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SECTION 230719 - HVAC PIPING INSULATION

TIPS:

To view non-printing **Editor's Notes** that provide guidance for editing, click on MasterWorks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on MasterWorks/Supporting Information.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Condensate drain piping, [**indoors**] [**and**] [**outdoors**].
 - 2. Chilled-water and brine piping, [**indoors**] [**and**] [**outdoors**].
 - 3. Condenser-water piping, [**indoors when used for water-side economizer or for condensate control**] [**and**] [**outdoors**].
 - 4. Heating hot-water piping, [**indoors**] [**and**] [**outdoors**].
 - 5. Steam and steam condensate piping, [**indoors**] [**and**] [**outdoors**].
 - 6. Refrigerant suction and hot-gas piping, [**indoors**] [**and**] [**outdoors**].
 - 7. Dual-service heating and cooling piping, [**indoors**] [**and**] [**outdoors**].
 - 8. Heat-recovery piping, [**indoors**] [**and**] [**outdoors**].
 - 9. Heated fuel-oil piping, [**indoors**] [**and**] [**outdoors**].

B. Related Sections:

1. Section 230713 "Duct Insulation."
2. Section 230716 "HVAC Equipment Insulation."
3. Section 232113.13 "Underground Hydronic Piping" for loose-fill pipe insulation in underground piping outside the building.
4. Section 336313 "Underground Steam and Condensate Distribution Piping" for loose-fill pipe insulation in underground piping outside the building.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Product Data: For coatings, indicating VOC content.
4. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.
5. Product Data: For sealants, indicating VOC content.
6. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

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

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.

1. Preformed Pipe Insulation Materials: 12 inches (300 mm) long by NPS 2 (DN 50).
2. Sheet Form Insulation Materials: 12 inches (300 mm) square.
3. Jacket Materials for Pipe: 12 inches (300 mm) long by NPS 2 (DN 50).
4. Sheet Jacket Materials: 12 inches (300 mm) square.
5. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
 - 1. Piping Mockups:
 - a. One 10-foot (3-m) section of NPS 2 (DN 50) straight pipe.
 - b. One each of a 90-degree threaded, welded, and flanged elbow.
 - c. One each of a threaded, welded, and flanged tee fitting.
 - d. One NPS 2 (DN 50) or smaller valve, and one NPS 2-1/2 (DN 65) or larger valve.
 - e. Four support hangers including hanger shield and insert.
 - f. One threaded strainer and one flanged strainer with removable portion of insulation.
 - g. One threaded reducer and one welded reducer.
 - h. One pressure temperature tap.
 - i. One mechanical coupling.
 - 2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
 - 3. Notify Architect seven days in advance of dates and times when mockups will be constructed.

4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Calcium Silicate:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Industrial Insulation Group, LLC (IIG-LLC).
 - b. **<Insert manufacturer's name>**.
 2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
- G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Pittsburgh Corning Corporation.
 - b. **<Insert manufacturer's name>**.
 2. Block Insulation: ASTM C 552, Type I.
 3. Special-Shaped Insulation: ASTM C 552, Type III.
 4. Board Insulation: ASTM C 552, Type IV.
 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 6. Preformed Pipe Insulation with Factory-Applied [ASJ] [ASJ-SSL]: Comply with ASTM C 552, Type II, Class 2.
 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - d. **<Insert manufacturer's name>**.

- I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type [I] [II with factory-applied vinyl jacket] [III with factory-applied FSK jacket] [III with factory-applied FSP jacket]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.
 - f. <Insert manufacturer's name>.
- J. Mineral-Fiber, Preformed Pipe Insulation:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens Corning.
 - e. <Insert manufacturer's name>.
 2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, [without factory-applied jacket] [with factory-applied ASJ] [with factory-applied ASJ-SSL]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 3. Type II, 1200 deg F (649 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, [without factory-applied jacket] [with factory-applied ASJ] [with factory-applied ASJ-SSL]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- K. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Owens Corning.
 - b. <Insert manufacturer's name>.
- L. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied [ASJ] [FSK jacket] complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612,

Type IB. Nominal density is **2.5 lb/cu. ft. (40 kg/cu. m)** or more. Thermal conductivity (k-value) at **100 deg F (55 deg C)** is **0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K)** or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.
 - f. **<Insert manufacturer's name>**.

M. Phenolic:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Kingspan Tarec Industrial Insulation NV.
 - b. Resolco International BV.
 - c. **<Insert manufacturer's name>**.
2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
 - a. Preformed Pipe Insulation: **[None] [ASJ]**.

N. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Duna USA Inc.
 - b. Dyplast Products.
 - c. Elliott Company of Indianapolis.
 - d. ITW Insulation Systems; Illinois Tool Works, Inc.
 - e. **<Insert manufacturer's name>**.
2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed **0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K)** at **75 deg F (24 deg C)** after 180 days of aging.
3. Flame-spread index shall be 25 or less, and smoke-developed index shall be 50 or less for thickness up to **1 inch (25 mm)** as tested by ASTM E 84.
4. Fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

- a. Pipe Applications: [**None**] [**ASJ**] [**ASJ-SSL**] [**PVDC**] [**PVDC-SSL**].
- O. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armacell LLC.
 - b. Nomaco Insulation.
 - c. **<Insert manufacturer's name>**.
- P. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed **0.26 Btu x in./h x sq. ft. x deg F (0.038 W/m x K)** after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Dow Chemical Company (The).
 - b. **<Insert manufacturer's name>**.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ramco Insulation, Inc.
 - b. **<Insert manufacturer's name>**.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ramco Insulation, Inc.
 - b. **<Insert manufacturer's name>**.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ramco Insulation, Inc.
 - b. **<Insert manufacturer's name>**.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of **50 to 800 deg F (10 to 427 deg C)**.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 - e. Vimasco Corporation.
 - f. **<Insert manufacturer's name>**.
 2. Adhesives shall have a VOC content of **[50] <Insert value>** g/L or less.
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of **minus 100 to plus 200 deg F (minus 73 to plus 93 deg C)**.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
 - b. **<Insert manufacturer's name>**.
 2. Adhesives shall have a VOC content of **[50] <Insert value>** g/L or less.
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of **minus 75 to plus 300 deg F (minus 59 to plus 149 deg C)**.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. **<Insert manufacturer's name>**.
 2. Adhesives shall have a VOC content of **[50] <Insert value>** g/L or less.

3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- E. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. K-Flex USA.
 - e. **<Insert manufacturer's name>**.
 2. Adhesives shall have a VOC content of [50] **<Insert value>** g/L or less.
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- F. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 - e. **<Insert manufacturer's name>**.
 2. Fiberglass adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- G. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of **minus 20 to plus 140 deg F (29 to plus 60 deg C)**.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. **<Insert manufacturer's name>**.
 2. Adhesives shall have a VOC content of [50] **<Insert value>** g/L or less.

3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- H. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 - e. **<Insert manufacturer's name>**.
 2. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- I. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Dow Corning Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. P.I.C. Plastics, Inc.
 - d. Speedline Corporation.
 - e. **<Insert manufacturer's name>**.
 2. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. VOC Content: [300] **<Insert value>** g/L or less.
 2. Low-Emitting Materials: Mastic coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the

Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
 - b. Knauf Insulation.
 - c. Vimasco Corporation.
 - d. **<Insert manufacturer's name>**.
 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, **0.013 perm (0.009 metric perm)** at **43-mil (1.09-mm)** dry film thickness.
 3. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**.
 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 - e. **<Insert manufacturer's name>**.
 2. Water-Vapor Permeance: ASTM F 1249, **0.05 perm (0.03 metric perm)** at **35-mil (0.9-mm)** dry film thickness.
 3. Service Temperature Range: **0 to 180 deg F (Minus 18 to plus 82 deg C)**.
 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. **<Insert manufacturer's name>**.
 2. Water-Vapor Permeance: ASTM F 1249, **0.05 perm (0.033 metric perm)** at **30-mil (0.8-mm)** dry film thickness.
 3. Service Temperature Range: **Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C)**.
 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 5. Color: White.

- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Knauf Insulation.
 - e. Mon-Eco Industries, Inc.
 - f. Vimasco Corporation.
 - g. **<Insert manufacturer's name>**.
 2. Water-Vapor Permeance: ASTM F 1249, **1.8 perms (1.2 metric perms)** at **0.0625-inch (1.6-mm)** dry film thickness.
 3. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**.
 4. Solids Content: 60 percent by volume and 66 percent by weight.
 5. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Vimasco Corporation.
 - d. **<Insert manufacturer's name>**.
 2. Adhesives shall have a VOC content of [**50**] **<Insert value>** g/L or less.
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 4. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 5. Service Temperature Range: **0 to plus 180 deg F (Minus 18 to plus 82 deg C)**.
 6. Color: White.

2.6 SEALANTS

- A. Cellular-Glass, Phenolic, and Polyisocyanurate Joint Sealants:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. Childers Brand; H. B. Fuller Construction Products.
- b. Eagle Bridges - Marathon Industries.
- c. Foster Brand; H. B. Fuller Construction Products.
- d. Mon-Eco Industries, Inc.
- e. Pittsburgh Corning Corporation.
- f. **<Insert manufacturer's name>**.

B. Polystyrene Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: **Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C)**.
4. Color: White or gray.
5. Sealant shall have a VOC content of 420 g/L or less.
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 - e. **<Insert manufacturer's name>**.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
5. Color: Aluminum.
6. Sealant shall have a VOC content of 420 g/L or less.
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. **<Insert manufacturer's name>**.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.

5. Color: White.
6. Sealant shall have a VOC content of 420 g/L or less.
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - a. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1) ITW Insulation Systems; Illinois Tool Works, Inc.
 - 2) <Insert manufacturer's name>.
6. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm (0.007 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - a. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1) ITW Insulation Systems; Illinois Tool Works, Inc.
 - 2) <Insert manufacturer's name>.
7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - a. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1) ITW Insulation Systems; Illinois Tool Works, Inc.
 - 2) <Insert manufacturer's name>.

8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perms) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. <Insert manufacturer's name>.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for pipe.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
 - b. Vimasco Corporation.
 - c. <Insert manufacturer's name>.

2.9 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Alpha Associates, Inc.
 - b. <Insert manufacturer's name>.

2.10 FIELD-APPLIED JACKETS

- A. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.

- c. Proto Corporation.
 - d. Speedline Corporation.
 - e. **<Insert manufacturer's name>**.
2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: **[White] [Color-code jackets based on system. Color as selected by Architect]**.
 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. ITW Insulation Systems; Illinois Tool Works, Inc.
 - c. RPR Products, Inc.
 - d. **<Insert manufacturer's name>**.
2. Aluminum Jacket: Comply with **ASTM B 209 (ASTM B 209M)**, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. **[Sheet and roll stock ready for shop or field sizing] [Factory cut and rolled to size]**.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: **[1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper] [3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper] [2.5-mil- (0.063-mm-) thick polysurlyn]**.
 - d. Moisture Barrier for Outdoor Applications: **[3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper] [2.5-mil- (0.063-mm-) thick polysurlyn]**.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
 - a. **[Sheet and roll stock ready for shop or field sizing] [Factory cut and rolled to size]**.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.

- c. Moisture Barrier for Indoor Applications: [~~1-mil- (0.025-mm-)~~ **thick, heat-bonded polyethylene and kraft paper**] [~~3-mil- (0.075-mm-)~~ **thick, heat-bonded polyethylene and kraft paper**] [~~2.5-mil- (0.063-mm-)~~ **thick polysurlyn**].
 - d. Moisture Barrier for Outdoor Applications: [~~3-mil- (0.075-mm-)~~ **thick, heat-bonded polyethylene and kraft paper**] [~~2.5-mil- (0.063-mm-)~~ **thick polysurlyn**].
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- D. Underground Direct-Buried Jacket: ~~125-mil- (3.2-mm-)~~ **thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.**
- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Pittsburgh Corning Corporation.
 - b. Polyguard Products, Inc.
 - c. **<Insert manufacturer's name>**.
- E. Self-Adhesive Outdoor Cladding/Jacketing: ~~60-mil- (1.5-mm-)~~ **thick, laminated vapor barrier with a waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a layered cross-laminated polyethylene film covered with [white] [silver] aluminum-foil facing and backed with a cold weather acrylic adhesive.**
- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc.; an American Biltrite company; Ideal Seal 777 [**Smooth Aluminum**] [**Embossed Aluminum**] [**Smooth White**] [**or**] [**White Embossed**] or comparable product by one of the following:
 - a. Polyguard Products, Inc.
 - b. **<Insert manufacturer's name>**.
 - 2. Thickness: [~~7.5 mils (0.19 mm)~~] [~~10 mils (0.25 mm)~~] [~~12 mils (0.30 mm)~~].
 - 3. Adhesion: Cold Seal acrylic adhesive, ~~80 ounces force/inch (2,234 g/25 mm)~~.
- F. PVDC Jacket for Indoor Applications: ~~4-mil- (0.10-mm-)~~ **thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.**

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. <Insert manufacturer's name>.

- G. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. <Insert manufacturer's name>.

- H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. <Insert manufacturer's name>.

2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc.; an American Biltrite company; 728 Cold Seal ASJ or a comparable product by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Venture Tape.
 - c. <Insert manufacturer's name>.
 2. Width: 3 inches (75 mm).
 3. Thickness: 9 mils (0.23 mm).
 4. Adhesion: 70 ounces force/inch (1,955 g/25 mm) in width.
 5. Elongation: 3 percent.
 6. Tensile Strength: 45 lbf/inch (197 N/25 mm) in width.
 7. ASJ Tape Disks: Precut disks of ASJ tape.

- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with rubber or acrylic adhesive; complying with ASTM C 1136.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc.; an American Biltrite company; **[491 FSK]** **[or]** **[791 Cold Seal Acrylic FSK]** or a comparable product by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Shurtape Technologies.
 - c. Venture Tape.
 - d. **<Insert manufacturer's name>**.
2. Width: **3 inches (75 mm)**.
3. Thickness: **6 mils (0.15 mm)**.
4. Adhesion (Rubber Adhesive): **100 ounces force/inch (2,793 g/25 mm)** in width.
5. Adhesion (Acrylic Adhesive): **90 ounces force/inch (2,514 g/25 mm)** in width.
6. Elongation: 3 percent.
7. Tensile Strength: **35 lbf/inch (153 N/mm)** in width.
8. FSK Tape Disks: Precut disks of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc.; an American Biltrite company; 370 White PVC Tape or a comparable product by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Venture Tape.
 - c. **<Insert manufacturer's name>**.
2. Width: **2 inches (50 mm)**.
3. Thickness: **5 mils (0.13 mm)**.
4. Adhesion: **20 ounces force/inch (559 g/25 mm)** in width.
5. Elongation: 500 percent.
6. Tensile Strength: **15 lbf/inch (66 N/25 mm)** in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with rubber or acrylic adhesive.

Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc.; an American Biltrite company; **[488 AWF rubber adhesive]** **[788 Cold Seal acrylic adhesive]** or a comparable product by one of the following:

- a. Avery Dennison Corporation, Specialty Tapes Division.
- b. Venture Tape.
- c. **<Insert manufacturer's name>**.
2. Width: **3 inches (72 mm)** nominal.
3. Thickness: **[3.0 mils (0.08 mm)] [4.0 mils (0.1 mm)]**.
4. Adhesion: Rubber adhesive; **90 ounces force/inch (2,514 g/25 mm)** in width.
5. Adhesion: Cold Seal acrylic adhesive; **50 ounces force/inch (1,396 g/25 mm)** in width.
6. Elongation: 3 percent.
7. Tensile Strength: **[14 lbf/inch (61 g/25 mm)] [20 lbf/inch (88 g/25 mm)]** in width.

- E. UL 181 Aluminum-Foil Tape: Vapor-retarder tape with acrylic or heat activated adhesive.

Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc.; an American Biltrite company; [**acrylic adhesive Ideal Seal 2000**] [**acrylic adhesive Ideal Seal 587 A/B**] [**or**] [**heat activated adhesive Ideal Seal 490**] or comparable product by one of the following:

- a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Berry Plastics.
 - c. Shurtape Technologies.
 - d. <**Insert manufacturer's name**>.
2. Width: [**2.5 inches (63.5 mm)**] [**3 inches (76.2 mm)**].
 3. Thickness: [**4.3 mils (0.11 mm)**] [**4.6 mils (0.12 mm)**] [**7.0 mils (0.18 mm)**].
 4. Adhesion: [**60 ounces force/inch (1,676 g/25 mm)**] [**72 ounces force/inch (2,011 g/25 mm)**].
 5. Tensile Strength: **25 lbs/inch (109 N/25 mm)**.

- F. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. <**Insert manufacturer's name**>.
2. Width: **3 inches (75 mm)**.
3. Film Thickness: **4 mils (0.10 mm)**.
4. Adhesive Thickness: **1.5 mils (0.04 mm)**.
5. Elongation at Break: 145 percent.
6. Tensile Strength: **55 lbf/inch (10.1 N/mm)** in width.

- G. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. <**Insert manufacturer's name**>.
2. Width: **3 inches (75 mm)**.
3. Film Thickness: **6 mils (0.15 mm)**.
4. Adhesive Thickness: **1.5 mils (0.04 mm)**.
5. Elongation at Break: 145 percent.
6. Tensile Strength: **55 lbf/inch (10.1 N/mm)** in width.

2.12 SECUREMENTS

- A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. RPR Products, Inc.
 - c. **<Insert manufacturer's name>**.
 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, [**Type 304**] [**or**] [**Type 316**]; **0.015 inch (0.38 mm)** thick, [**1/2 inch (13 mm)**] [**3/4 inch (19 mm)**] wide with [**wing seal**] [**or**] [**closed seal**].
 3. Aluminum: **ASTM B 209 (ASTM B 209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14, **0.020 inch (0.51 mm)** thick, [**1/2 inch (13 mm)**] [**3/4 inch (19 mm)**] wide with [**wing seal**] [**or**] [**closed seal**].
 4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Staples: Outward-clinching insulation staples, nominal **3/4-inch- (19-mm-)** wide, stainless steel or Monel.
- C. Wire: [**0.080-inch (2.0-mm) nickel-copper alloy**] [**0.062-inch (1.6-mm) soft-annealed, stainless steel**] [**0.062-inch (1.6-mm) soft-annealed, galvanized steel**].
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. C & F Wire.
 - b. **<Insert manufacturer's name>**.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer **5 mils (0.127 mm)** thick and an epoxy finish **5 mils (0.127 mm)** thick if operating in a temperature range between **140 and 300 deg F (60 and 149 deg C)**. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 2. Carbon Steel: Coat carbon steel operating at a service temperature between **32 and 300 deg F (0 and 149 deg C)** with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with **3-inch- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
 3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [**2 inches (50 mm)**] [**4 inches (100 mm)**] o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least **4 inches (100 mm)** beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches (50 mm)** below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least **2 inches (50 mm)**.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. 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.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. 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. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. 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.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least **2 inches (50 mm)** over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at **12-inch (300-mm)** intervals and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least **3 inches (75 mm)**. Secure inner layer with wire spaced at **12-inch (300-mm)** intervals. Secure outer layer with stainless-steel bands at **12-inch (300-mm)** intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least **1 inch (25 mm)**. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.7 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at **12-inch (300-mm)** intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least **3 inches (75 mm)**. Secure inner layer with **0.062-inch (1.6-mm)** wire spaced at **12-inch (300-mm)** intervals. Secure outer layer with stainless-steel bands at **12-inch (300-mm)** intervals.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.11 INSTALLATION OF POLYISOCYANURATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed **1-1/2-inch (38-mm)** thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.

C. Insulation Installation on Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of polyisocyanurate insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.12 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.13 INSTALLATION OF POLYSTYRENE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, and make thickness same as adjacent pipe insulation, not to exceed **1-1/2-inch (38-mm)**.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed section of polystyrene insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.14 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with **1-1/2-inch (38-mm)** laps at longitudinal seams and **3-inch- (75-mm-)** wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with **1-inch (25-mm)** overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with **2-inch (50-mm)** overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands **12 inches (300 mm)** o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.

2. Wrap factory-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of **2 inches (50 mm)** over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of **33-1/2 inches (850 mm)** or less. The **33-1/2-inch- (850-mm-)** circumference limit allows for **2-inch- (50-mm-)** overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.15 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 1. Flat Acrylic Finish: [**Two**] <**Insert number**> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.16 FIELD QUALITY CONTROL

- A. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of

inspection shall be limited to **[three]** <Insert number> locations of straight pipe, **[three]** <Insert number> locations of threaded fittings, **[three]** <Insert number> locations of welded fittings, **[two]** <Insert number> locations of threaded strainers, **[two]** <Insert number> locations of welded strainers, **[three]** <Insert number> locations of threaded valves, and **[three]** <Insert number> locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.17 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
 2. Underground piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.18 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below **60 Deg F (16 Deg C)**:
1. All Pipe Sizes: Insulation shall be **[one of]** the following:
 - a. Cellular Glass: **[1-1/2 inches (38 mm)]** <Insert dimension> thick.
 - b. Flexible Elastomeric: **[3/4 inch (19 mm)] [1 inch (25 mm)]** <Insert dimension> thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: **[1/2 inch (13 mm)] [1 inch (25 mm)]** <Insert dimension> thick.
 - d. Phenolic: **[1 inch (25 mm)]** <Insert dimension> thick.
 - e. Polyisocyanurate: **[1 inch (25 mm)]** <Insert dimension> thick.
 - f. Polyolefin: **[3/4 inch (19 mm)] [1 inch (25 mm)]** <Insert dimension> thick.
- B. Chilled Water and Brine, **40 Deg F (5 Deg C)** and below:
1. **[NPS 3 (DN 80)]** <Insert pipe size> and Smaller: Insulation shall be **[one of]** the following:
 - a. Cellular Glass: **[1-1/2 inches (38 mm)] [2 inches (50 mm)]** <Insert dimension> thick.
 - b. Mineral-Fiber, **[Preformed Pipe, Type I] [or] [Pipe Insulation Wicking System]**: **[1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)]** <Insert dimension> thick.
 - c. Phenolic: **[1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)]** <Insert dimension> thick.

- d. Polyisocyanurate: [1 inch (25 mm)] <Insert dimension> thick.
2. [NPS 4 (DN 100) to NPS 12 (DN 300)] <Insert pipe size range>: Insulation shall be [one of] the following:
 - a. Cellular Glass: [1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - b. Mineral-Fiber, [Preformed Pipe, Type I] [or] [Pipe Insulation Wicking System]: [1-1/2 inches (38 mm)] [2 inches (50 mm)] <Insert dimension> thick.
 - c. Phenolic: [1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - d. Polyisocyanurate: [1 inch (25 mm)] <Insert dimension> thick.
 3. [NPS 14 (DN 350)] <Insert pipe size> and Larger: Insulation shall be [one of] the following:
 - a. Cellular Glass: [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - b. Mineral-Fiber, [Preformed Pipe, Type I,] [Pipe and Tank Insulation,] [or] [Pipe Insulation Wicking System]: [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - c. Phenolic: [1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
- C. Chilled Water and Brine, above 40 Deg F (5 Deg C):
1. [NPS 12 (DN 300)] <Insert pipe size> and Smaller: Insulation shall be [one of] the following:
 - a. Cellular Glass: [1-1/2 inches (38 mm)] [2 inches (50 mm)] <Insert dimension> thick.
 - b. Flexible Elastomeric: [1 inch (25 mm)] <Insert dimension> thick.
 - c. Mineral-Fiber, [Preformed Pipe, Type I] [or] [Pipe Insulation Wicking System]: [1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)] <Insert dimension> thick.
 - d. Phenolic: [1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - e. Polyisocyanurate: [1 inch (25 mm)] <Insert dimension> thick.
 - f. Polyolefin: [1 inch (25 mm)] <Insert dimension> thick.
 2. [NPS 14 (DN 350)] <Insert pipe size> and Larger: Insulation shall be [one of] the following:
 - a. Cellular Glass: [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - b. Mineral-Fiber [Preformed Pipe, Type I,] [Pipe and Tank Insulation,] [or] [Pipe Insulation Wicking System]: [1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - c. Phenolic: [1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
- D. Condenser-Water Supply and Return:

1. **[NPS 12 (DN 300)]** <Insert pipe size> and Smaller: Insulation shall be[**one of**] the following:
 - a. Cellular Glass: **[1-1/2 inches (38 mm)] [2 inches (50 mm)]** <Insert dimension> thick.
 - b. Flexible Elastomeric: **[1 inch (25 mm)]** <Insert dimension> thick.
 - c. Mineral-Fiber, Preformed Pipe, Type I: **[1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)]** <Insert dimension> thick.
 - d. Phenolic: **[1 inch (25 mm)] [1-1/2 inches (38 mm)]** <Insert dimension> thick.
 - e. Polyisocyanurate: **[1 inch (25 mm)]** <Insert dimension> thick.
 - f. Polyolefin: **[1 inch (25 mm)]** <Insert dimension> thick.

2. **[NPS 14 (DN 350)]** <Insert pipe size> and Larger: Insulation shall be[**one of**] the following:
 - a. Cellular Glass: **[2 inches (50 mm)] [3 inches (75 mm)]** <Insert dimension> thick.
 - b. Mineral-Fiber, **[Preformed Pipe, Type I] [or] [Pipe and Tank Insulation]: [1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)]** <Insert dimension> thick.
 - c. Phenolic: **[1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)]** <Insert dimension> thick.

- E. Heating-Hot-Water Supply and Return, **200 Deg F (93 Deg C)** and Below:
 1. **[NPS 12 (DN 300)]** <Insert pipe size> and Smaller: Insulation shall be[**one of**] the following:
 - a. Cellular Glass: **[1-1/2 inches (38 mm)] [2 inches (50 mm)]** <Insert dimension> thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I: **[1 inch (25 mm)] [2 inches (50 mm)]** <Insert dimension> thick.
 - c. Phenolic: **[1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)]** <Insert dimension> thick.
 - d. Polyisocyanurate: **[1 inch (25 mm)]** <Insert dimension> thick.

 2. **[NPS 14 (DN 350)]** <Insert pipe size> and Larger: Insulation shall be[**one of**] the following:
 - a. Cellular Glass: **[2 inches (50 mm)] [3 inches (75 mm)]** <Insert dimension> thick.
 - b. Mineral-Fiber, **[Preformed Pipe, Type I] [or] [Pipe and Tank Insulation]: [1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)]** <Insert dimension> thick.
 - c. Phenolic: **[1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)]** <Insert dimension> thick.

- F. Heating-Hot-Water Supply and Return, above **200 Deg F (93 Deg C)**:
 1. **[NPS 3/4 (DN 20)]** <Insert pipe size> and Smaller: Insulation shall be[**one of**] the following:

- a. Calcium Silicate: [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - b. Cellular Glass: [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - c. Mineral-Fiber, Preformed Pipe, Type I or II: [1-1/2 inches (38 mm)] [2 inches (50 mm)] <Insert dimension> thick.
2. [NPS 1 (DN 25)] <Insert pipe size> and Larger: Insulation shall be[one of] the following:
 - a. Calcium Silicate: [3 inches (75 mm)] [4 inches (100 mm)] <Insert dimension> thick.
 - b. Cellular Glass: [3 inches (75 mm)] [4 inches (100 mm)] <Insert dimension> thick.
 - c. Mineral-Fiber, Preformed Pipe, Type I or II: [3 inches (75 mm)] [4 inches (100 mm)] <Insert dimension> thick.
- G. Steam and Steam Condensate, 350 Deg F (177 Deg C) and Below:
1. [NPS 3/4 (DN 20)] <Insert pipe size> and Smaller: Insulation shall be[one of] the following:
 - a. Calcium Silicate: [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - b. Cellular Glass: [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - c. Mineral-Fiber, Preformed Pipe, Type I or II: [1-1/2 inches (38 mm)] [2 inches (50 mm)] <Insert dimension> thick.
 2. [NPS 1 (DN 25)] <Insert pipe size> and Larger: Insulation shall be[one of] the following:
 - a. Calcium Silicate: [3 inches (75 mm)] [4 inches (100 mm)] <Insert dimension> thick.
 - b. Cellular Glass: [3 inches (75 mm)] [4 inches (100 mm)] <Insert dimension> thick.
 - c. Mineral-Fiber, [Preformed Pipe, Type I or II] [or] [Pipe and Tank Insulation]: [3 inches (75 mm)] [4 inches (100 mm)] <Insert dimension> thick.
- H. Steam and Steam Condensate, above 350 Deg F (177 Deg C):
1. [NPS 3/4 (DN 20)] <Insert pipe size> and Smaller: Insulation shall be[one of] the following:
 - a. Calcium Silicate: [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - b. Cellular Glass: [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - c. Mineral-Fiber, Preformed Pipe, Type I or II: [1-1/2 inches (38 mm)] [2 inches (50 mm)] <Insert dimension> thick.
 2. [NPS 1 (DN 25)] <Insert pipe size> and Larger: Insulation shall be[one of] the following:

- a. Calcium Silicate: [3 inches (75 mm)] [4 inches (100 mm)] <Insert dimension> thick.
 - b. Cellular Glass: [3 inches (75 mm)] [4 inches (100 mm)] <Insert dimension> thick.
 - c. Mineral-Fiber, [Preformed Pipe, Type I or II] [or] [Pipe and Tank Insulation]: [3 inches (75 mm)] [4 inches (100 mm)] <Insert dimension> thick.
- I. Refrigerant Suction and Hot-Gas Piping:
1. All Pipe Sizes: Insulation shall be[one of] the following:
 - a. Cellular Glass: [1-1/2 inches (38 mm)] <Insert dimension> thick.
 - b. Flexible Elastomeric: [1 inch (25 mm)] <Insert dimension> thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: [1 inch (25 mm)] <Insert dimension> thick.
 - d. Phenolic: [1 inch (25 mm)] <Insert dimension> thick.
 - e. Polyisocyanurate: [1 inch (25 mm)] <Insert dimension> thick.
 - f. Polyolefin: [1 inch (25 mm)] <Insert dimension> thick.
- J. Refrigerant Suction and Hot-Gas Flexible Tubing:
1. All Pipe Sizes: Insulation shall be[one of] the following:
 - a. Flexible Elastomeric: [1 inch (25 mm)] <Insert dimension> thick.
 - b. Polyolefin: [1 inch (25 mm)] <Insert dimension> thick.
- K. Dual-Service Heating and Cooling, 40 to 200 Deg F (5 to 93 Deg C):
1. [NPS 12 (DN 300)] <Insert pipe size> and Smaller: Insulation shall be[one of] the following:
 - a. Cellular Glass: [1-1/2 inches (38 mm)] [2 inches (50 mm)] <Insert dimension> thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I: [1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)] <Insert dimension> thick.
 - c. Phenolic: [1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - d. Polyisocyanurate: [1 inch (25 mm)] <Insert dimension> thick.
 2. [NPS 14 (DN 350)] <Insert pipe size> and Larger: Insulation shall be[one of] the following:
 - a. Cellular Glass: [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - b. Mineral-Fiber, [Preformed Pipe, Type I] [or] [Pipe and Tank Insulation]: [1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
 - c. Phenolic: [1-1/2 inches (38 mm)] [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> thick.
- L. Heat-Recovery Piping:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:
 - a. Cellular Glass: [**1-1/2 inches (38 mm)**] <Insert dimension> thick.
 - b. Flexible Elastomeric: [**1 inch (25 mm)**] <Insert dimension> thick.
 - c. Mineral-Fiber, [**Preformed Pipe Insulation, Type I**] [or] [**Pipe and Tank Insulation**]: [**1 inch (25 mm)**] <Insert dimension> thick.
 - d. Phenolic: [**1 inch (25 mm)**] <Insert dimension> thick.
 - e. Polyisocyanurate: [**1 inch (25 mm)**] <Insert dimension> thick.
 - f. Polyolefin: [**1 inch (25 mm)**] <Insert dimension> thick.

3.19 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water and Brine:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:
 - a. Cellular Glass: [**3 inches (75 mm)**] <Insert dimension> thick.
 - b. Flexible Elastomeric: [**3 inches (75 mm)**] <Insert dimension> thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: [**3 inches (75 mm)**] <Insert dimension> thick.
 - d. Phenolic: [**2 inches (50 mm)**] <Insert dimension> thick.
 - e. Polyisocyanurate: [**2 inches (50 mm)**] <Insert dimension> thick.
 - f. Polyolefin: [**3 inches (75 mm)**] <Insert dimension> thick.
 - g. Polystyrene: [**2 inches (50 mm)**] <Insert dimension> thick.

B. Condenser-Water Supply and Return:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:
 - a. Cellular Glass: [**2 inches (50 mm)**] <Insert dimension> thick.
 - b. Flexible Elastomeric: [**2 inches (50 mm)**] <Insert dimension> thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches (50 mm)**] <Insert dimension> thick.
 - d. Phenolic: [**2 inches (50 mm)**] <Insert dimension> thick.
 - e. Polyisocyanurate: [**2 inches (50 mm)**] <Insert dimension> thick.
 - f. Polyolefin: [**2 inches (50 mm)**] <Insert dimension> thick.
 - g. Polystyrene: [**2 inches (50 mm)**] <Insert dimension> thick.

C. Heating-Hot-Water Supply and Return, **200 Deg F (93 Deg C)** and Below:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:
 - a. Cellular Glass: [**3 inches (75 mm)**] <Insert dimension> thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches (50 mm)**] <Insert dimension> thick.
 - c. Phenolic: [**2 inches (50 mm)**] <Insert dimension> thick.
 - d. Polyisocyanurate: [**2 inches (50 mm)**] <Insert dimension> thick.

D. Heating-Hot-Water Supply and Return, above **200 Deg F (93 Deg C)**:

1. All Pipe Sizes: Insulation shall be [**one of**] the following:
 - a. Calcium Silicate: [**3 inches (75 mm)**] <Insert dimension> thick.
 - b. Cellular Glass: [**3 inches (75 mm)**] <Insert dimension> thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: [**2 inches (50 mm)**] <Insert dimension> thick.

- E. Steam and Steam Condensate, **350 Deg F (177 Deg C)** and Below:
 1. All Pipe Sizes: Insulation shall be [**one of**] the following:
 - a. Calcium Silicate: [**4 inches (100 mm)**] <Insert dimension> thick.
 - b. Cellular Glass: [**4 inches (100 mm)**] <Insert dimension> thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: [**3 inches (75 mm)**] <Insert dimension> thick.

- F. Steam and Steam Condensate, above **350 Deg F (177 Deg C)**:
 1. All Pipe Sizes: Insulation shall be [**one of**] the following:
 - a. Calcium Silicate: [**5 inches (125 mm)**] <Insert dimension> thick.
 - b. Cellular Glass: [**5 inches (125 mm)**] <Insert dimension> thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: [**4 inches (100 mm)**] <Insert dimension> thick.

- G. Refrigerant Suction and Hot-Gas Piping:
 1. All Pipe Sizes: Insulation shall be [**one of**] the following:
 - a. Cellular Glass: [**2 inches (50 mm)**] <Insert dimension> thick.
 - b. Flexible Elastomeric: [**2 inches (50 mm)**] <Insert dimension> thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches (50 mm)**] <Insert dimension> thick.
 - d. Phenolic: [**2 inches (50 mm)**] <Insert dimension> thick.
 - e. Polyisocyanurate: [**2 inches (50 mm)**] <Insert dimension> thick.
 - f. Polyolefin: [**2 inches (50 mm)**] <Insert dimension> thick.
 - g. Polystyrene: [**2 inches (50 mm)**] <Insert dimension> thick.

- H. Refrigerant Suction and Hot-Gas Flexible Tubing:
 1. All Pipe Sizes: Insulation shall be [**one of**] the following:
 - a. Flexible Elastomeric: [**2 inches (50 mm)**] <Insert dimension> thick.
 - b. Polyolefin: [**2 inches (50 mm)**] <Insert dimension> thick.

- I. Heat-Recovery Piping:
 1. All Pipe Sizes: Insulation shall be [**one of**] the following:
 - a. Cellular Glass: [**2 inches (50 mm)**] <Insert dimension> thick.
 - b. Flexible Elastomeric: [**2 inches (50 mm)**] <Insert dimension> thick.

- c. Mineral-Fiber, Preformed Pipe Insulation, Type I: [2 inches (50 mm)] <Insert dimension> thick.
 - d. Phenolic: [2 inches (50 mm)] <Insert dimension> thick.
 - e. Polyisocyanurate: [2 inches (50 mm)] <Insert dimension> thick.
 - f. Polyolefin: [2 inches (50 mm)] <Insert dimension> thick.
 - g. Polystyrene: [2 inches (50 mm)] <Insert dimension> thick.
- J. Dual-Service Heating and Cooling:
- 1. All Pipe Sizes: Insulation shall be [one of] the following:
 - a. Cellular Glass: [3 inches (75 mm)] <Insert dimension> thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: [2 inches (50 mm)] <Insert dimension> thick.
 - c. Phenolic: [2 inches (50 mm)] <Insert dimension> thick.
 - d. Polyisocyanurate: [2 inches (50 mm)] <Insert dimension> thick.
- K. Fuel Oil Piping, Heated:
- 1. All Pipe Sizes: Insulation shall be [one of] the following:
 - a. Cellular Glass: [2 inches (50 mm)] <Insert dimension> thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: [2 inches (50 mm)] <Insert dimension> thick.

3.20 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

- A. Loose-fill insulation, for belowground piping, is specified in Section 232113.13 "Underground Hydronic Piping" and Section 336313 "Underground Steam and Condensate Distribution Piping."
- B. Chilled Water, All Sizes: Cellular glass, [2 inches (50 mm)] <Insert dimension> thick.
- C. Condenser-Water Supply and Return, All Sizes: Cellular glass, [2 inches (50 mm)] <Insert dimension> thick.
- D. Heating-Hot-Water Supply and Return, All Sizes, 200 Deg F (93 Deg C) and Below: Cellular glass, [3 inches (75 mm)] <Insert dimension> thick.
- E. Heating-Hot-Water Supply and Return, All Sizes, above 200 Deg F (93 Deg C):
 - 1. Calcium Silicate: [3 inches (75 mm)] <Insert dimension> thick.
 - 2. Cellular Glass: [3 inches (75 mm)] <Insert dimension> thick.
- F. Steam and Steam Condensate, All Sizes, 350 Deg F (177 Deg C) and Below:
 - 1. Calcium Silicate: [4 inches (100 mm)] <Insert dimension> thick.
 - 2. Cellular Glass: [4 inches (100 mm)] <Insert dimension> thick.
- G. Steam and Steam Condensate, All Sizes, above 350 Deg F (177 Deg C):

1. Calcium Silicate: [**5 inches (125 mm)**] <Insert dimension> thick.
 2. Cellular Glass: [**5 inches (125 mm)**] <Insert dimension> thick.
- H. Dual-Service Heating and Cooling, All Sizes, **40 to 200 Deg F (4 to 93 Deg C)**: Cellular glass, [**3 inches (75 mm)**] <Insert dimension> thick.
- I. Fuel Oil Piping, All Sizes, Heated: Cellular glass, [**2 inches (50 mm)**] <Insert dimension> thick.

3.21 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
1. None.
 2. [PVC] [PVC, Color-Coded by System]: [**20 mils (0.5 mm)**] [**30 mils (0.8 mm)**] thick.
 3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] [**0.032 inch (0.81 mm)**] [**0.040 inch (1.0 mm)**] thick.
 4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] [**0.032 inch (0.81 mm)**] thick.
 5. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [**0.010 inch (0.25 mm)**] [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] thick.
 6. Self-Adhesive Foil Laminate with acrylic adhesive, [Smooth Aluminum] [Embossed Aluminum] [White Embossed].
 7. <Insert jacket type>.
- D. Piping, Exposed:
1. None.
 2. [PVC] [PVC, Color-Coded by System]: [**20 mils (0.5 mm)**] [**30 mils (0.8 mm)**] thick.
 3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] [**0.032 inch (0.81 mm)**] [**0.040 inch (1.0 mm)**] thick.
 4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] [**0.032 inch (0.81 mm)**] thick.
 5. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [**0.010 inch (0.25 mm)**] [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] thick.
 6. Self-Adhesive Foil Laminate with acrylic adhesive, [Smooth Aluminum] [Embossed Aluminum] [White Embossed].
 7. <Insert jacket type>.

3.22 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
1. None.
 2. [PVC] [PVC, Color-Coded by System]: [20 mils (0.5 mm)] [30 mils (0.8 mm)] thick.
 3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch (0.41 mm)] [0.020 inch (0.51 mm)] [0.024 inch (0.61 mm)] [0.032 inch (0.81 mm)] [0.040 inch (1.0 mm)] thick.
 4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch (0.41 mm)] [0.020 inch (0.51 mm)] [0.024 inch (0.61 mm)] [0.032 inch (0.81 mm)] thick.
 5. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch (0.25 mm)] [0.016 inch (0.41 mm)] [0.020 inch (0.51 mm)] [0.024 inch (0.61 mm)] thick.
 6. Self-Adhesive Foil Laminate with acrylic adhesive, [Smooth Aluminum] [Embossed Aluminum] [White Embossed].
 7. <Insert jacket type>.
- D. Piping, Exposed:
1. PVC: [20 mils (0.5 mm)] [30 mils (0.8 mm)] [40 mils (1.0 mm)] thick.
 2. [Painted] Aluminum, [Smooth] [Corrugated] [Stucco Embossed] [with Z-Shaped Locking Seam]: [0.016 inch (0.41 mm)] [0.020 inch (0.51 mm)] [0.024 inch (0.61 mm)] [0.032 inch (0.81 mm)] [0.040 inch (1.0 mm)] thick.
 3. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed] [with Z-Shaped Locking Seam]: [0.010 inch (0.25 mm)] [0.016 inch (0.41 mm)] [0.020 inch (0.51 mm)] [0.024 inch (0.61 mm)] thick.
 4. Self-Adhesive Foil Laminate with acrylic adhesive, [Smooth Aluminum] [Embossed Aluminum] [White Embossed].
 5. <Insert jacket type>.

3.23 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 230719