 psig to 119 psig) | Rigid Fiberglass | ASJ | 3” | 4” | 4.5” | 4.5” | 4.5” |
| In Pits | Mineral Wool | PMJ | 2.5” | 3.5” | 4” | 4” | 4” |
| In Conduits | Mineral Wool | None | 2.5” | 3.5” | 4” | 4” | 4” |
| High Pressure Steam(120 psig or greater) | Rigid Fiberglass | ASJ | 4.5” | 5” | 5” | 5” | 5” |
| In Pits | Mineral Wool | PMJ | 4” | 4.5” | 4.5” | 5” | 5” |
| In Conduits | Mineral Wool | None | 4” | 4.5” | 4.5” | 5” | 5” |
| High Pressure Cond.In Conduits | Mineral Wool | None | 2.5” | 3.5” | 4” | 4” | 4” |
| High Pressure Cond.In Pits | Mineral Wool | PMJ | 2.5” | 3.5” | 4” | 4” | 4” |
| Cond. Pump Disch. | Mineral Wool | None | 1.5” | 1.5” | 2” | 2” | 2” |
| In conduits |
| Boiler Feed Piping(201-250 deg F) | Mineral Wool | ASJ | 2.5” | 2.5” | 2.5” | 3” | 3” |
| Boiler Feed Piping(251-350 deg F) | Mineral Wool | PMJ | 2.5” | 3.5” | 4” | 4” | 4” |
| Valves and Exp.Joints in Pits | E Glass Fiber | Blanket | 2” | 2” | 2” | 2” | 2” |
| Boiler Blow Down(201-250 deg F) | Mineral Wool | ASJ | 1” | 1” | 1” | 1” | 1” |
| Boiler Blow Down(251-350 deg F) | Mineral Wool | PMJ | 1” | 1.5” | 1.5” | 2” | 2” |
| Remote GeneratorRadiator Piping | Rigid Fiberglass | ASJ | 1.5” | 1.5” | 2” | 2” | 2” |

Insulation on all steam distribution systems and high pressure steam pipe over 2” shall be installed in multiple layers not exceeding 3” in thickness.

The following piping and fittings are not to be insulated:

1. Hot water piping inside radiation, convector, or cabinet heater enclosures
2. Steam Traps
3. Piping unions for systems not requiring a vapor retarding Jacket

For systems with fluid temperatures 65° F or less, furnish and install removable elastomeric insulation covers, plugs or caps for all mechanical equipment and devices that require access by balancing contractors or service and maintenance personnel. Examples include but are not limited to: flow sensing devices, circuit setters, manual ball valve air vents, drain valves, blowdown valves, pressure/temperature test plugs, grease fittings, pump bearing caps, equipment labels, etc. Covers shall be tight fitting to ensure a complete vapor retarding barrier.

DUCT INSULATION

GENERAL:

Secure flexible blanket duct insulation on sides and bottom of ductwork over 24" wide with weld pins. Space fasteners 18” on center or less as required to prevent sagging. Compress insulation no more than 25%.

Secure rigid board insulation to ductwork with weld pins. Apply insulation with joints firmly butted together and placed as close as possible to the equipment surface. Pins shall be located a maximum of 3” from each edge and spaced no greater than 12” on center.

Install weld pins without damage to the interior galvanized surface of the duct. Clip pins back to washer and cover penetrations with tape of same material as jacket. Firmly butt seams and joints and cover with 4” tape of same material as jacket. Seal tape with plastic applicator and secure with staples. All joints, seams, edges and penetrations to be fully vapor sealed with vapor retarding mastic.

Stop and point insulation around access doors and damper operators to allow operation without disturbing insulation or jacket material.

External supply duct insulation is not required where ductwork contains continuous 1” acoustical liner. Provide 4” overlap of external insulation over ends of acoustically lined sections.

Where insulated ductwork is supported by trapeze hangers, the insulation shall be installed continuous through the hangers. Drop the supporting channels required to facilitate the installation of the insulation. Where rigid board or flexible insulation is specified, install high density inserts to prevent the weight of the ductwork from crushing the insulation.

Where insulated low temperature (below 45ºF) ductwork is supported by steel metal straps or wire ropes that are secured directly to the duct, the straps or ropes shall be completely covered with insulation and sealed to provide a complete vapor retarding barrier.

Where insulated duct risers are supported by steel channels secured directly to the duct, extend the insulation and vapor retarding jacketing to encapsulate the support channels.

Protective coverings should be specified for ductwork insulation in high humidity or wet areas, exterior installations, breechings, where insulation is subject to physical abuse, where functionally required or where insulation is to be painted.

Where ductwork exposed to the weather is insulated with any product other than fluid-applied ductwork insulation, the top surface of the insulation shall be sloped a minimum of ½” per foot to eliminate ponding and create positive drainage off insulation.

Tapered Insulation shall be ASTM C1289, Type II, Class 1, Grade 2; rigid board polyisocyanurate insulation with felt or fibrous mat facing on both sides, factory tapered to 1/2” per foot slope. Tapered insulation board shall have a start thickness at the perimeter of 1/2”. Tapered insulation board shall be mechanically fastened to ductwork. Tapered insulation applied to rectangular ductwork less than or equal to 24” in width may be sloped from one side. Tapered insulation applied to rectangular ductwork greater than 24” in width shall be sloped in two directions with the high point at the centerline of the duct.

BREECHING:

Fasten insulation over weld pins and secure with washers. Space fasteners not less than 3” from edge or corner and 12" on center longitudinally and 9" on center in the transverse direction. Clip pins back to washer and cover penetrations with tape of same material as jacket. Firmly butt seams and joints and cover with 4” tape of same material as jacket. Seal tape with plastic applicator and secure with staples.

GREASE DUCTS:

Strictly adhere to manufacturer’s installation instructions and rating requirements for application of fire-stop insulation. Cover all exhaust ducts serving Type I kitchen hoods with fire-stop insulation from a point prior to penetration of ceiling, wall, floor or concealment through building to termination at outside of building. Extend fire-stop insulation through roof curbs.

For grease ducts that run in exposed locations and where the insulation could be subject to damage, discuss the possible use of premanufactured exhaust grease ducts with DFD reviewer.

FLUID-APPLIED DUCTWORK INSULATION (FDI):

Ductwork to be insulated with fluid-applied ductwork insulation shall be installed with a bottom-of-duct elevation of 36” minimum above roof level to allow proper application of the insulation.

Proceed with work only when weather conditions comply with Manufacturer recommendations and other current published data and MSDS information. Do not exceed temperature limitations recommended by coating manufacturer.

The top of ducts insulated with fluid-applied ductwork insulation shall be sloped using tapered insulation prior to applying fluid-applied insulation. Tapered Insulation shall be ASTM C1289, Type II, Class 1, Grade 2; rigid board polyisocyanurate insulation with felt or fibrous mat facing on both sides, factory tapered to 1/2” per foot slope. Tapered insulation board shall have a start thickness at the perimeter of 1/2”. Tapered insulation board shall be mechanically fastened to ductwork. Tapered insulation applied to rectangular ductwork less than or equal to 24” in width may be sloped from one side. Tapered insulation applied to rectangular ductwork greater than 24” in width shall be sloped in two directions with the high point at the centerline of the duct.

Air intake vents, blowers, air conditioning units and evaporative coolers shall be disconnected or otherwise modified to prevent fumes from entering the building or from contaminating the substrate surface with condensate water.

Coordinate scheduling with the Owner in order to relocate or protect vehicles, building occupants and building contents from damage during construction operations.

Existing materials designated to remain, which are damaged or defaced as a result of the work shall be replaced at Contractor's expense to like new condition.

[Reinstall] [Install] all rooftop mounted equipment in a watertight manner and repair any damage to sheet metal or other components related to connection and protection of the system.

Prevent materials from entering and clogging roof drains and conductors. Remove roof drain plugs when no work is taking place or when rain is forecast.

Protection of surfaces:

Take every precaution to prevent water leakage or debris falling into the building interior, or other such occurrences. Contractor is responsible for any damage to the building interior, or contents, during application.

Provide special protection or avoid heavy traffic on completed work or roof surfaces. Temporary walkways and work platforms shall be provided as necessary.

Wall surfaces shall be protected with tarpaulins or other suitable cover to prevent damage, staining or discoloration that might result from operations. Windows, doorways, docks, walkways, etc. may require special protection measures.

Protect building and adjacent area and property within the area from over spray.

**Caution:**

Installation of primers, polyurethane foam or coatings shall not interfere with the proper function of: Manual Volume Dampers, Turning Vanes, Fire Dampers, Smoke Dampers and Combination Fire/Smoke Dampers, Control Dampers, Smoke Detectors, Access Doors, Duct Pressure Relief Doors, Flashings, Duct Flexible Connections, Sound Attenuators, Hoods for Intake and Exhaust, Louvers, Air Blenders and Air Flow Stations.

Installation of Spray Polyurethane Foam (SPF) Insulation:

When required, install approved polyurethane foam to an average thickness as specified in the duct insulation schedule (1" minimum required) and terminated neatly at designated places.

Mask areas where coating is to be terminated to prevent surface contamination with foam over spray.

Foam spray application shall be limited to that which can be completed to full foam thickness in one day. All exposed foam tie-in end laps and side laps must be primed at the end of each workday.

The completed foam surface shall be smooth to orange peel texture; popcorn texture is not acceptable.

The completed foam surface shall be free of pinholes and/or "glass windows" caused by improper equipment calibration or climatic conditions. The SPF shall not have any soft or spongy areas or areas with hard or brittle strings of improperly proportioned material

Eliminate areas of ponding using approved polyurethane foam to create positive drainage.

Remove protective masking at terminations.

Apply protective coating to foam surface on the same day as polyurethane foam is installed.

The foam shall not be left exposed or uncoated for more than 4 hours. If coating application is delayed beyond that time, consult manufacturer for primer recommendations.

Installation of Coating System:

Do not apply coating when moisture is present on the substrate.

Wind barriers shall be used if wind conditions could affect the quality of the material being applied.

Coating must cover all surfaces completely. An extra pass of coating material may be required at all edges and penetrations.

Base coat(s) and primer(s) shall be allowed to cure before proceeding with subsequent applications.

All coating and primers shall be coated within recommended time period. If application is delayed beyond that time, consult Manufacturer for primer recommendations.

Application Thickness:

15 Year NDL System

Average Application Thickness: Topcoat Average thickness shall be 36 Average TDM (Total Dry Mils), (3.75 gallons per 100 sq. ft. minimum application recommended.)

Application rates must be checked periodically to assure proper coating thickness. This may be done by checking dry film thickness.

Contractor to estimate coating requirements based on actual experience and needs to figure losses due to applicator experience, surface texture, wind, waste, and other factors increasing estimated gallons required.

The total dry mil thickness of all coatings, as well as the total dry mil thickness of the topcoat(s) shall meet the minimums required by Manufacturer.

Application of approved silicone enhanced water-borne elastomeric coating:

Spray apply the approved coating to achieve the required TDM. The polyurea shall completely cover the SPF including all termination, penetrations, expansion joint covers, parapets and flashings. Spray pattern shall overlap the previous pass to insure complete coverage.

To assure complete coverage with approved silicone enhanced water-borne elastomeric coating, applicator needs to figure losses due to over-spray, surface texture and wind and increase the gallons as needed to meet specifications.

Pay special attention to overspray, which can texture or discolor adjoining finished sections. Wind direction should conduct overspray away from finished surfaces.

Spray Equipment:

This product must be applied with plural component spray equipment. The proportioning pump should be a positive displacement type set up in a 1:1 ratio, capable of maintaining dynamic pressure of 1,500 psi and fluid temperatures of 150º F during the maximum output of the proportioner. Fluid spray hoses should be of the dual heated type with temperature controls capable of maintaining 150º F fluid temperatures the full length to the spray gun. The heated hose assembly must be insulated and be high-pressure type with designed working pressure to handle the maximum pressure delivered by the proportioner. The inside lining of the hose assembly must be of a material that is unaffected by the coating or solvents used for cleanup. Contact Manufacturer for specific instructions and spray equipment recommendations.

The silicone enhanced water-borne elastomeric shall not be left exposed or uncoated for more than 4 hours. If fire retardant coating application is delayed beyond that time, consult manufacturer for primer recommendations.

Entire application shall receive a final coat of compatible, fire retardant coating (Flame spread <25 Smoke <50). Minimum thickness shall be no less than that tested for Spread of Flame rating (ASTM E-84 /UL-723).

Refasten all mechanical equipment and remount other rooftop equipment as necessary.

DUCTWORK PROTECTIVE COVERINGS:

In addition to the jackets specified in the duct insulation schedule below the following protective coverings are required:

Provide a protective covering of 2 coats of indoor/outdoor vapor retarding mastic with fibrous glass or canvas fabric covering (FMJ) or self-adhering jacket (SAJ) meeting 25/50 Flame Spread/Smoke Rating.for the following ductwork:

1. Ductwork within [6’][8’][10’] of floor, catwalks and mezzanines in mechanical rooms

Edit the above based on the actual duct layout and the frequency of traffic in mechanical rooms.

Provide a protective self-adhering jacket (SAJ) for the following insulated ductwork:

Enter applications if different than those listed in duct insulation schedule below.

DUCT INSULATION SCHEDULE:

Provide duct insulation on new and existing remodeled ductwork in the following schedule:

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| **SERVICE** | **INSULATION TYPE** | **JACKET** | **THICKNESS** |
|  |  |  |  |
| Outside air ducts | Rigid Fiberglass | FSK | 2" |
| Mixed air ducts | Rigid Fiberglass | FSK | 2" |
| Exposed supply ducts\* | Rigid Fiberglass | FSK | 2" |
| Concealed supply ducts | Flexible Fiberglass | FSK | 1.5" |
| All Ducts located in unconditioned Attics/Shafts\*\*\* | Flexible Fiberglass | FSK | 3" |
| Exhaust and relief ducts downstream of motorized backdraft dampers | Rigid Fiberglass | FSK | 2" |
| Combustion Air Ducts | Rigid Fiberglass | FSK | 2" |
| All ducts exposed to weather | Ext. Polystyrene orFluid-Applied\*\* | SAJ | 3” |
| Exhaust ducts downstream of heat recovery units and desiccant dryers | Rigid Fiberglass | FSK | 2" |
| Grease ducts serving Type I Kitchen hoods | Fire-Stop | See Spec. | As Req’d. for Specified Hourly Rating |
| Heat recovery units other than kitchen hood exhaust | Rigid Fiberglass | FSK | 1” |
| Breech. and boiler wind boxes | Fireproofing | See Spec. | 3” |
| Louver blank-off panels \*\*\*\* | Ext. Polystyrene | SAJ | 4" |

\* Exposed supply branch ducts located in the space they are serving do not require insulation. Exposed supply main ducts running through spaces they serve shall be insulated as exposed supply ducts scheduled above.

AE shall review the need for insulation on exposed duct systems. Any systems/spaces that do not require insulation shall be clearly identified on the drawings and in the specifications.

\*\* No jacket is required for Fluid-Applied ductwork insulation. The two part Fluid-Applied system serves as insulation and protective jacket.

\*\*\* Outside air ductwork between the isolation damper and the outside air intake does not require insulation where it is in an unheated attic.

\*\*\*\* Insulating value of any louver or curb blank off panel needs to meet the building envelope insulating value required by current building code.

EQUIPMENT INSULATION

GENERAL:

Do not insulate over equipment access manholes, fittings, nameplates or ASME stamps. Bevel and seal insulation at these locations.

PROTECTIVE JACKETS:

Provide a protective metal jacket (PMJ) for the following:

1. Generator exhaust pipe (that is not concealed in a shaft) and muffler.

SEMI-RIGID FIBERGLASS:

Apply insulation to equipment shells using weld pins, bonding adhesive, banded and wired in place. Fill all joints, seams and depressions with insulating cement to a smooth, even surface. Cover with reinforcing fabric and 2 coats of mastic (FMJ). Use vapor retarding mastic on systems requiring a vapor retarding barrier.

ELASTOMERIC/POLYOLEFIN:

Apply full cover coat of adhesive to surface to be insulated, insulation and edge butt joints. Place insulation with edge joints firmly butted pressing to surface for full adhesion. Seal seams and joints vapor tight.

REMOVABLE COVERS:

Provide insulated easily removable galvanized steel metal boxes for routine service access on the following equipment:

Specify locations where galvanized steel metal boxes are required or edit this section.

Provide insulated easily removable elastomeric insulation sections for the following equipment:

Specify locations where elastomeric insulation sections are required or edit this section.

EQUIPMENT INSULATION SCHEDULE:

Provide equipment insulation as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| **EQUIPMENT** | **INSULATION TYPE** | **JACKET** | **THICKNESS** |
|  |  |  |  |
| Reheat coil casing in exposed supply ducts | Rigid Fiberglass | FSK | 2” |
| Reheat coil casing in concealed supply ducts | Flexible Fiberglass | FSK | 1-1/2” |
| Insulation must be provided on reheat coils to prevent condensation on coil casing during summer when coil is inactive, but air conditioning is used. |
| Hot Water Storage tanks | Semi-Rigid Fiberglass |  ASJ | 2” |
| Hot Water Air separators | Semi-Rigid Fiberglass | ASJ/FMJ | 1.5” |
| Chilled Water Air separators | Elastomeric/Polyolefin | None | 1” |
| Chilled water compression tanks | Elastomeric/Polyolefin | None | 1” |
| Chilled Water Pumps | Elastomeric/Polyolefin | None | 1” |
| Chiller evaporator shell, suction piping, heads, and water boxes | Elastomeric/Polyolefin | None | 1” |
| Heat exchangers | Semi-Rigid Fiberglass | ASJ/PMJ | 2” |
| Condensate receivers (unless otherwise noted) | Semi-Rigid Fiberglass | ASJ/PMJ | 2” |
| Condensate receivers should be insulated in most cases. Receivers should not be insulated if they are in close proximity to devices that tend to generate flash steam within the receiver, such as Wing type coils. Condensate receivers should be left uninsulated in this case to increase heat rejection, prevent generation of flash steam and alleviate venting problems. If possible locate the condensate receiver away from equipment and use uninsulated or finned condensate lines to cool condensate before it reaches the receiver. Note insulation requirements for condensate requirements here or on plans. |
| Flash tanks | Mineral Wool | PMJ | 2” |
| Blowdown separator | Mineral Wool | PMJ | 2” |
| Deaerators | Mineral Wool | PMJ | 2-1/2” |
| Steam Economizer | Mineral Wool | PMJ | 2” |
| Water cooled condenser shell \* | Elastomeric/Polyolefin | None | 1” |
| Humidifier separator | Rigid Fiberglass | ASJ | 2” |
| Air Handling Unit Casings or attached component sections not factory insulated\*\* | Rigid Fiberglass | ASJ | 2” |
| Diesel generator exhaust pipe and muffler | Calcium Silicate/ Fireproofing | PMJ\*\*\* | 3" |
| NG generator exhaust pipe and muffler | High Temperature Calcium Silicate/ Fireproofing | PMJ\*\*\* | 3" |
|  |  |  |  |

\* Condenser shell only needs to be insulated when condenser is city, lake, or river water cooled or when "free cooling" is used.

\*\* The thickness and type of insulation provided for non-factory fabricated transitions or component sections shall be consistent with the sections constructed at the factory.

\*\*\* Protective metal jacket (PMJ) is only required in exposed locations.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 23 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

END OF SECTION