

## PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and Divisions 00 and 01, apply to this Section.
- B. Related Sections:
  - 1. Division 07.
  - 2. Division 09.
  - 3. Division 22.
  - 4. Division 23.

### 1.2 SUMMARY

- A. This Section includes preformed, rigid, and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

### 1.3 SUBMITTALS

- A. General: See Section 23 05 00 general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
  - 1. Mineral Fiber Insulation.
  - 2. Flexible Elastomeric Thermal Insulation.
  - 3. Cellular Glass Insulation.
  - 4. Calcium Silicate Insulation.
  - 5. Prefabricated Thermal Insulating Fitting Covers.
  - 6. PVC Jacket.
  - 7. Standard PVC Fitting Covers.
  - 8. Aluminum Jacket.
  - 9. Stainless Steel Jacket.
  - 10. Thermal Insulated Removable Pads.

### 1.4 CODES AND STANDARDS

- A. Codes and Standards shall be the current version adopted by the Authority Having Jurisdiction.

### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.
- B. Protect insulation and jackets from moisture and dirt.

#### 1.7 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for Mechanical Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for insulation application.
- C. Coordinate installation of electric heat tracing.

#### 1.8 SCHEDULING

- A. Schedule insulation application after testing piping systems and, where required, after installing and testing heat-trace tape. Insulation application may begin on segments of piping that have satisfactory test results.

### PART 2 – PRODUCTS

#### 2.1 INSULATION MATERIALS

- A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Knauf Fiberglass.
    - b. Owens Corning.
    - c. Johns Manville.
    - d. Or Approved Equal.
  2. Preformed Pipe Insulation: Molded pipe insulation manufactured to meet ASTM C 585 for sizes required in the particular system. Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547.
    - a. Factory applied paper free all service vapor retarding outer jacket and adhesive closure system rated for a maximum service temperature of 850 deg F. Circumferential joints shall be sealed with paper free butt strips that are compatible with facing.
    - b. Polybrominated Diphenyl Esters (PBDE's) are not allowed.
    - c. Alternate paper free insulation systems may include but are not limited to unfaced fiber glass pipe insulation with a field applied paper free jacket material such as Polyvinyl Chloride (PVC) or Polyvinylidene Chloride (PVDC).

3. Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
  4. Water Based Fire-Resistive Adhesive: Comply with ASTM C 916 Type II in the following classes and grades:
    - a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
    - b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
    - c. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Childers.
      - 2) Foster.
      - 3) Miracle.
      - 4) Or Approved Equal.
  5. Vapor Barrier Coating: Fire- and water-resistive, vapor barrier coatings for indoor applications. Comply with MIL-C-19565C, Type II and be QPL listed. Water Vapor Permeance. ASTM E 96 Procedure B, 0.013 perms or less at 43 mils dry.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Childers.
      - 2) Foster.
      - 3) Vimasco.
      - 4) Or Approved Equal.
  6. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
  7. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
  8. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
- B. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armacell.
    - b. Or Approved Equal
  2. Adhesive: Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Foster.
    - b. Childers.
    - c. Armacell
    - d. K-Flex.
    - e. Or Approved Equal.
  3. Ultraviolet-Protective Coating: Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Foster.
    - b. Armacell.
    - c. Or Approved Equal.
  4. Metal Jacketing Flashing Sealant: Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Foster.
    - b. Childers.
    - c. Or Approved Equal.
- C. Cellular Glass Insulation: All glass, closed cell structure, comply with ASTM C 552, operating temperature from minus 450 deg F to 900 deg F (-268 deg C to 482 deg C), thermal diffusivity 0.016 ft<sup>2</sup>/Hr, no increase in weight at 90% relative humidity (hygroscopicity). Fabricate in half sections where possible, curved sidewall segments for larger diameter pipes.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Pittsburgh Corning (Foamglass), or approved equivalent.
  2. Weather Barrier Coating: Flexible, latex coating, comply with ASTM E 84 and E 96.
  3. Asphalt Cutback coating: Asphalt coating formulated for cellular glass insulation.
  4. Polyester Fabric: Open mesh, synthetic fabric.
  5. Joint Sealant: Butyl sealant, comply with MIL-I-24244.
  6. Protective Membranes:
    - a. Heat-Sealed Membrane: 125-mil thick heat-sealed high polymer asphalt membrane with an integral glass scrim, integral 1 mil aluminum foil, and mylar film.
    - b. Self-Sealing Membrane: 70-mil thick self-sealing high polymer asphalt membrane with an integral glass scrim and mylar film.
  7. Calcium Silicate Insulation: Preformed pipe sections of noncombustible, inorganic, hydrous calcium silicate with a nonasbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Owens Corning.
      - 2) Pabco.
      - 3) Johns Manville.
      - 4) Or Approved Equal
  8. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

## 2.2 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.

1. Adhesive: As recommended by insulation material manufacturer.
  2. PVC Jacket Color: White.
- C. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC.
1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers and end caps.
  2. Adhesive: As recommended by insulation material manufacturer.
  3. PVC Jacket Color: White.
- D. Aluminum Jacket: ASTM B 209, 3003 alloy, H-14 temper, factory cut and rolled to indicated sizes or roll stock, ready for shop or field cutting and forming to indicated sizes.
1. Finish and Thickness: Stucco-embossed finish, 0.016 inch thick.
  2. Moisture Barrier: 1-mil- thick, heat-bonded polyethylene and kraft paper.
  3. Elbows: Preformed, 45- and 90-degree, short- and long-radius elbows; same material, finish, and thickness as jacket.
- E. Stainless-Steel Jacket: ASTM A 666, Type 304 or 316; factory cut and rolled to indicated sizes or roll stock ready for shop or field cutting and forming to indicated sizes.
1. Finish and Thickness: Smooth finish, 0.10-inch thick.
  2. Moisture Barrier: 1-mil- thick, heat-bonded polyethylene and kraft paper.
  3. Elbows: Gore type, for 45- and 90-degree elbows in same material, finish, and thickness as jacket.

### 2.3 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8-oz./sq. yd.
1. Tape Width: 4 inches.
- B. Bands: 3/4-inch-wide, in one of the following materials compatible with jacket:
1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
  2. Galvanized Steel: 0.005 inch thick.
  3. Aluminum: 0.007 inch thick.
  4. Brass: 0.010 inch thick.
  5. Nickel-Copper Alloy: 0.005 inch thick.
- C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

### 2.4 THERMAL INSULATED REMOVABLE PADS

- A. The inner and outer jacketing on the removable pads shall be silicone impregnated fiberglass.
- B. The insulation material inside the pads shall be fiberglass thermal insulating wool.
- C. Lacing hooks, and washers shall be stainless steel.

- D. Tie wire shall be stainless steel.
- E. Fasteners shall be stainless steel staples STCR 5019-3/8-inch, or equal.
- F. Thickness for all pads: 2-inch.

## 2.5 VAPOR RETARDERS

- A. Vapor-Barrier Coating: Fire- and water-resistive, vapor-barrier coatings for indoor applications. Comply with MIL-C-19565C, Type II and be QPL listed. Water Vapor Permeance: ASTM E 96 Procedure B, 0.013 perms or less at 43 mils dry.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers.
    - b. Foster.
    - c. Vimasco.
    - d. Or Approved Equal

## PART 3 – EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

### 3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply 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. Seal joints and seams with vapor-retarder coating on below ambient insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.
- I. Apply elastomeric insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier coating.
  - 1. Apply insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
  - 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- N. Apply adhesives and coatings at the manufacturer's recommended coverage rate.
- O. Apply insulation with integral jackets as follows:
  - 1. Pull jacket tight and smooth.
  - 2. Circumferential Joints: Cover with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
  - 3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply 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 4 inches o.c.
    - a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
  - 4. Vapor-Retarder Barrier Coatings: Where vapor retarders are indicated, apply specified coating on seams and joints and at ends adjacent to flanges, unions, valves, and fittings. All below ambient, insulated fittings, flanges, valves and unions shall be coated with vapor barrier coating and reinforcing mesh.
  - 5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder coating.

- P. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
  - 1. Seal penetrations with vapor-barrier coating.
  - 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
  - 3. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
  - 4. Seal metal jacket to roof flashing with metal jacketing flashing sealant.
- Q. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-barrier coating.
- R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- S. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
  - 1. Firestopping and fire-resistive joint sealers are specified in Division 07.
- T. Floor Penetrations: Apply insulation continuously through floor assembly.
  - 1. For insulation with vapor retarders, seal insulation with vapor-barrier coating where floor supports penetrate vapor retarder.

### 3.4 MINERAL-FIBER INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
  - 1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
  - 2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-barrier coating. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.
  - 3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
  - 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-barrier coating.
- B. Apply insulation to flanges as follows:
  - 1. Apply preformed pipe insulation to outer diameter of pipe flange.
  - 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the 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. Cover flanges with standard PVC fitting covers.
- C. Apply insulation to fittings and elbows as follows:
  - 1. Apply preformed insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
  3. Cover fittings and elbows with standard PVC fitting covers.
- D. Apply insulation to valves and specialties as follows:
1. Apply preformed insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
  2. When preformed insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
  3. Apply insulation to flanges as specified for flange insulation application.
  4. Cover valves and specialties with standard PVC fitting covers. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-barrier coating.
  5. Provide thermal insulated removable pads for larger sizes where PVC fitting covers are not available.

### 3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
1. Follow manufacturer's written instructions for applying insulation.
  2. Seal longitudinal seams and end joints with specified contact adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- B. Apply insulation to flanges as follows:
1. Apply pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the 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 the same thickness as pipe insulation.
  4. Secure insulation to flanges and seal seams with contact adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- C. Apply insulation to fittings and elbows as follows:
1. Apply mitered sections of pipe insulation.
  2. Secure insulation materials and seal seams with contact adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- D. Apply insulation to valves and specialties as follows:
1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
  2. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to stainer basket.

3. Apply insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

### 3.6 CELLULAR GLASS INSULATION APPLICATION

- A. Follow manufacturer's written instructions for applying insulation.
- B. Apply insulation to pipes, fittings, and elbows as follows:
  1. Where vapor retarders are indicated, seal all joints full depth with joint sealant, fill tightly with no voids.
  2. Provide protective membranes as indicated. Apply membranes at factory where possible.

### 3.7 CALCIUM SILICATE INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
  1. Secure each layer of insulation to pipe with stainless-steel bands at 12-inch intervals and tighten without deforming insulation materials.
  2. Apply two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch, soft-annealed, stainless steel wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
  3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to surface of installed insulation. When dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin the finish coat to achieve smooth finish.
- B. Apply insulation to flanges as follows:
  1. Apply preformed pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the 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 the same material and thickness as pipe insulation.
  4. Finish flange insulation the same as pipe insulation.
- C. Apply insulation to fittings and elbows as follows:
  1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
  2. When premolded sections of insulation are not available, apply mitered sections of calcium silicate insulation. Secure insulation materials with stainless-steel wire.
  3. Finish insulation of fittings the same as pipe insulation.
- D. Apply insulation to valves and specialties as follows:
  1. Apply mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

- For check valves, arrange insulation for access to stainer basket without disturbing insulation.
2. Apply insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation the same as pipe insulation.

### 3.8 FIELD-APPLIED JACKET APPLICATION

- A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.
  1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  2. Embed glass cloth between two 0.062-inch- thick coats of jacket manufacturer's recommended adhesive.
  3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.
- B. PVC Jackets:
  1. Apply 1-inch overlap at longitudinal seams and end joints.
  2. Seal with manufacturers recommended adhesive.
  3. Apply PVC jackets for exposed piping in mechanical rooms [up to 8-feet from floor] and insulated piping within custom air-handling units.
- C. Metal Jackets:
  1. Apply 2-inch overlap at longitudinal seams and end joints.
    - a. Overlap longitudinal seams arranged to shed water.
    - b. Seal joints with metal jacketing recommended by jacket manufacturer.
  2. Secure jacket with bands 12 inches o.c. and at end joints.
  3. Apply stainless steel jackets for exposed piping in food service areas.
  4. Apply aluminum jackets for exposed exterior installations.

### 3.9 FINISHES

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

### 3.10 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
  1. Flexible connectors.
  2. Vibration-control devices.
  3. Fire-suppression piping.
  4. Drainage piping located in crawl spaces, unless otherwise indicated.
  5. Below-grade piping, unless otherwise indicated.
  6. Chrome-plated pipes and fittings, unless potential for personnel injury.
  7. Flow regulators.
  8. Meters.

9. Backflow preventers.
10. Steam traps.
11. Pipe insulation is not required between the control valve and coil on runouts when the control valve is located within 4-feet of the coil and the pipe size is 1-inch or less.

### 3.11 THERMAL INSULATION REMOVABLE PADS

- A. All flanges and valves including control valves, gate valves and butterfly valves shall be insulated with removable pads for systems that are indicated under the applications schedule.

### 3.12 INSULATION APPLICATION SCHEDULE, GENERAL

- A. Refer to insulation application schedules for required insulation materials, thickness and vapor retarders.

### 3.13 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Domestic hot and recirculated hot water.
  1. Insulation Material: Mineral-fiber, preformed.
  2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 1-1/4-inch: 1-inch.
    - b. Pipe, 1-1/2-inch and above: 1-1/2-inch.
  3. Vapor Retarder Required: No.
  4. Insulation Conductivity Range: 0.21 – 0.28 BTU·in/(hr·ft<sup>2</sup>·°F).
- B. Service: Domestic cold water.
  1. Insulation Material: Mineral-fiber, preformed.
  2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 1-1/4-inch: 1/2-inch.
    - b. Pipe, 1-1/2-inch and above: 1-inch.
  3. Vapor Retarder Required: No.
  4. Insulation Conductivity Range: 0.21 – 0.27 BTU·in/(hr·ft<sup>2</sup>·°F).
- C. Service: Steam Condensate Receiver Vent Exposed.
  1. Insulation Material: Mineral-fiber, preformed.
  2. Insulation Thickness: 1/2-inch.
  3. Vapor Retarder Required: No.
- D. Service: Domestic hot water where heat tracing is installed.
  1. Insulation Material: Mineral-fiber, preformed.
  2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 1-1/4-inch: 1-inch.
    - b. Pipe, 1-1/2-inch and above: 1-1/2-inch.

3. Vapor Retarder Required: No.
  4. Insulation Conductivity Range: 0.24 – 0.28 BTU-in/(hr-ft<sup>2</sup>·°F).
- E. Service: Rainwater and overflow rainwater.
1. Insulation Material: Mineral-fiber, preformed.
  2. Insulation Thickness: 1/2-inch.
  3. Vapor Retarder Required: Yes.
  4. Insulate all horizontal pipe runs. Insulate all vertical pipe risers down to 10-feet below the roof.
- F. Service: Roof drain and overflow roof drain bodies.
1. Insulation Material: Flexible elastomeric.
  2. Insulation Thickness: 1-inch.
  3. Vapor Retarder Required: Yes.
- G. Service: Soil, waste, and sewage force main piping where heat tracing is installed.
1. Insulation Material: Mineral-fiber, preformed.
  2. Insulation Thickness: 1-1/2-inch.
  3. Vapor Retarder Required: Yes.
- H. Service: Condensate drain piping used for air washers, air-cooling coils, overflow from evaporative coolers and similar air-conditioning equipment.
1. Insulation Material: Flexible elastomeric.
  2. Insulation Thickness: 1-inch.
  3. Vapor Retarder Required: Yes.
- I. Service: Chilled-water supply and return, including pipe within custom air-handling units.
1. Insulation Material: Mineral-fiber, preformed.
  2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 1-1/4-inch: 1-inch.
    - b. Pipe, 1-1/2-inch and above: 1-1/2-inch.
  3. Insulation Conductivity Range: 0.21 – 0.28 BTU-in/(hr-ft<sup>2</sup>·°F).
  4. Vapor Retarder Required: Yes.
- J. Service: Refrigerant piping.
1. Insulation Material: Flexible elastomeric.
  2. Insulation Thickness: 1-inch.
  3. Vapor Retarder Required: Yes.
- K. Service: Heating hot-water supply and return, including pipe within custom air-handling units.
1. Insulation Material: Mineral-fiber, preformed.
  2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 1-1/4-inch: 1-1/2-inch.

- b. Pipe, 1-1/2-inch and above: 2-inch.
  - 3. Vapor Retarder Required: No.
  - 4. Insulation Conductivity Range: 0.25 – 0.29 BTU-in/(hr-ft<sup>2</sup>·°F).
- L. Service: Heat recovery water supply and return, including pipe within custom air-handling units.
- 1. Insulation Material: Mineral-fiber, preformed.
  - 2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 1-1/4-inch: 1-inch.
    - b. Pipe, 1-1/2-inch and above: 1-1/2-inch.
  - 3. Insulation Conductivity Range: 0.21 – 0.28 BTU-in/(hr-ft<sup>2</sup>·°F).
  - 4. Vapor Retarder Required: Yes.
- M. Service: Steam and condensate, 100 psi and below.
- 1. Insulation Material: Mineral-fiber, preformed.
  - 2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 3/4-inch: 3-inch.
    - b. Pipe, 1-inch – 1-1/4-inch: 4-inch.
    - c. Pipe, 1-1/2-inch and above: 4-1/2-inch.
  - 3. Vapor Retarder Required: No.
  - 4. Insulation Conductivity Range: 0.29 – 0.32 BTU-in/(hr-ft<sup>2</sup>·°F).
- N. Service: Steam and condensate, above 100 psi.
- 1. Insulation Material: Mineral-fiber, preformed.
  - 2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 3/4-inch: 4-1/2-inch.
    - b. Pipe, 1-inch and above: 5-inch.
  - 3. Vapor Retarder Required: No.
  - 4. Insulation Conductivity Range: 0.32 – 0.34 BTU-in/(hr-ft<sup>2</sup>·°F).
- O. Service: Process cold water, below 40 deg F.
- 1. Insulation Material: Mineral fiber, preformed.
  - 2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 3/4-inch: 1/2-inch.
    - b. Pipe, 1-inch – 6-inch: 1-1/2-inch.
    - c. Pipe, 8-inch and above: 1-1/2-inch.
  - 3. Vapor Retarder Required: Yes.
  - 4. Insulation Conductivity Range: 0.20 – 0.26 BTU-in/(hr-ft<sup>2</sup>·°F).

- P. Service: MRI Quench Vent Stainless Steel, Helium Exhaust Pipe.
1. Insulation Material: Mineral fiber, preformed.
  2. Insulation Thickness: 5-inch.
  3. Vapor Retarder Required: Yes.
  4. Insulation Conductivity: 0.28 BTU·in/(hr·ft<sup>2</sup>·°F) at 50 deg F. Insulate brackets and clamps all the way to the structure.
- Q. Service: Diesel-engine coolant.
1. Insulation Material: Mineral-fiber, preformed.
  2. Insulation Thickness: 1/2-inch.
  3. Vapor Retarder Required: Yes.
- R. Service: Diesel-engine exhaust.
1. Insulation Material: Calcium silicate.
  2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Steel Pipe, 6-inch – 8-inch: 4-1/2-inch.
    - b. Steel Pipe, 10-inch and above: 6-inch.
  3. Vapor Retarder Required: No.

### 3.14 EXTERIOR INSULATION APPLICATION SCHEDULE

- A. This application schedule is for aboveground insulation outside the building.
- B. Service: Domestic water.
1. Insulation Material: Cellular glass with self-sealing membrane.
  2. Insulation Thickness: 1-1/2-inch.
  3. Vapor Retarder Required: Yes.
- C. Service: Rainwater and overflow rainwater.
1. Insulation Material: Cellular glass with self-sealing membrane.
  2. Insulation Thickness: 1-1/2-inch.
  3. Vapor Retarder Required: Yes.
- D. Service: Refrigerant piping.
1. Insulation Material: Flexible elastomeric.
  2. Insulation Thickness: 1-inch.
  3. Vapor Retarder Required: Yes.
- E. Service: Chilled-water supply and return.
1. Insulation Material: Cellular glass with self-sealing membrane.
  2. Insulation Thickness: 1-1/2-inch.
  3. Vapor Retarder Required: Yes.
  4. Insulation Conductivity Range: 0.22 – 0.28 BTU·in/(hr·ft<sup>2</sup>·°F).

- F. Service: Condenser-water supply and return.
  - 1. Insulation Material: Cellular glass with self-sealing membrane.
  - 2. Insulation Thickness: 1-1/2-inch.
  - 3. Vapor Retarder Required: Yes.
  
- G. Service: Heating hot-water supply and return.
  - 1. Insulation Material: Cellular glass with self-sealing membrane.
  - 2. Insulation Thickness: 2-inch.
  - 3. Vapor Retarder Required: No.
  - 4. Insulation Conductivity Range: 0.25 – 0.29 BTU·in/(hr·ft<sup>2</sup>·°F).
  
- H. Service: Steam and condensate, 100 psi and below.
  - 1. Insulation Material: Cellular glass with heat-sealed membrane.
  - 2. Insulation Thickness: 4-1/2-inch.
  - 3. Vapor Retarder Required: No.
  - 4. Insulation Conductivity Range: 0.29 – 0.32 BTU·in/(hr·ft<sup>2</sup>·°F).
  
- I. Service: Diesel-engine coolant.
  - 1. Insulation Material: Cellular glass with self-sealing membrane.
  - 2. Insulation Thickness: 1-1/2-inch.
  - 3. Vapor Retarder Required: Yes.

### 3.15 UNDERGROUND INSULATION APPLICATION SCHEDULE

- A. Service: Chilled-water supply and return.
  - 1. Insulation Material: Cellular glass with self-sealing membrane.
  - 2. Insulation Thickness: 1-1/2-inch.
  - 3. Vapor Retarder Required: Yes.
  - 4. Insulation Conductivity Range: 0.22 – 0.28 BTU·in/(hr·ft<sup>2</sup>·°F).
  
- B. Service: Heating hot-water supply and return.
  - 1. Insulation Material: Cellular glass with heat-sealed membrane.
  - 2. Insulation Thickness: 2-inch.
  - 3. Vapor Retarder Required: No.
  - 4. Insulation Conductivity Range: 0.25 – 0.29 BTU·in/(hr·ft<sup>2</sup>·°F).

**END OF SECTION**