

## **SECTION 220700 – INSULATION FOR PLUMBING PIPING AND EQUIPMENT**

Latest Update: 6-26-2019 See Underlined Text

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all “Underlines.”)

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

#### **1.2 SUMMARY**

- A. This section includes the requirements for insulating plumbing piping and equipment for the following:
  - 1. Cellular insulation.
  - 2. Flexible elastomeric insulation.
  - 3. Mineral fiber blanket insulation.
  - 4. Mineral fiber preformed pipe insulation.
  - 5. Insulating cement.
  - 6. Achieves.
  - 7. Mastics.
  - 8. Lagging achieves.
  - 9. Sealants.
  - 10. Factory jackets.
  - 11. Field cloths.
  - 12. Field jackets.
  - 13. Tapes.
  - 14. Securements.
  - 15. Protective shields.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each specified product include:
  - 1. Product Data: Product data for each type of mechanical insulation identifying manufacturer, k-value, thickness, and accessories. Include mastics, adhesives, jacketing, covers, canvas materials, vapor barrier material, etc.
  - 2. Samples: Samples of each type of insulation and jacket. Identify each sample describing product and intended use. Submit the following sizes of sample materials:
    - a. Board and Block Insulation: twelve (12) inches square section.
    - b. Pre-Formed Pipe Insulation: twelve (12) inches long, two (2) inch NPS

B. LEED Submittals: <Delete if not a LEED project>

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

1. 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.
2. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation & Maintenance Manual: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.6 QUALITY ASSURANCE

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

- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of twenty five (25) or less, and smoke-developed index of fifty (50) or less.
2. Insulation Installed Outdoors: Flame-spread index of seventy five (75) or less, and smoke-developed index of one hundred fifty (150) or less.

- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

#### 1.7 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.

#### 1.8 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Plumbing Specification Section "Hangers and Supports for Plumbing 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.

#### 1.9 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.

#### 1.10 WARRANTY/GUARANTEES

- A. See Division 22 Specification Section "Basic Mechanical Requirements – Plumbing" for warranty and guarantee requirements.

### **PART 2 - PRODUCTS**

#### 2.1 GENERAL PRODUCT REQUIREMENTS

- A. Equipment Design and Selection: Insulation and accessories shall be designed and selected, for the intended use, in accordance with the details on the drawings and the requirements of this specification.
- B. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Fiberglass, Fiber Board and Cellular Insulation: Subject to compliance with requirements, provide products by one (1) of the following:
    - a. Owings Corning Inc.
    - b. John Manville
    - c. Knauf Inc.
    - d. Pittsburgh Corning Corporation; Foamglas.
  
  2. Elastomeric Insulation: Subject to compliance with requirements, provide products by one (1) of the following:
    - a. Armstrong.
    - b. Armcell
    - c. Knauf Inc.
  
  3. Adhesives, Mastics, and Sealants: Provide adhesives, mastics and sealant products recommended by the insulation manufacturer or by one (1) of the following:
    - a. Foster Brand.
    - b. Fueller Company.
    - c. Eagle Bridge.
- 2.2 INSULATION MATERIALS <Delete types of insulation not required for particular project.>
- A. Comply with requirements in "Piping and Equipment Insulation Schedule.
  - 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.
- 2.3 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.
- <Most projects do not require cellular glass. Delete when not applicable. >

<The following materials are for use with surface temperatures from minus 450°F to 800°F. >

A. Products: Subject to compliance with requirements, available product that may be incorporated into the Work include, but are not limited to, the following:

1. Pittsburgh Corning Corporation; Foamglas.

B. Block Insulation: ASTM C 552, Type I.

1. Special-Shaped Insulation: ASTM C 552, Type III.

2. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.

3. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.

4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

#### 2.4 FLEXIBLE ELASTOMERIC INSULATION

A. Closed-cell, with smooth skin on both sides. Comply with ASTM C 534, TYPE I for tubular materials.

<Do not specify materials at greater than 3/4 thickness, since smoke development rating exceeds 50. >

<The following materials are for use with surface temperatures from minus 40°F to 200°F. >

#### 2.5 MINERAL-FIBER BLANKET INSULATION

A. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, TYPE II and ASTM C 1290, TYPE I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

#### 2.6 MINERAL-FIBER, PREFORMED PIPE INSULATION <MINERAL FIBER IS FOR TEMPERATURES FROM 100°F TO 1,600°F. >

A. Type I, 850°F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

#### 2.7 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

- a. Ramco Insulation, Inc.; Super-Stik.
  2. Thermal Conductivity: 1.2 average maximum at 400°F mean temperature.
  3. Compressive Strength: 100 psi at 5% deformation.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.
- C. ADHESIVES Thermal Conductivity: 1.0 average maximum at 500°F mean temperature.
1. Compressive Strength: 10 psi at 5% deformation.

## 2.8 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. Cellular-Glass Adhesive: Two (2) component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of -100°F to +200°F.
1. Products: Subject to compliance with requirements, provide one (1) of the following:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
  2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.9 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: -20°F to +180°F.
3. Solids Content: ASTM D 1644, 58% by volume and 70% by weight.
4. Color: Aluminum.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
2. Service Temperature Range: 0°F to 180°F.
3. Solids Content: ASTM D 1644, 44% by volume and 62% by weight.
4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services..

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
2. Service Temperature Range: -50°F to +220°F.
3. Solids Content: ASTM D 1644, 33% by volume and 46% by weight.
4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.

2. Service Temperature Range: -20°F to +180°F.
3. Solids Content: 60% by volume and 66% by weight.
4. Color: White.

## 2.10 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
  3. Service Temperature Range: 0°F to 180°F.
  4. Color: White.

## 2.11 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: -100°F to +300°F.
4. Color: White or gray.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: -40°F to +250°F.
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.12 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.



## 2.13 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.

## 2.14 FIELD-APPLIED JACKETS <Delete types of jackets not used for particular project>

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- 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. Adhesive: As recommended by jacket material manufacturer.
  - 2. Color: White.
  - 3. 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.

## 2.15 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  - 1. Width: Four (4) inch.
  - 2. Thickness: 11.5 mils.
  - 3. Adhesion: 90 ounces force/inch in width.
  - 4. Elongation: 2%.
  - 5. Tensile Strength: 40 lbf/inch in width.
  - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
  - 1. Width: Two (2) inches.
  - 2. Thickness: 6 mils.
  - 3. Adhesion: 64 ounces force/inch in width.
  - 4. Elongation: 500%.
  - 5. Tensile Strength: 18 lbf/inch in width.

## 2.16 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 0.015 inch thick, one half (1/2) inch wide
2. Aluminum: ASTM B 209 (ASTM B 209M with wing seal.), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, one half (1/2) inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal three quarters (3/4) inch wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy or 0.062-inch 1.6 soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. C & F Wire.

## 2.17 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers,:

1. Description: Manufactured plastic wraps for covering plumbing hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

## 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.

B. 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 five (5) mils thick and an epoxy finish five (5) mils thick if operating in a temperature range between 140°F and 300°F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  2. Carbon Steel: Coat carbon steel operating at a service temperature between 32°F and 300°F 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 applies 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 three (3) inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced four (4) inches on center.
  3. Overlap jacket longitudinal seams at least one and one half (1-1/2) inches. 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 two (2) inches on center.
    - 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% 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 four (4) inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment. <Edit listing below to suit project requirements. >
1. Fibrous glass ducts.

2. Factory-insulated flexible ducts.
3. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
4. Flexible connectors for ducts and pipes.
5. Vibration control devices.
6. Testing laboratory labels and stamps.
7. Nameplates and data plates.
8. Insulated access panels and doors in air distribution systems.
9. Fire protection piping systems.
10. Sanitary drainage and vent piping.
11. Drainage piping located in crawl spaces, unless indicated otherwise.
12. Chrome-plated pipes and fittings, except for plumbing fixtures for the disabled.
13. Piping specialties including air chambers, unions, strainers, check valves, plug valves, and flow regulators.
14. Metal ducts with duct liner. <Delete if exterior insulation. >

### 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 two (2) inches below top of roof flashing.
  4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: <Specify factory fabricate below grade systems in other Sections if insulation is required.>
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations. <Coordinate the requirements for the following 3 paragraphs with the architectural specification section for "Joint Sealants." >
- 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 Architectural Specification Section "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 Architectural Specification Section "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 (2) 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 (2) 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 (2) 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 (2) 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 (2) 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 two (2) inches 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 (2) 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 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 six (6) inches on center.
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 (2) 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 one (1) inch, 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.

### 3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturers 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 manufacturers 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.

### 3.8 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 six (6) inches on center.
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 one (1) inch, 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.

### 3.9 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 two (2) inch overlap at seams and joints.
  2. Embed glass cloth between two 0.062 inch thick coats of lagging adhesive.
  3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where PVC jackets are indicated, install with one (1)-inch overlap at longitudinal seams and end joints. Seal with manufacturers 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.

### 3.10 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Architectural Specification Sections "Exterior Painting" and "Interior Painting."

1. Flat Acrylic Finish: Two (2) 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 (2) 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.
- 3.11 FIELD QUALITY CONTROL <Edit for particular project.>
- A. Testing Agency: Owner will 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 locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three 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.
- 3.12 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION
- A. Mineral-Fiber, Pipe, and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
    1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50% coverage of tank and vessel surfaces.
    2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
    3. Protect exposed corners with secured corner angles.

4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
    - a. Do not weld anchor pins to ASME-labeled pressure vessels.
    - b. Select insulation hangers and adhesives that are compatible with service temperature and with substrate.
    - c. On tanks and vessels, maximum anchor-pin spacing is three (3) inches from insulation end joints, and sixteen (16) inches on center in both directions.
    - d. Do not over compress insulation during installation.
    - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    - f. Impale insulation over anchor pins and attach speed washers.
    - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
  6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately six (6) inches from each end. Install wire or cable between two circumferential girdles twelve (12) inches on center. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of forty eight (48) inches on center. Use this network for securing insulation with tie wire or bands.
  7. Stagger joints between insulation layers at least three (3) inches.
  8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
  9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
  10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 50% coverage of adhesive to surface with manufacturer's recommended adhesive.
  2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on six (6) inch centers, starting at corners. Install 3/8-inch diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.040 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.13 INSULATION SCHEDULES

A. General: Mechanical System Descriptions for Plumbing, HVAC and Abbreviations used in the following schedules include:

1. Pipe System Descriptions for Plumbing Systems:
  - a. Domestic Water Piping Systems: Include cold water, hot water, hot water recirculating piping, serving non laboratory areas.
  - b. Laboratory Water Piping Systems: Include cold water, hot water, hot water recirculating piping, serving laboratory areas.
  - c. Water Makeup Systems: Include domestic cold water piping for makeup water connections for HVAC Systems.
  - d. Storm Water Systems: Above ground horizontal storm water piping (exposed and concealed) and the roof drain sump.
2. Abbreviations:
  - a. Field-Applied Jackets:
    - 1) P: PVC.
    - 2) GC: Glass Cloth.
    - 3) A: Aluminum.
    - 4) SS: Stainless Steel.
    - 5) ASJ: All Service Jacket.
  - b. Pipe Sizes - NPS: Nominal Pipe Size.
  - c. N/A: Not Applicable.
  - d. MER: Mechanical Equipment Room.

B. Insulation Schedules:

<b>PLUMBING SYSTEMS - PIPING</b>						
<b>Pipe System</b>	<b>Pipe Size in Inches (NPS)</b>	<b>Materials</b>	<b>Thick-ness in Inches</b>	<b>Vapor Barrier Re-quired</b>	<b>Field Applied Jacket-MER</b>	<b>Field Applied Jacket NON-MER</b>
Sanitary Drains and Traps Exposed at Fixtures for Disabled	1/2 to 1-1/2	Flexible Elastomeric	1/2	Yes	None	None
Horizontal Storm Water Piping above ground (exposed and concealed)	All Sizes plus the drain sump	Fiberglass	1-1/2	No	ASJ	ASJ
Concealed Interior Domestic Water-40°F - 110°F	1/2 to 1, Branch Run outs	Fiberglass Flexible Elastomeric	1/2 1/2	Yes Yes	N/A N/A	None None
	1/2 to 1-1/2	Fiberglass	1	Yes	N/A	None
	2 to 36	Fiberglass	1-1/2	Yes	N/A	None

<b>PLUMBING SYSTEMS - PIPING</b>						
<b>Pipe System</b>	<b>Pipe Size in Inches (NPS)</b>	<b>Materials</b>	<b>Thick-ness in Inches</b>	<b>Vapor Barrier Required</b>	<b>Field Applied Jacket-MER</b>	<b>Field Applied Jacket NON-MER</b>
Exposed Interior Domestic Water Piping - 40°F - 110°F,	1/2 to 1, Branch Run - outs	Fiberglass Flexible Elastomeric	1/2 1/2	Yes Yes	GC	P P
	1/ 2 to 1 1/2	Fiberglass	1	Yes	GC	P
	2 to 36	Fiberglass	1 1/2	Yes	N / A	P
HVAC System Makeup Water Piping	1/ 2 to 3	Fiberglass	1	Yes	GC	P

<b>PLUMBING SYSTEMS - EQUIPMENT</b>						
<b>System Equipment</b>	<b>Material</b>	<b>Form</b>	<b>Thickness in Inches</b>	<b>Vapor Barrier Required</b>	<b>Field Applied Jacket - MER</b>	<b>Field Applied Jacket - NON-MER</b>
Interior Exposed Domestic Cold Water Equipment, Tanks and Pumps 40°F - 110°F	Fiberglass	Block or Board	2	Yes	GC	GC
	Cellular Glass	Block	1 1/2	Yes	GC	GC
	Flexible Elastomeric	Sheet	1	Yes	GC	GC
Exposed Interior Domestic Hot Water Equipment, Tanks and Pumps, 40°F - 110°F	Fiberglass	Block or Board	2	No	GC	GC
	Cellular Glass	Block	2	No	None	None
	Flexible-Elastomeric	Sheet	1	No		

END OF SECTION 220700