

**SECTION 22 07 11  
PLUMBING INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Field applied insulation for thermal efficiency and condensation control for
  - 1. Plumbing piping and equipment.
- B. Definitions
  - 1. ASJ: All service jacket, white finish facing or jacket.
  - 2. Cold: Equipment or piping handling media at design temperature of 60 degrees F (16 degrees C) or below.
  - 3. Exposed: Piping and equipment exposed to view in finished areas including mechanical equipment rooms or exposed to outdoor weather.
  - 4. Density: Pcf - pounds per cubic foot (kg/m3 - kilograms per cubic meter).
  - 5. Thermal conductance: Heat flow rate through materials.
    - a. Flat surface: BTU per hour per square foot (Watt per square meter).
    - b. Pipe or Cylinder: BTU per hour per linear foot (Watt per square meter).
  - 6. Thermal Conductivity (k): BTU per inch thickness, per hour, per square foot, per degrees F temperature difference (Watt per meter, per degrees C).
  - 7. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). For the purpose of this specification, vapor retarders/vapor barriers shall have a maximum published permeance of .02 perms
  - 8. CW: Cold water.
  - 9. SD: Storm Drain.
  - 10. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: General mechanical requirements and items, which are common to more than one section of Division 22.

D. Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING: Hot and cold water piping.

E. Section 22 05 33, HEAT TRACING FOR PLUMBING PIPING: Insulation over heating cables.

### 1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.

B. American Society for Testing and Materials (ASTM):

B209-2014..... Standard Specification for Aluminum and  
Aluminum-Alloy Sheet and Plate

C450-2008 (R2014).....Standard Practice for Fabrication of Thermal  
Insulating Fitting Covers for NPS Piping, and  
Vessel Lagging

Adjunct to C450..... Compilation of Tables that Provide Recommended  
Dimensions for Prefab and Field Thermal  
Insulating Covers, etc.

C533-2013..... Standard Specification for Calcium Silicate  
Block and Pipe Thermal Insulation

C534/C534M-2014..... Standard Specification for Preformed Flexible  
Elastomeric Cellular Thermal Insulation in  
Sheet and Tubular Form

C552-2014..... Standard Specification for Cellular Glass  
Thermal Insulation

C680-2014..... Standard Practice for Estimate of the Heat  
Gain or Loss and the Surface Temperatures of  
Insulated Flat, Cylindrical, and Spherical  
Systems by Use of Computer Programs

C1126-2014.....Standard Specification for Faced or Unfaced  
Rigid Cellular Phenolic Thermal Insulation

C1136-2012..... Standard Specification for Flexible, Low  
Permeance Vapor Retarders for Thermal  
Insulation

C1710-2011..... Standard Guide for Installation of Flexible  
Closed Cell Preformed Insulation in Tube and  
Sheet Form

- D1668/D1668M-1997a(2014) e1 Standard Specification for Glass Fabrics  
(Woven and Treated) for Roofing and  
Waterproofing
- E84-2015a..... Standard Test Method for Surface Burning  
Characteristics of Building Materials
- E2231-2015..... Standard Practice for Specimen Preparation and  
Mounting of Pipe and Duct Insulation to Assess  
Surface Burning Characteristics
- C. Federal Specifications (Fed. Spec.):
- L-P-535E-1979..... Plastic Sheet (Sheeting): Plastic Strip; Poly  
(Vinyl Chloride) and Poly (Vinyl Chloride -  
Vinyl Acetate), Rigid.
- D. International Code Council, (ICC):
- IMC-2015..... International Mechanical Code
- E. Military Specifications (Mil. Spec.):
- MIL-A-3316C (2)-1990.... Adhesives, Fire-Resistant, Thermal Insulation
- MIL-A-24179A (2)-1987... Adhesive, Flexible Unicellular-Plastic Thermal  
Insulation
- MIL-PRF-19565C (1)-1988.Coating Compounds, Thermal Insulation, Fire-and  
Water-Resistant, Vapor-Barrier
- MIL-C-20079H-1987.....Cloth, Glass; Tape, Textile Glass; and Thread,  
Glass and Wire-Reinforced Glass
- F. National Fire Protection Association (NFPA):
- 90A-2015..... Standard for the Installation of Air-  
Conditioning and Ventilating Systems
- G. Underwriters Laboratories, Inc (UL):
- 723-2008 (R2013)..... Standard for Test for Surface Burning  
Characteristics of Building Materials
- 1887-2004 (R2013).....Standard for Fire Test of Plastic Sprinkler  
Pipe for Visible Flame and Smoke  
Characteristics
- H. 3E Plus® version 4.1 Insulation Thickness Computer Program: Available  
from NAIMA with free download; <http://www.pipeinsulation.net>

#### 1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in  
accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND  
SAMPLES.

- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 07 11, PLUMBING INSULATION", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
- D. Shop Drawings:
  - 1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM Designation, Federal and Military specifications.
    - a. Insulation materials: Specify each type used and state surface burning characteristics.
    - b. Insulation facings and jackets: Each type used and state surface burning characteristics.
    - c. Insulation accessory materials: Each type used.
    - d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation shall follow the guidelines in accordance with ASTM C1710.
    - e. Make reference to applicable specification paragraph numbers for coordination.
    - f. All insulation fittings (exception flexible unicellular insulation) shall be fabricated in accordance with ASTM C450 and the referenced Adjunct to ASTM C450.

#### **1.5 QUALITY ASSURANCE**

- A. Refer to article QUALITY ASSURANCE, in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- B. Criteria:
  - 1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.11.2.6, parts of which are quoted as follows:
    - 4.3.3.1 Pipe and duct insulation and coverings, duct linings, vapor retarder facings, adhesives, fasteners, tapes, and supplementary materials added to air ducts, plenums, panels and duct silencers used in duct systems shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with ASTM E84 and appropriate mounting practice, e.g. ASTM E2231.
    - 4.3.3.3 Coverings and linings for air ducts, pipes, plenums and panels including all pipe and duct insulation materials shall not

flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service. In no case shall the test temperature be below 250 degrees F (121 degrees C).

4.3.11.2.6.3 Nonferrous fire sprinkler piping shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 5 ft (1.5 m) or less when tested in accordance with UL 1887, Standard for Safety Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.

4.3.11.2.6.8 Smoke detectors shall not be required to meet the provisions of Section 4.3.

2. Test methods: ASTM E84, UL 723, or NFPA 255.
3. Specified k factors are at 75 degrees F (24 degrees C) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.
- C. Every package or standard container of insulation or accessories delivered to the job site for use shall have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.
- D. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

#### **1.6 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in

electronic version on compact disc or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version 10 provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

#### **1.7 STORAGE AND HANDLING OF MATERIAL**

- A. Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

## **PART 2 - PRODUCTS**

### **2.1 FIBER GLASS**

A. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1,  $k = 0.26$  (0.037) at 75 degrees F (24 degrees C), for use at temperatures up to 450 degrees F (230 degrees C) with an all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.

### **2.2 CELLULAR GLASS CLOSED-CELL**

- A. Comply with Standard ASTM C177, C518, density 7.5 pcf (120 kg/m<sup>3</sup>) nominal,  $k = 0.29$  (0.033) at 75 degrees F (24 degrees C).
- B. Pipe insulation for use at temperatures up to 400 degrees F (200 degrees C) with all service vapor retarder jacket.

### **2.3 FLEXIBLE ELASTOMERIC CELLULAR THERMAL**

- A. ASTM C177, C518,  $k = 0.27$  (0.039) at 75 degrees F (24 degrees C), flame spread not over 25, smoke developed not over 50, for temperatures from minus 40 degrees F (4 degrees C) to 200 degrees F (93 degrees C). No jacket required.

### **2.4 INSULATION FACINGS AND JACKETS**

- A. Vapor Retarder, higher strength with low water permeance  $\leq 0.02$  or less perm rating, Beach puncture 50 units for insulation facing on pipe insulation jackets. Facings and jackets shall be all service type (ASJ) or PVDC Vapor Retarder jacketing.
- B. ASJ jacket shall be white kraft bonded to 1 mil (0.025 mm) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 50 units, Suitable for painting without sizing. Jackets shall have minimum 1-1/2 inch (40 mm) lap on longitudinal joints and minimum 3 inch (75 mm) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.
- C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: Foil-Scrim-Kraft (FSK) or PVDC vapor retarder jacketing type for concealed ductwork and equipment.
- D. Except for flexible elastomeric cellular thermal insulation (not for high humidity exposures), field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all

exterior piping exposed to outdoor air in high humidity areas conveying fluids below ambient temperature. The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 30 inch-pounds (35 cm-kg) for interior locations and 80 inch-pounds (92 cm-kg) for exterior or exposed locations or where the insulation is subject to damage.

- E. Except for cellular glass thermal insulation, when all longitudinal and circumferential joints are vapor sealed with a vapor barrier mastic or caulking, vapor barrier jackets may not be provided. For aesthetic and physical abuse applications, exterior jacketing is recommended. Otherwise field applied vapor barrier jackets shall be provided, in addition to the applicable specified facings and jackets, on all exterior piping. The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 30 inch-pounds (35 cm-kg) for interior locations and 80 inch-pounds (92 cm-kg) for exterior or exposed locations or where the insulation is subject to damage.
- F. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be polyvinyl chloride (PVC) conforming to Fed Spec L-P-335, composition A, Type II Grade GU, and Type III, minimum thickness 0.03 inches (0.7 mm). Provide color matching vapor retarder pressure sensitive tape.
- G. Aluminum Jacket-Piping systems: ASTM B209, 3003 alloy, H-14 temper, 0.023 inch (0.6 mm) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.024 inch (0.6 mm) minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel bands shall be installed on all circumferential joints. Bands shall be 0.5 inches (13 mm) wide on 18 inch (450 mm) centers. System shall be weatherproof if utilized for outside service.

## **2.5 PIPE COVERING PROTECTION SADDLES**

- A. Cold pipe support: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass or high density Polyisocyanurate insulation of the same thickness as



adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 3 pcf (48 kg/m3).

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size inches (mm)	Insert Blocks inches (mm)
Up through 5 (125)	6 (150) long
6 (150)	6 (150) long
8 (200), 10 (250), 12 (300)	9 (225) long

## **2.6 ADHESIVE, MASTIC, CEMENT**

- A. Mil. Spec. MIL-A-3316, Class 1: Jacket and lap adhesive and protective finish coating for insulation.
- B. Mil. Spec. MIL-A-3316, Class 2: Adhesive for laps and for adhering insulation to metal surfaces.
- C. Mil. Spec. MIL-A-24179, Type II Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.
- D. Mil. Spec. MIL-C-19565, Type I: Protective finish for outdoor use.
- E. ASTM C449: Mineral fiber hydraulic-setting thermal insulating and finishing cement.
- F. Other: Insulation manufacturers' published recommendations.

## **2.7 MECHANICAL FASTENERS**

- A. Staples: Outward clinching galvanized steel
- B. Bands: 1/2 inch (13 mm) nominal width, brass, galvanized steel, aluminum or stainless steel.

## **2.8 REINFORCEMENT AND FINISHES**

- A. Glass fiber fitting tape: Mil. Spec MIL-C-20079, Type II, Class 1.
- B. Tape for Flexible Elastomeric Cellular Insulation: As recommended by the insulation manufacturer.
- C. Corner beads: 2 inch (50 mm) by 2 inch (50 mm), 26 gauge (0.55 mm) thick galvanized steel; or, 1 inch (25 mm) by 1 inch (25 mm), 28 gauge (0.47 mm) thick aluminum angle adhered to 2 inch (50 mm) by 2 inch (50 mm) Kraft paper.
- D. PVC fitting cover: Fed. Spec L-P-535, Composition A, 11-86 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 40 degrees F (4 degrees C) to 250 degrees F (121 degrees C). Below 40 degrees F (4 degrees C) and above 250 degrees F (121 degrees C). Provide double layer insert. Provide color matching vapor barrier pressure sensitive tape.

## **PART 3 - EXECUTION**

### **3.1 GENERAL REQUIREMENTS**

- A. Required pressure tests of piping joints and connections shall be completed and the work approved by the Contracting Officer Representative (COR) for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- B. Except for specific exceptions, insulate all specified equipment, and piping (pipe, fittings, valves, accessories). Insulate each pipe individually. Do not use scrap pieces of insulation where a full length section shall fit.
- C. Insulation materials shall be installed in a first-class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A).
- D. Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 60 degrees F (16 degrees C) and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 6 inches (150 mm).
- E. Install vapor stops with operating temperature 60 degrees F (15 degrees C) and below at all insulation terminations on either side of valves, pumps, fittings, and equipment and particularly in straight lengths every 15 to 20 feet (4.6 to 6.1 m) of pipe insulation. The annular space between the pipe and pipe insulation of approx. 1 inch (25 mm) in length at every vapor stop shall be sealed with appropriate vapor barrier sealant. Bio-based materials shall be utilized when possible.
- F. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- G. Plumbing work not to be insulated unless otherwise noted:
  - 1. Piping in contact with earth.

- H. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- I. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights.  
Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.
- J. Freeze protection of above grade outdoor piping (over heat tracing tape): 1 inch (25 mm) thick insulation. Provide metal jackets for all pipes.
- K. Provide vapor barrier jackets over insulation as follows:
  - 1. All piping exposed to outdoor weather.
- L. Provide metal jackets over insulation as follows:
  - a. All plumbing piping exposed to outdoor weather.
  - b. A 2 inch (50 mm) overlap is required at longitudinal and circumferential joints with the overlap at the bottom.

### **3.2 INSULATION INSTALLATION**

- A. Cellular Glass Insulation:
  - 1. Pipe and tubing, covering nominal thickness in millimeters and inches as specified in the schedule at the end of this section.
- B. Flexible Elastomeric Cellular Thermal Insulation:
  - 1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions and finish with two coats of weather resistant finish as recommended by the insulation manufacturer.
  - 2. Pipe and tubing insulation:
    - a. Use proper size material. Do not stretch or strain insulation.
    - b. To avoid undue compression of insulation, provide cork stoppers or wood inserts at supports as recommended by the insulation manufacturer. Insulation shields are specified under Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
    - c. Where possible, slip insulation over the pipe or tubing prior to connection, and seal the butt joints with adhesive. Where the slip-on technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, shall

be employed. Make changes from mineral fiber insulation in a straight run of pipe, not at a fitting. Seal joint with tape.

3. Pipe insulation: nominal thickness in millimeters (inches as specified in the schedule at the end of this section.

### 3.3 PIPE INSULATION SCHEDULE

A. Provide insulation for piping systems as scheduled below:

Operating Temperature Range/Service	Insulation Material	4 (100) and Above
-40 to 60 degrees F (-40 to 16 degrees C) Storm Drain piping	Fiber Glass (Above ground piping only)	1 (25)
-40 to 60 degrees F (-40 to 16 degrees C) Storm Drain piping	Cellular Glass Closed-Cell Rigid (Exterior Locations only)	1 (25)
-40 to 60 degrees F (-40 to 16 degrees C) Storm Drain piping	Flexible Elastomeric Cellular Thermal (Above ground piping only)	1 (25)

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