

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Piping Insulation.
- B. External Ductwork Insulation.
- C. Equipment Insulation.

1.02 RELATED REQUIREMENTS

- A. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields, pipe saddles, and high-density insulation inserts.
- B. Division 23 Section "Buried Hydronic Piping," for insulation of piping installed below grade.
- C. Division 23 Section "Metal Ducts" for duct liner insulation.

1.03 DEFINITIONS

- A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees F.
- B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees F.
- C. Cold Duct: Ductwork that carries airflow with a minimum operating temperature less than 65 degrees F temperature.
- D. Hot Duct: Ductwork that carries airflow with a minimum operating temperature greater than 75 degrees F temperature.
- E. Neutral Ductwork: Ductwork that carries airflow with temperatures between the defined cold and hot temperatures.
- F. Cold Equipment: Equipment that carries fluids with a minimum operating temperature less than 60 degrees F.

- G. Hot Equipment: Equipment that carries fluids with a minimum operating temperature greater than 105 degrees F.
- H. Exposed: Insulation that is visible from the occupied space.
- I. Exposed to Weather: Insulation that is exposed to potential damage caused by weather, including sunlight, moisture, wind, and solar radiation.
- J. Exterior: Locations outside of or within the building envelope (walls, roof, floors, etc) as defined by the architectural drawings and specifications.
- K. Unconditioned Spaces: An enclosed space within a building that is not provided with mechanical heating or cooling.

1.04 SUBMITTALS

- A. Product Data: Submit technical product data, thermal characteristics, and materials for each type of mechanical insulation.
- B. Insulation Schedule: Include product name, conductivity k-value, thickness, and furnished accessories for each service.
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.
- D. Manufacturer's Instructions: Include installation instructions for storage, handling, protection, examination, preparation, and installation of the product.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualification: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.
- B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25

or less and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

1. Exception: Exterior mechanical insulation may have flame spread index of 75 and smoke developed index of 150.
2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.
3. Exception: Polyisocyanurate insulation that is not installed in a return air plenum may have a flame spread index of 25 and smoke developed index of 450.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage; store in original wrapping.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.01 PIPING INSULATION MATERIALS

- A. Mineral Fiber (rock, slag, or glass):
 1. Manufacturers:
 - a) CertainTeed Corp.
 - b) Johns Manville.
 - c) Knauf Insulation.
 - d) Owens Corning.
 2. Insulation: ASTM C547, Type I or II, rigid mineral fiber, pre-formed for the application.

- a) K-value: ASTM C518 or C177, maximum 0.24 at 75 degrees F.
- b) Minimum Service Temperature: 0 degrees F
- c) Maximum Service Temperature: 850 degrees F for Type I, 1200 degrees F for Type II.
- d) Density: Between 3 to 6 pounds per cubic foot for Type I, between 6 to 8 pounds per cubic foot for Type II.

3. Factory Applied Jacket: ASTM C1136, Type I.

- a) All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms and self-sealing lap.
- b) Poly ASJ: Paper/Foil/Scrim with polymer coating, water vapor permeance of 0.01 perms and self-sealing lap.
- c) Color: White.

B. Cellular Glass:

1. Manufacturers:

- a) Owens Corning.

2. Insulation: ASTM C552, Type II, Grade 6, rigid closed glass cells pre-formed for the application.

- a) K-value: ASTM C518 or C177, maximum 0.34 at 75 degrees F.
- b) Minimum Service Temperature: Minus 450 degrees F.
- c) Maximum Service Temperature: 800 degrees F.
- d) Density: Minimum 6.12 pounds per cubic feet.

C. Polyisocyanurate:

1. Manufacturers:

- a) Dyplast Products.
- b) Johns Manville.
- c) Approved equal.

2. Insulation: ASTM C591, Grade 2, Type IV for ASTM E84 25/50 compliance, Type I for ASTM E84 25/450 compliance; rigid molded, pre-formed for the application.

- a) K-value: ASTM C518 or C177, maximum 0.2 at 75 degrees F.
- b) Minimum Service Temperature: Minus 297 degrees F
- c) Maximum Service Temperature: 300 degrees F.
- d) Density: Maximum 6 pounds per cubic feet.

D. Flexible Elastomeric:

1. Manufacturers:
 - a) Aeroflex USA, Inc.
 - b) Armacell LLC.
 - c) K-Flex USA.

2. Insulation: ASTM C534, Grade I, flexible elastomeric cellular rubber insulation, pre-formed for the application.
 - a) K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
 - b) Minimum Service Temperature: Minus 297 degrees F
 - c) Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.

3. Factory Applied Jacket:
 - a) Polymeric Coating: Multi-ply, polymeric blend coating, 16 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.03 perms. Reference Piping Jacket Schedule in Part 3 of this specification for application of this jacket.

E. Field-Applied Jacket:

1. Canvas: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
2. Semi-rigid PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, including factory-furnished, pre-cut insulation blanket inserts for fittings.
 - a) Outdoor Applications: Provide minimum 30 mils thickness and UV protection.
 - b) Manufacturers:
 - 1) Johns Manville Zeston PVC Jacketing and 2000 Series Fitting Covers
 - 2) Proto Corp LoSmoke PVC Jacketing and Pro Fitting Covers.
 - 3) Or approved equal.
3. Rigid Aluminum Shell: One-piece, pre-formed cover conforming to ASTM C1729 with weather-proof construction. Shell shall have the following minimum thickness based on the outer insulation diameter:

Outer Insulation Diameter (in)	Minimum Aluminum Jacket Thickness, (in)		
	Non-Rigid Insulation	Rigid Insulation	Finish
≤ 8	0.016	0.016	Stucco
< 12	0.020	0.016	Stucco
≤ 24	0.024	0.016	Stucco
≤ 36	0.032	0.020	See Note 1

Note 1: Use corrugated finish for non-rigid insulation. Use stucco finish for rigid insulation.

a) Banding:

- 1) For piping less than or equal to 8 inches, provide 0.020 inch thick, 3/4 inch wide aluminum bands.
- 2) For piping larger than 8 inches, provide 0.020 inch thick, 3/4 inch wide stainless steel bands.

4. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.

- a) Water Vapor Transmission: 0.0 perms per ASTM E96.
- b) Puncture Resistance: Minimum 65 pounds per ASTM D1000.

5. Rubberized Asphalt Vapor Barrier Cladding: UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulated duct and piping applications. Provide Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding, or approved equal.

- a) Water Vapor Transmission: 0.0 perms per ASTM E96.
- b) Puncture Resistance: Minimum 15 pounds per ASTM D1000.

6. Interior Vapor Barrier Membrane: Multi-ply, composite membrane of aluminum foil with polyester films on each side to protect the aluminum foil. Membrane shall be reversible to provide a clean, white finish on one side or smooth silver finish on the other side. Provide Polyguard Products, Inc. ZeroPerm or approved equal.

- a) Water Vapor Transmission: 0.0 perms per ASTM E96.
- b) Puncture Resistance: Minimum 10 pounds per ASTM D1000.

F. Pipe Insulation Accessories: Provide staples, bands, wires, cement, and other appurtenances as recommended by insulation manufacturer for applications indicated.

G. Adhesives, Sealers, Mastics, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

- 1. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2, or equal.
- 2. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.

3. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.
4. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance in accordance with ASTM C755 for insulation application. Provide Foster 30-80, Childers CP-38, or equal.

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note 1)

Insulation Application	Insulation Permeability, Less than 4.0 perm-in. (Note 2)	Insulation Permeability, 4.0 or greater perm-in. (Note 2)
	Vapor Retarder perms	Vapor Retarder perms
Pipe and vessels (33 F to ambient)	0.05	0.05
Pipe and vessels (-40 F to 32 F)	0.02	0.02
Ducts (40 F to ambient)	1.0	0.03

Notes:

1. Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.
 5. Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.
- H. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.
- I. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.
- J. High Density Insulation Billets:
 1. Calcium Silicate: ASTM C533 and C795.
 2. Flexible elastomeric: ASTM C534, Type 1.
 3. Polystyrene: ASTM C578, Type XIII.

2.02 EXTERNAL DUCTWORK INSULATION MATERIALS

- A. Flexible Mineral Fiber (rock, slag, or glass):
 1. Manufacturers:
 - a) CertainTeed Corp.
 - b) Johns Manville.
 - c) Knauf Insulation.
 - d) Owens Corning.
 2. Insulation: ASTM C553, Type I or II, flexible mineral fiber blanket.

- a) K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
- b) Minimum Service Temperature: Minus 20 degrees F
- c) Maximum Service Temperature: 450 degrees.
- d) Density:
 - 1) 1.5 pounds per cubic foot.

3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

- a) Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms and 2 inch stapling tab.
- b) Polypropylene Scrim Kraft (PSK): Kraft paper with glass fiber yarn and bonded to metalized polypropylene, water vapor permeance of 0.02 perms and 2 inch stapling tab.
- c) Color: Black.

B. Rigid Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

- a) Johns Manville.
- b) Knauf Insulation.
- c) Owens Corning.

2. Insulation: ASTM C612, Type IA or IB, rigid mineral fiber board.

- a) K-value: ASTM C518 or C177, maximum 0.25 at 75 degrees F.
- b) Minimum Service Temperature: 0 degrees F
- c) Maximum Service Temperature: 450 degrees.
- d) Density:
 - 1) 3.0 pounds per cubic foot.

3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

- a) All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms.
- b) Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms.
- c) Polypropylene Scrim Polyester (PSP): Polyester paper with glass fiber yarn and bonded to polypropylene, water vapor permeance of 0.02 perms.
- d) Color: White.

C. Cellular Glass:

1. Manufacturers:

- a) Owens Corning.
2. Insulation: ASTM C552, Type I, Grade 6, rigid closed glass cells, block form.
- a) K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
 - b) Minimum Service Temperature: Minus 450 degrees F.
 - c) Maximum Service Temperature: 800 degrees F.
 - d) Density: Minimum 6 pounds per cubic feet.
- D. Polyisocyanurate:
1. Manufacturers:
- a) Dyplast Products.
 - b) Johns Manville.
 - c) Approved equal.
2. Insulation: ASTM C591, Grade 2, Type IV for ASTM E84 25/50 compliance, Type I for ASTM E84 25/450 compliance; rigid board.
- a) K-value: ASTM C518 or C177, maximum 0.2 at 75 degrees F.
 - b) Minimum Service Temperature: Minus 297 degrees F
 - c) Maximum Service Temperature: 300 degrees F.
 - d) Density: Maximum 6 pounds per cubic feet.
- E. Flexible Elastomeric:
1. Manufacturers:
- a) Aeroflex USA, Inc.
 - b) Armacell LLC.
 - c) K-Flex USA.
2. Insulation: ASTM C534, Grade 1, flexible elastomeric cellular rubber insulation, sheet form.
- a) K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
 - b) Minimum Service Temperature: Minus 40 degrees F
 - c) Maximum Service Temperature: 180 degrees F.
3. Factory Applied Jacket:
- a) Flexible Metal Cladding: Metallic factory-laminated cladding, 17.5 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.00 perms. Provide ArmaTuff or equal. Reference

Duct Jacket Schedule in Part 3 of this specification for application of this jacket.

F. Field-Applied Jacket:

1. Aluminum: ASTM B209, 3003 alloy, H-14 temper, with 3-mil thick polyfilm moisture barrier to interior surface.
 - a) Thickness: 0.032 inch sheet.
 - b) Finish: Smooth or Stucco. Reference Part 3 for jacket applications.
 - c) Joining: Longitudinal slip joints and 2 inch laps.
 - d) Fittings: 0.032 inch thick die shaped fitting covers with factory attached protective liner.
 - e) Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.
2. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.
 - a) Water Vapor Transmission: 0.0 perms per ASTM E96.
 - b) Puncture Resistance: Minimum 65 pounds per ASTM D1000.
3. Rubberized Asphalt Vapor Barrier Cladding: UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulation. Provide Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding, or approved equal.

G. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, pins with insulation retaining washers, anchors, corner angles and other appurtenances as recommended by insulation manufacturer for applications indicated.

H. Adhesives, Sealers, Mastics, and Protective Finishes: Provide cements, adhesives, coatings, sealers, mastics, protective finishes, and similar compounds as recommended by insulation manufacturer for applications indicated.

1. Mineral Fiber Lagging Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127, or equal water-based adhesive.
2. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 47 mils dry per ASTM E96. Provide Fosters 30-80, Childers CP-38, Design Polymeric 3040, or equal.
3. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.

4. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

2.03 EQUIPMENT INSULATION MATERIALS

A. Flexible Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

- a) CertainTeed Corp.
- b) Johns Manville.
- c) Knauf Insulation.
- d) Owens Corning.

2. Insulation: ASTM C553, Type I and II or ASTM C547 Type II, flexible mineral fiber blanket.

- a) K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
- b) Minimum Service Temperature: Minus 20 degrees F
- c) Maximum Service Temperature: 450 degrees F for ASTM C553 Types I and II, 1200 degrees F for ASTM C547 Type II.
- d) Density: Minimum 1.5 pounds per cubic foot.

3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

- a) Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms and 2 inch lap.
- b) Color: White.

B. Flexible Removeable and Reusable Blanket Insulation:

1. Manufacturers:

- a) Auburn Manufacturing.
- b) Approved equal.

2. Insulation: ASTM C553, Type V, flexible, noncombustible.

- a) Comply with ASTM C1695.
- b) K-value: ASTM C518 or C177, maximum 0.37 at 100 degrees F.
- c) Minimum Service Temperature: 32 degrees F
- d) Maximum Service Temperature: 500 degrees.

C. Rigid Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

- a) Johns Manville.
- b) Knauf Insulation.
- c) Owens Corning.

2. Insulation: ASTM C612, Type IA or IB, rigid mineral fiber board.

- a) K-value: ASTM C518 or C177, maximum 0.25 at 75 degrees F.
- b) Minimum Service Temperature: 0 degrees F
- c) Maximum Service Temperature: 450 degrees.
- d) Density: Minimum 3.0 pounds per cubic foot.

3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

- a) All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms.
- b) Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms.
- c) Color: White.

D. Cellular Glass:

1. Manufacturers:

- a) Owens Corning.

2. Insulation: ASTM C552, Type I, Grade 6, rigid closed glass cells, block form.

- a) K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
- b) Minimum Service Temperature: Minus 450 degrees F.
- c) Maximum Service Temperature: 800 degrees F.
- d) Density: Minimum 6.12 pounds per cubic feet.

E. Flexible Elastomeric:

1. Manufacturers:

- a) Aeroflex USA, Inc.
- b) Armacell LLC.
- c) K-Flex USA.

2. Insulation: ASTM C534, Grade I or II, flexible elastomeric cellular rubber insulation, sheet form.

- a) K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
- b) Minimum Service Temperature: Minus 40 degrees F

- c) Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.

F. Field-Applied Jacket:

1. Canvas: UL listed, minimum 8 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
2. Aluminum: ASTM B209, 3003 alloy, H-14 temper, with 3-mil thick polyfilm moisture barrier to interior surface.
 - a) Thickness: 0.032 inch sheet.
 - b) Finish: Smooth.
 - c) Joining: Longitudinal slip joints and 2 inch laps.
 - d) Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.
3. Stainless Steel: ASTM A666, Type 304 stainless steel.
 - a) Thickness: 0.010 inch sheet.
 - b) Finish: Smooth.
 - c) Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.
4. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.
 - a) Water Vapor Transmission: 0.0 perms per ASTM E96.
 - b) Puncture Resistance: Minimum 65 pounds per ASTM D1000.
5. Rubberized Asphalt Vapor Barrier Cladding: UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulation. Provide Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding, or approved equal.
6. Interior Vapor Barrier Membrane: Multi-ply, composite membrane of aluminum foil with polyester films on each side to protect the aluminum foil. Membrane shall be reversible to provide a clean, white finish on one side or smooth silver finish on the other side. Provide Polyguard Products, Inc. ZeroPerm or approved equal.
 - a) Water Vapor Transmission: 0.0 perms per ASTM E96.
 - b) Puncture Resistance: Minimum 10 pounds per ASTM D1000.

- G. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors, stud pins, and other appurtenances as recommended by insulation manufacturer for applications indicated.

- H. Adhesives, Sealers, Mastics, and Protective Finishes: Provide cements, adhesives, coating, sealers, mastics, and protective finishes as recommended by insulation manufacturer for applications indicated.
1. Mineral Fiber Lagging Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127, or equal water-based adhesive.
 2. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 47 mils dry per ASTM E96. Provide Foster 30-80, Childers CP-38, Design Polymeric 3040, or equal.
 3. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36. Childers CP-50AHV2 or equal.
 4. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Test piping and ductwork for design pressure, liquid tightness, and continuity prior to applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 PROTECTION AND REPLACEMENT

- A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.
- B. Repair existing mechanical insulation that is damaged during this construction period. Use insulation of same type and thickness as existing insulation. Install new jacket lapping and sealed over existing.
- C. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

3.03 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.

3.04 PIPING SYSTEM INSULATION INSTALLATION

- A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation and protect it from puncture and other damage.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Exposed Piping: Locate insulation and cover seams in least visible locations.
- E. Cold Pipe Insulation:
 - 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
 - 2. Provide vapor barrier jacket according to the Piping Jacket Schedule.
 - 3. Provide high density insulation material under supports or pre-insulated supports. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers & Supports for HVAC Piping & Equipment" for pre-insulated supports and insulation shields. and for exception where high density insulation inserts are not required.
 - 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
 - 5. Secure all-service jacket with self-sealing longitudinal laps.
 - 6. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.
- F. Hot Pipe Insulation:
 - 1. Insulate entire system, including fittings, valves, unions flanges, strainers, flexible connections, pump bodies, and expansion joints.

2. Provide jackets without vapor barrier according to the Piping Jacket Schedule. Jackets with vapor barrier are allowed.
3. Provide high density insulation material or pre-insulated supports where supports are installed outside of the insulation. Protect insulation with shields to prevent puncture or other damage. Refer to Section “Hangers & Supports for HVAC Piping & Equipment” for pre-insulated supports and insulation shields and for exception where high density insulation inserts are not required.
4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
5. Secure all-service jacket with self-sealing longitudinal laps.
6. Butt pipe insulation tightly at insulation joints and wrap insulation around supports. Apply 3 inch wide vapor barrier tape or band over joint.

G. Insulation of Fittings, Valves, Strainers, Flanges, and Unions:

1. Insulate fittings, joints, and valves with molded insulation of like material, vapor barrier coating, and thickness as adjacent pipe. Provide pre-formed insulation pieces, segmented insulation, or sectional pipe insulation for the application. Provide the same insulation jacket as adjoining pipe.
2. Sectional pipe insulation: Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Hold sectional cuts in place with tie wire or bands. Wire and bands shall be compatible with insulation and jacket.
3. Segmented pipe insulation: Cover segmented insulated surfaces with a layer of finishing cement and finish with a coating or mastic. Reinforce the mastic with fabric-reinforcing mesh. Trowel the coating or mastic to a smooth and well-shaped contour.
4. Butt each insulation piece tightly against adjoining piece of insulation. Bond pieces together according to Cold Pipe or Hot Pipe installation instructions.
5. Insulate valves up to and including the bonnets, valve stuffing-box studs, bolts, and nuts with a removeable insulation cover. Sectional valve insulation covers shall divide the section along the vertical center line of the valve body.
6. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover.
7. Insulate flanges and unions with a removeable insulation cover. Sectional pipe insulation covers shall divide the section along the center line of pipe.
8. When removeable covers are made from sectional block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, around the insulated device with tie wire. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

9. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation. PVC fitting covers with end caps are also acceptable. Tape PVC covers to adjoining insulation facing using PVC tape.
 10. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- H. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- I. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated. Maintain vapor barrier through the penetration.
- J. Exterior Piping and Piping Exposed to Weather:
1. General: Provide piping jacket around insulation as scheduled in the Piping Jacket Schedule. Jacket material shall be approved by the jacket manufacturer for use with the specific insulation material that it covers. Locate longitudinal seams of outer shell (aluminum, flexible elastomeric, or cladding as applicable) at bottom of pipe. Provide insulation shields so that the piping supports cannot puncture, cut or break the jacket.
 2. Paintable Coating: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
 3. Polymeric Coating: Provide insulation shields so that the piping supports do not puncture, cut or break the jacket.
 4. Rigid aluminum shell: Space attachment bands 12 inches on center and directly centered over end joints.
 5. Multilayer Laminate Vapor Barrier Cladding: Install cladding only when ambient temperature is above 50 degrees F. Provide low-temp products for installation in low ambient temperatures down to 10 degrees F.
 6. Rubberized Asphalt Vapor Barrier Cladding: Install cladding for use in ambient temperatures as low as minus 10 degrees F.

3.05 PIPING SYSTEM INSULATION SCHEDULE

- A. Reference Pipe Insulation Thickness Schedule at the end of this specification for thickness requirements based on insulation conductivity.

- B. Do not apply insulation to piping that operates outside of the minimum and maximum service temperature range.
- C. Omit insulation on the following:
 - 1. Hot piping within radiation enclosures or unit cabinets.
 - 2. Cold piping within unit cabinets provided piping is located over drain pan.
 - 3. Heating piping between coil and shutoff valves provided piping is located within heated space and not more than three feet from coil.
 - 4. Condensate piping between steam trap and union.
 - 5. Flexible connections and expansion joints in pipes with fluids above ambient temperatures.
- D. Exterior Piping: Insulate all exterior HVAC piping with one of the following:
 - 1. Cellular glass.
 - 2. Flexible elastomeric, use high temperature formula for systems with operating temperatures above 220 F. (not acceptable for steam, steam condensate or hot water piping systems with temperatures above 300 F).
- E. Cold Piping (40 degrees F (4.4 degrees C) to 60 degrees F):
 - 1. Service:
 - a) Chilled water supply and return piping.
 - b) Air conditioner condensate drain piping.
 - 2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 - a) Mineral fiber.
 - b) Cellular glass.
 - c) Polyisocyanurate.
 - d) Flexible elastomeric.
- F. Warm Temperature Piping (105 degrees to 140 degrees F (40 to 94 degrees C)):
 - 1. Service:
 - a) Heating hot water supply and return piping.
 - 2. Insulate each piping system specified above with one of the following types of insulation.
 - a) Mineral fiber.
 - b) Cellular glass.
 - c) Polyisocyanurate.

- d) Flexible elastomeric.

3.06 PIPE INSULATION THICKNESS SCHEDULE

A. IECC – 2018 Requirements, Pipe Insulation

Fluid Operating Temp. Range (°F) And Usage	Minimum Pipe Insulation Thickness						
	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity, Btu·in./(hr·ft ² ·°F)	Mean Rating Temp., °F.	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Insulation Thickness, in.							
>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50	0.5	1.0	1.0	1.0	1.5

Notes:

- a) For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.
- b) For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r[(1 + t/r)^{(K/k)} - 1]$ where
 - 1) T = minimum insulation thickness (in.),
 - 2) r = actual outside radius of pipe (in.),
 - 3) t = insulation thickness listed in the table for applicable fluid temperature and pipe size,
 - 4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in/hr·ft²·°F); and
 - 5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
- c) Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
- d) For piping that shall be installed below grade, reference Division 23 section “Underground Hydronic and Steam Piping.”
- e) The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe,

reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

3.07 PIPING JACKET SCHEDULE

- A. Exposed piping within mechanical rooms (below 10 feet):
 - 1. Semi-rigid PVC.
 - 2. Rigid aluminum shell.

- B. Exposed piping within mechanical rooms (above 10 feet):
 - 1. Canvas.
 - 2. Semi-rigid PVC.
 - 3. Rigid aluminum shell.

- C. Exposed piping:
 - 1. All-service jacket.
 - 2. Canvas.
 - 3. Semi-rigid PVC.

- D. Piping within return air plenums:
 - 1. All-service jacket.
 - 2. Canvas.

- E. Exterior piping and piping exposed to weather:
 - 1. Paintable coating (flexible elastomeric insulation only).
 - 2. Polymeric Coating (flexible elastomeric insulation only).
 - 3. Semi-rigid PVC for outdoor application(flexible elastomeric insulation on refrigerant piping only).
 - 4. Rigid aluminum shell.
 - 5. Multilayer laminate vapor barrier cladding.
 - 6. Rubberized asphalt vapor barrier cladding.

3.08 DUCTWORK INSULATION SYSTEM INSTALLATION

- A. Maintain continuous thermal and vapor-barrier integrity throughout entire installation and protect it from puncture and other damage.

- B. Install insulation on duct systems subsequent to painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces.
- D. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Install insulation without sag on underside of duct. Where rectangular ducts are 24 inches in width or greater, secure external insulation to the bottom of the duct with mechanical fasteners, spaced on 18 inches on center (maximum). Fasteners shall include 2-inch square self-sticking galvanized carbon-steel base plates with minimum 0.106-inch diameter zinc-coated, low carbon steel, fully annealed shank spindle, length to suit depth of insulation. Secure insulation to spindles with self-locking washers incorporating a spring steel insert to ensure permanent cap retention. Lift duct off trapeze hangers and insert spacers to avoid insulation compression.
- F. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- G. Corner Angles: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.
- H. Lined Ductwork: At interface of lined and wrapped ductwork, overlap lined ductwork by 2 feet (minimum) with wrapped insulation.
- I. Cold Ducts:
 - 1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
 - 2. Provide vapor barrier jacket according to the Ductwork Jacket Schedule.
 - 3. Seal joints with vapor barrier mastic.
 - 4. Continue insulation, including vapor barrier, through walls, sleeves, hangers, and other duct penetrations.
 - 5. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 - 6. Where cold ducts are installed in mechanical rooms or non-conditioned spaces (excludes return air plenums), prevent condensation from forming on the duct supports by providing one or more of the following:
 - a) Install thermal break such as rigid board insulation between the support and duct.

- b) Wrap support that is in contact with the duct with external duct wrap insulation to prevent condensation. Wrap shall extend a minimum of 12 inches from point of contact of the support with the duct. Tape joints to provide a thermal and vapor barrier. Coat all taped joints, punctures and seams with 4 inch wide coating of vapor barrier mastic.
- c) If a support device similar to Unistrut is used, foam fill or stuff tube.

J. Hot and Neutral Ducts:

- 1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
- 2. Provide jackets with or without vapor barrier according to the Ductwork Jacket Schedule.
- 3. Secure joints with staples, tape, or wires.
- 4. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

K. Exterior Ductwork and Ductwork Exposed to Weather:

- 1. Slope ductwork to ensure that water cannot pond anywhere on the duct. Do not vary the insulation thickness to achieve drainage.
- 2. Jackets shall be approved by the jacket manufacturer for use with the specific insulation material it covers.
- 3. Locate longitudinal seams of jacket at bottom of duct. Install jacket in strict conformance with cladding manufacturer's instructions.
- 4. Seal joints with vapor barrier mastic and reinforcing mesh as recommended by manufacturer or protective jacket as specified.
- 5. Install aluminum jacket with three metal jacket bands per section.
- 6. Multilayer Laminate Vapor Barrier Cladding: Install cladding only when ambient temperature is above 50 degrees F. Provide low-temp products for installation in low ambient temperatures down to 10 degrees F.
- 7. Rubberized Asphalt Vapor Barrier Cladding: Install cladding for use in ambient temperatures as low as minus 10 degrees F.
- 8. Cover seams in flexible metal cladding with ArmaTuff seal tape or equal.

3.09 DUCTWORK SYSTEM INSULATION SCHEDULE

A. Omit insulation on the following:

- 1. Fibrous glass ductwork (ductboard).
- 2. Lined ductwork.
- 3. Ductwork with sound absorbing linings.

B. Prohibited insulation:

1. Polyisocyanurate installed within a return air plenum.

C. Outdoor Air:

1. Service:
 - a) Interior untreated outdoor air intake ducts.
 - b) Pre-conditioned outdoor air ducts.
 - c) Combustion air intake ducts.
2. Acceptable Insulation:
 - a) Flexible mineral fiber.
 - b) Rigid mineral fiber.
 - c) Cellular glass.
 - d) Polyisocyanurate.
 - e) Flexible elastomeric.

D. Supply Air:

1. Service:
 - a) Supply ducts from air handling equipment.
 - b) Insulate neck and bells of supply diffusers.
2. Acceptable Insulation:
 - a) Flexible mineral fiber.
 - b) Rigid mineral fiber.
 - c) Cellular glass.
 - d) Polyisocyanurate.
 - e) Flexible elastomeric.

E. Return Air:

1. Service:
 - a) Interior ductwork within 10 feet of exterior roof or wall penetrations.
 - b) Interior ductwork routed through or from unconditioned spaces and plenums.
2. Acceptable Insulation:
 - a) Flexible mineral fiber.
 - b) Rigid mineral fiber.
 - c) Cellular glass.

- d) Polyisocyanurate.
- e) Flexible elastomeric.

F. Exhaust Air.

1. Service:

- a) Interior ductwork within 10 feet of exterior roof or wall penetrations.
- b) Interior ductwork routed through conditioned spaces (excludes ductwork routed in shafts) that is exhausting from unconditioned spaces (such as loading docks, garages, etc.).
- c) Interior ductwork downstream of heat recovery device (wheel, plate, heat pipe, etc.) to exterior discharge outlet.
- d) Exterior ductwork upstream of heat recovery device (wheel, plate, heat pipe, etc.).
- e) Range and kitchen hood non-grease exhaust ductwork.
- f) Dishwasher exhaust ducts within 10 feet of discharge to the outdoors.

2. Acceptable Insulation:

- a) Flexible mineral fiber.
- b) Rigid mineral fiber.
- c) Cellular glass.
- d) Polyisocyanurate.
- e) Flexible elastomeric.

G. Range and hood grease exhaust ductwork: Refer to Section “Air Duct Accessories” for requirements of fire-rated wrap insulation for grease exhaust duct.

H. Relief Air.

1. Service:

- a) Interior ductwork within 10 feet of exterior roof or wall penetrations.
- b) Downstream of heat recovery device (wheel, plate, heat pipe, etc.) to exterior discharge outlet.

2. Acceptable Insulation:

- a) Flexible mineral fiber.
- b) Rigid mineral fiber.
- c) Cellular glass.
- d) Polyisocyanurate.

- e) Flexible elastomeric.
- I. HVAC plenums and unit housings not pre-insulated at factory or lined.
- 1. Acceptable Insulation:
 - a) Flexible mineral fiber.
 - b) Rigid mineral fiber.
 - c) Cellular glass.
 - d) Polyisocyanurate.
 - e) Flexible elastomeric.
- J. Exterior Ductwork:
- 1. Service:
 - a) Supply ductwork.
 - b) Return ductwork.
 - c) Exhaust ductwork.
 - d) Pre-conditioned outside air downstream of conditioning unit.
 - e) Plenums and unit housings not pre-insulated at factory or lined.
 - 2. Acceptable Insulation:
 - a) Cellular glass.
 - b) Polyisocyanurate.
 - c) Flexible elastomeric.
 - d) Omit insulation on phenolic foam ductwork and fittings. Refer to Division 23 Section "Nonmetal Ducts."

3.010 DUCT SYSTEM INSULATION THICKNESS SCHEDULE

- A. Flexible Mineral Fiber:
- 1. Interior Ductwork:
 - a) 1.5 pounds per cubic foot density:
 - 1) 1-1/2 inch thick, minimum R-4.2.
 - 2. Meet R-value installed at maximum 25% compression, application limited to concealed locations.
- B. Rigid Mineral Fiber:
- a) 3 pounds per cubic foot density:
 - 1) 1 inch thick, minimum R-4.2.

2. Ductwork installed in machine, fan, and mechanical equipment rooms:
 - a) 2 inch thick, minimum R-8.0.
3. Ductwork Exposed to Weather, or Ductwork:
 - a) 2 inch thick, minimum R-8.0.
4. Ductwork in an Unconditioned Space:
 - a) 1-1/2 inch thick, minimum R-6.0.

C. Cellular Glass:

1. Interior Ductwork:
 - a) 1-1/2 inch thick, minimum R-5.0.
2. Ductwork Exposed to Weather, or Ductwork:
 - a) 2-1/2 inch thick, minimum R-8.0.
3. Ductwork in an Unconditioned Space:
 - a) 2 inch thick, minimum R-6.0.

D. Polyisocyanurate:

1. Interior Ductwork:
 - a) 1 inch thick, minimum R-6.0.
2. Ductwork Exposed to Weather:
 - a) 1-1/2 inch thick, minimum R-8.0.
3. Ductwork in an Unconditioned Space:
 - a) 1 inch thick, minimum R-6.0.

E. Flexible Elastomeric:

1. Interior Ductwork:
 - a) 1 inch thick, minimum R-4.2.
2. Ductwork Exposed to Weather:
 - a) 2 inch thick, minimum R-8.0.
3. Ductwork in an Unconditioned Space:

- a) 1-1/2 inch thick, minimum R-6.0.

3.011 DUCTWORK JACKET SCHEDULE

- A. Omit jacket on internally lined ductwork.
- B. Exposed ductwork within mechanical rooms (below 10 feet):
 - 1. Foil Scrim Kraft (FSK).
 - 2. Polypropylene Scrim Kraft (PSK).
 - 3. All-Service Jacket (ASJ).
 - 4. Polypropylene Scrim Polyester (PSP).
 - 5. Flexible Metal Cladding (flexible elastomeric only).
 - 6. Aluminum with smooth finish.
- C. Exposed ductwork within mechanical rooms (above 10 feet):
 - 1. Foil Scrim Kraft (FSK).
 - 2. Polypropylene Scrim Kraft (PSK).
 - 3. All-Service Jacket (ASJ).
 - 4. Polypropylene Scrim Polyester (PSP).
 - 5. Flexible Metal Cladding (flexible elastomeric only).
- D. Exposed ductwork:
 - 1. Foil Scrim Kraft (FSK).
 - 2. Polypropylene Scrim Kraft (PSK).
 - 3. All-Service Jacket (ASJ).
 - 4. Polypropylene Scrim Polyester (PSP).
 - 5. Flexible Metal Cladding (flexible elastomeric only).
 - 6. Aluminum with smooth finish.
- E. Ductwork within return air plenums:
 - 1. Foil Scrim Kraft (FSK).
 - 2. Polypropylene Scrim Kraft (PSK).
 - 3. All-Service Jacket (ASJ).
 - 4. Polypropylene Scrim Polyester (PSP).
 - 5. Flexible Metal Cladding (flexible elastomeric only).
- F. Ductwork in an unconditioned space:
 - 1. Foil Scrim Kraft (FSK).
 - 2. Polypropylene Scrim Kraft (PSK).

3. All-Service Jacket (ASJ).
4. Polypropylene Scrim Polyester (PSP).
5. Flexible Metal Cladding (flexible elastomeric only).

3.012 EQUIPMENT INSULATION INSTALLATION

- A. Install insulation subsequent to painting, testing, and acceptance of tests.
- B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.
- C. Protect insulation to prevent puncture and other damage.
- D. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.
- E. Do not apply insulation to equipment, breechings, or stacks while hot.
- F. Do not insulate flanges and unions of equipment carrying fluids less than 105 degrees F.
- G. Provide neatly beveled edge at interruptions of insulation.
- H. Fasten insulation to equipment with studs, pins, clips, adhesives, wires, or bands.
- I. Stagger insulation joints for both single and double layer application, where feasible. Apply each layer of insulation separately. Tape all joints using glass cloth or a suitable, matching acrylic adhesive tape; minimum 3 inches wide.
- J. Coat insulated surfaces of calcium silicate with layer of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
- K. Cover insulated surfaces with jacketing, factory or field applied, neatly fitted and firmly secured. Lap seams at least 2 inches. Apply over vapor barrier where applicable. Tape all joints using glass cloth or a suitable, matching acrylic adhesive tape; minimum 3 inches wide.
- L. Cold Equipment:

1. Insulate entire system, including flanges and unions. Maintain continuous vapor-barrier integrity throughout entire installation and protect it from puncture and other damage.
2. Provide vapor barrier jacket, factory or field applied over mineral fiber insulation. Finish with glass cloth or vapor barrier adhesive.
3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.

M. Hot Equipment:

1. Insulate entire system, including flanges and unions.
2. Provide jacket, with or without vapor barrier, factory or field applied over mineral fiber insulation. Finish with glass cloth or vapor barrier adhesive.

3.013 EQUIPMENT INSULATION SCHEDULE

A. Omit Insulation on the following:

1. Boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplates.
2. Factory pre-insulated equipment.

B. Do not apply insulation to equipment that operates outside of the minimum and maximum service temperature range.

C. Provide flexible removable and reusable blanket insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

D. Cold Equipment:

1. Service:

- a) Cold surfaces not factory insulated.
- b) Drip pans under chilled equipment.
- c) Chilled water expansion tanks, air separators and piping accessories.
- d) Chilled water pumps.

2. Acceptable Insulation:

a) Flexible Mineral Fiber:

- 1) 2 inch thick for cold surfaces above 35 degrees F.

b) Rigid Mineral Fiber:

- 1) 2 inch thick for cold surfaces above 35 degrees F.

- c) Cellular Glass:
 - 1) 3 inch thick for surfaces above 35 degrees F.
 - d) Flexible Elastomeric:
 - 1) 3 inch thick for surfaces above 35 degrees F.
- E. Hot Equipment:
- 1. Service:
 - a) Boilers.
 - b) Hot water expansion tanks, air separators, and piping accessories.
 - c) Hot water pumps.
 - d) Boiler feedwater storage tanks.
 - e) Deaerators.
 - 2. Acceptable Insulation:
 - a) Flexible Mineral Fiber:
 - 1) 2 inch thick for all other applications.
 - b) Rigid Mineral Fiber:
 - 1) 2 inch thick for all other applications.
- F. Breechings, Chimneys, and Stacks:
- 1. Service:
 - a) Breechings between heating equipment outlet and stack or chimney connection, except for double wall or factory insulated breechings.
 - b) Stack from bottom to top except for factory insulated stacks.
 - 2. Acceptable Insulation:
 - a) Flexible Mineral Fiber: 2 inch thick.
 - b) Calcium Silicate: 2 inch thick.
- G. Generator Exhaust:
- 1. Service:
 - a) Emergency generator exhaust piping from generator outlet to discharge.

2. Acceptable Insulation: Insulate each generator exhaust with one of the following types and thicknesses of insulation.
 - a) Flexible Mineral Fiber (ASTM C547 Type II only): 2 inch thick.
 - b) Calcium Silicate: 2 inch thick.

3.014 EQUIPMENT JACKET SCHEDULE

- A. Omit jacketing on equipment pre-insulated and jacketed from the factory.
- B. Interior Equipment (all except flexible elastomeric insulation):
 1. Canvas.
 2. Aluminum.
 3. Stainless steel.
- C. Equipment in unconditioned spaces (all except flexible elastomeric insulation):
 1. Canvas.
 2. Aluminum.
 3. Stainless steel.
- D. Exterior Equipment or Equipment Exposed to Weather:
 1. Aluminum.
 2. Stainless Steel.
 3. Multilayer Laminate Vapor Barrier Cladding.
 4. Rubberized Asphalt Vapor Barrier Cladding.
- E. Exterior Generator Exhaust or Generator Exhaust Exposed to Weather:
 1. Aluminum.
 2. Stainless Steel.

END OF SECTION

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