



Standard Practice for Selection and Application of Thermal Insulation for Piping and Machinery¹

This standard is issued under the fixed designation F683; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This practice provides guidance in the selection of types and thicknesses of thermal insulation materials for piping, machinery, and equipment for nonnuclear shipboard applications. Methods and materials for installation, including lagging, are also detailed.

1.2 Supplemental requirements and exceptions to the requirements discussed herein for ships of the U.S. Navy are included in Supplementary Requirements S1.

1.3 Asbestos or asbestos-containing materials shall not be used.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents²

2.1 ASTM Standards:³

A167 Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

A653/A653M Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate

B209M Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)

C168 Terminology Relating to Thermal Insulation

C195 Specification for Mineral Fiber Thermal Insulating Cement

C449/C449M Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement

C533 Specification for Calcium Silicate Block and Pipe Thermal Insulation

C534 Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

C547 Specification for Mineral Fiber Pipe Insulation

C552 Specification for Cellular Glass Thermal Insulation

C553 Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

C610 Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation

C612 Specification for Mineral Fiber Block and Board Thermal Insulation

C680 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

C892 Specification for High-Temperature Fiber Blanket Thermal Insulation

C1482 Specification for Polyimide Flexible Cellular Thermal and Sound Absorbing Insulation

D962 Specification for Aluminum Powder and Paste Pigments for Paints

F1138 Specification for Spray Shields for Mechanical Joints

¹ This practice is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.02 on Insulation/Processes.

Current edition approved ~~May~~ ~~Sept. 1, 2008~~ ~~2010~~. Published ~~July 2008~~ ~~October 2010~~. Originally approved in 1980. Last previous edition approved in ~~2003~~ ~~2008~~ as ~~F683-03a~~ ~~F683-08~~. DOI: 10.1520/F0683-108.

² The latest revision of all referenced documents shall apply.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

2.2 Federal Specifications:⁴

HH-P-31 Packing and Lapping Material, Fibrous Glass Metallic and Plain Cloth and Tape
 TT-P-28 Paint, Aluminum, Heat Resisting (1200°F)

2.3 Military Specifications:⁴

MIL-PRF-24596 Coating Compounds, Nonflaming, Fire-Protective (Metric)
 DoD-E-24607 Enamel, Interior, Nonflaming (Dry), Chlorinated Alkyd Resin, Semigloss (Metric)
 DoD-I-24688 Type I, Insulation, Polyimide, Sheet and Tube
 MIL-A-3316 Adhesive, Fire-Resistant, Thermal Insulation
 MIL-A-24179 Adhesive, Flexible, Unicellular-Plastic, Thermal Insulation
 MIL-C-2861 Cement Insulation, High Temperature
 MIL-C-19565 Coating Compounds, Thermal Insulation Pipe Covering—Fire and Water-Resistant Vapor Barrier and Weather Resistant
 MIL-C-20079 Cloth, Glass, Tape, Textile Glass and Thread, Glass
 MIL-C-22395 Compound, End Sealing, Thermal Insulation Pipe Covering—Fire, Water, and Weather Resistant
 MIL-DTL-24441 Paint, Epoxy-Polyamide, Green Primer, Formula 150, Type III
 MIL-I-22023 Insulation Felt, Thermal and Sound Absorbing Felt, Fibrous Glass, Flexible
 MIL-I-2781 Insulation, Pipe, Thermal
 MIL-PRF-2818 Insulation Blanket, Thermal
 MIL-PRF-2819 Insulation, Block, Thermal
 MIL-I-16411 Insulation, Felt, Thermal, Glass Fiber
 MIL-PRF-22344 Insulation, Pipe, Thermal
 MIL-P-15280 Plastic Material, Unicellular (Sheets and Tubes)
 MIL-PRF-32161 Insulation, High Temperature Fire Protection, Thermal and Acoustic
 MIL-STD-769 Thermal Insulation Requirements for Machinery and Piping
 MIL-STD-2118 Trap, Steam, Angle, Thermostatic

2.4 Other Documents:

Title 46 Code of Federal Regulations (CFR), Shipping (Parts 164.009 and 164.012)⁴

Electric Boat Specification⁴

EB 4013 Anti-Sweat and Refrigerant Insulation (Sheet and Tubes)⁵

USCG Type Approval 164.109 IMO FTP Code Annex 1, Part 1⁶

USCG Type Approval 164.112 IMO FTP Code Annex 1, Parts 2 and 5⁶

2.5 Drawings, NAVSHIP:

803-5184182 Passive Fire Protection Insulation⁴

804-5959214 Piping Insulation, Installation Details⁷

804-5959212 Machinery Insulation, Installation Details⁴

2.6 NAVSEA:

Naval Ships Technical Manual, Chapter 635—Thermal, Fire, and Acoustic Insulation⁴

803-5184182 Passive Fire Protection Insulation⁴—Chapter 635—Thermal, Fire, and Acoustic Insulation⁷

3. Terminology

3.1 *Definitions*—For definitions of terms relating to insulating materials used in this practice, refer to Terminology C168.

4. Materials and Manufacture

4.1 *Insulation and Lapping Material Specifications*, as listed in Tables 1-17, describe those materials that are intended for use in the indicated temperature ranges. The specifications and requirements outlined herein are not intended to prevent the use of new test methods or materials, provided that sufficient technical data is submitted to demonstrate that the proposed test method or material is equivalent in quality, effectiveness, durability, and safety to that prescribed by this practice.

5. General Requirements

5.1 Piping, including valves, fittings, and flanges conveying vapors, gases, or liquids that attain temperatures outside the range from 55 to 125°F (13 to 52°C) during normal operation, shall be insulated except as otherwise stated herein.

⁴ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS or <http://assist.daps.dia.mil/quicksearch>.

⁵ Available from Electric Boat Corp., 75 Eastern Point Rd., Groton, CT 06340.

⁶ Available from International Maritime Organization, London, United Kingdom

⁷ Available from U.S. Government Printing Office.

⁷ Available from Naval Logistics Library, St.Louis, MO or on-line at <http://nll.ahf.nmci.navy.mil>

TABLE 1 Insulation and Lagging Materials for Pipe, Tubing, and Fittings Used for Interior Piping Systems^{A,B}

Temperature Range °F (°C)	Insulation	Specification	Lagging ^C	Specification
—20 to +40 (–29 to +4)	cellular glass	G552, Type II	fibrous glass cloth	MIL-C-20079, Type I, Classes —3 through 9
–20 to +40 (–29 to +4)	cellular glass	C552, Type II	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	polyimide foam ^D	G1482, Type I, with —vapor retarder	sheet steel galvanized fibrous glass cloth	commercial MIL-C-20079, Type I, Classes —3 through 9
	polyimide foam ^D	C1482, Type I, with vapor retarder	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	elastomeric foam plastic ^A	MIL-P-15280, Form T	fibrous glass cloth	MIL-C-20079, Type I, Classes —3 through 9
	elastomeric foam plastic ^A	MIL-P-15280, Form T EB 4013 C534, Type I	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
—41 to 125 (5 to 51)	cellular glass	G552, Type II	fibrous glass cloth	MIL-C-20079, Type I, Classes —3 through 9
41 to 125 (5 to 51)	cellular glass	C552, Type II	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	polyimide foam	G1482, Type I, with —vapor retarder	sheet steel galvanized fibrous glass cloth	commercial MIL-C-20079, Type I, Classes —3 through 9
	polyimide foam	C1482, Type I, with vapor retarder	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	elastomeric foam plastic ^A	MIL-P-15280, Form T	fibrous glass cloth	MIL-C-20079, Type I, Classes —3 through 9
	elastomeric foam plastic ^A	MIL-P-15280, Form T EB 4013 C534, Type I	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	mineral fiber ^D	G547, Type II	fibrous glass cloth	MIL-C-20079, Type I, Classes —3 through 9
	mineral fiber ^D	C547, Type II	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
—126 to 450 (52 to 232)	cellular glass	G552, Type II	sheet steel galvanized fibrous glass cloth	commercial MIL-C-20079, Type I, Classes —3 through 9
126 to 450 (52 to 232)	cellular glass	C552, Type II	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	polyimide foam ^E 400°F (204°C) max	G1482, Type I	fibrous glass cloth	MIL-C-20079, Type I, Classes —3 through 9
	polyimide foam ^E 400°F (204°C) max	C1482, Type I	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	elastomeric foam plastic ^A —180°F (82°C) max	MIL-P-15280, Form T	fibrous glass cloth	MIL-C-20079, Type I, Classes —3 through 9
	elastomeric foam plastic ^A 180°F (82°C) max	MIL-P-15280, Form T EB 4013 C534, Type I	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	calcium silicate	G533	sheet steel galvanized fibrous glass cloth	commercial MIL-C-20079, Type I, Classes —3 through 9
	calcium silicate	C533	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	expanded perlite	G610	sheet steel galvanized fibrous glass cloth	commercial MIL-C-20079, Type I, Classes —3 through 9
	expanded perlite	C610	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
—451 to 1050 (233 to 566)	cellular glass, 800°F —(427°C) max	G552, Type II	sheet steel galvanized fibrous glass cloth	commercial MIL-C-20079, Type I, Classes —3 through 9
451 to 1050 (233 to 566)	cellular glass, 800°F (427°C) max	C552, Type II	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	mineral fiber	G547, Class 2 (850°F [454°C] —max) or Class 3	sheet steel galvanized sheet steel black	commercial commercial
	mineral fiber	C547, Type IV, Grade A	sheet steel black	commercial
	calcium silicate	C533	sheet steel black	commercial
	expanded perlite	C610	sheet steel black	commercial

^A See 5.4.

^B Insulation and lagging materials are acceptable for the temperature ranges indicated; other materials are capable of being used provided the requirements of this practice are satisfied. Thermal insulating tape is capable of being used as allowed by Section 8 of this practice.

^C Lagging shall be used over insulation only.

^D See Supplementary Requirements S1.5.

^E See Supplementary Requirements S1.15.

TABLE 2 Insulation and Lagging Materials for Pipe, Tubing, and Fittings Used for Weather-Exposed Piping Systems^A

Temperature Range ° F (°C)	Insulation	Specification	Lagging ^B	Specification
-20 to +40 (-29 to +4)	cellular glass	G552, Type II	fibrous glass cloth	MIL-C-20079, Type I Class 7 (fittings) Class 9 (piping)
	cellular glass	C552, Type II	fibrous glass cloth	MIL-C-20079, Type I Class 7 (fittings) Class 9 (piping)
-20 to +40 (-29 to +4)	polyimide foam	G1482, Type I, with vapor retarder	fibrous glass cloth	MIL-C-20079, Type I Class 7 (fittings) Class 9 (piping)
	polyimide foam	C1482, Type I, with vapor retarder	fibrous glass cloth	MIL-C-20079, Type I Class 7 (fittings) Class 9 (piping)
	perlite	G610	fibrous glass cloth	MIL-C-20079, Type I Class 7 (fittings) Class 9 (piping)
	perlite	C610	fibrous glass cloth	MIL-C-20079, Type I Class 7 (fittings) Class 9 (piping)
	elastomeric foam plastic	MIL-P-15280, Form T	corrosion resistant steel	A167, Type 304
	elastomeric foam plastic	MIL-P-15280, Form T	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	elastomeric foam plastic	MIL-P-15280, Form T	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	elastomeric foam plastic	MIL-P-15280, Form T	corrosion resistant steel	A167, Type 304
	elastomeric foam plastic	MIL-P-15280, Form T	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	elastomeric foam plastic	MIL-P-15280, Form T	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
41 to 100 (5 to 37)	cellular glass	G552, Type II	corrosion-resistant steel	A167, Type 304
	cellular glass	C552, Type II	corrosion-resistant steel	A167, Type 304
41 to 100 (5 to 37)	polyimide foam	G1482, Type I, with vapor retarder	fibrous glass cloth	MIL-C-20079, Type I Class 7 (fittings) Class 9 (piping)
	polyimide foam	C1482, Type I, with vapor retarder	fibrous glass cloth	MIL-C-20079, Type I Class 7 (fittings) Class 9 (piping)
	perlite	G610	corrosion-resistant steel	A167, Type 304
	perlite	C610	corrosion-resistant steel	A167, Type 304
	calcium silicate	G533	corrosion-resistant steel	A167, Type 304
	calcium silicate	C533	corrosion-resistant steel	A167, Type 304
	mineral fiber ^C	G547, Class 2 or 3	corrosion-resistant steel	A167, Type 304
	mineral fiber ^C	C547, Class 2 or 3	corrosion-resistant steel	A167, Type 304
	elastomeric foam plastic	MIL-P-15280, Form T	corrosion resistant steel	A167, Type 304
	elastomeric foam plastic	MIL-P-15280, Form T	corrosion resistant steel	A167, Type 304
elastomeric foam plastic	MIL-P-15280, Form T	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9	
elastomeric foam plastic	MIL-P-15280, Form T	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9	
101 to 450 (38 to 232)	cellular glass	G552, Type II	corrosion-resistant steel	A167, Type 304
	cellular glass	C552, Type II	corrosion-resistant steel	A167, Type 304
101 to 450 (38 to 232)	polyimide foam ^B 400°F (204°C) max	G1482, Type I	corrosion-resistant steel	A167, Type 304
	polyimide foam ^B 400°F (204°C) max	C1482, Type I	corrosion-resistant steel	A167, Type 304
	perlite	G610	corrosion-resistant steel	A167, Type 304
	perlite	C610	corrosion-resistant steel	A167, Type 304
	calcium silicate	G533	corrosion-resistant steel	A167, Type 304
	calcium silicate	C533	corrosion-resistant steel	A167, Type 304
	mineral fiber ^C	G547	corrosion-resistant steel	A167, Type 304
	mineral fiber ^C	C547	corrosion-resistant steel	A167, Type 304
	elastomeric foam plastic 180°F (82°C) Max	MIL-P-15280, Form T	corrosion resistant steel	A167, Type 304
	elastomeric foam plastic 180°F (82°C) Max	MIL-P-15280, Form T	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9

TABLE 3 Insulation and Lagging Materials for Machinery and Equipment^{A,B}

Temperature Range °F (°C)	Insulation	Specification	Lagging	Specification
—20 to +40 (–29 to +4)	elastomeric foam plastic ^A	MIL-P-15280, Form S	fibrous glass cloth	MIL-C-20079, Type I, Classes —3 through 9
—20 to +40 (–29 to +4)	elastomeric foam plastic ^A	MIL-P-15280, Form S	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	polyimide foam	—C1482, Type I	fibrous glass cloth with vapor —retarder	MIL-C-20079 Type I, Classes —3 through 9
	polyimide foam	C1482, Type I	fibrous glass cloth with vapor retarder	MIL-C-20079 Type I, Classes 3 through 9
	cellular glass	—C552, Type II	sheet steel galvanized	commercial ^C
	cellular glass	C552, Type II	sheet steel galvanized	commercial ^C
—41 to 125 (5 to 51)	elastomeric foam plastic ^A	MIL-P-15280, Form S	fibrous glass cloth	MIL-C-20079, Type I, Classes —3 through 9
—41 to 125 (5 to 51)	elastomeric foam plastic ^A	MIL-P-15280, Form S	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	polyimide foam	—C1482, Type I	fibrous glass cloth with vapor —retarder	MIL-C-20079, Type I, Classes —3 through 9
	polyimide foam	C1482, Type I	fibrous glass cloth with vapor retarder	MIL-C-20079, Type I, Classes 3 through 9
	cellular glass	—C552, Type I	fibrous glass cloth, or sheet —steel black commercial	MIL-C-20079, Type I, Classes —3 through 9 —commercial ^C
	cellular glass	C552, Type I	fibrous glass cloth, or sheet steel black commercial	MIL-C-20079, Type I, Classes 3 through 9 commercial ^C
	mineral fiber blanket	—C553	sheet steel black, commercial —or fibrous glass cloth with —vapor retarder	MIL-C-20079, Type I, Classes —3 through 9 —commercial ^C
	mineral fiber blanket	C553	sheet steel black, commercial or fibrous glass cloth with vapor retarder	MIL-C-20079, Type I, Classes 3 through 9 commercial ^C
—126 to 1200 (52 to 649)	fibrous glass felt	—MIL-I-16411, Type II	fibrous glass cloth	MIL-C-20079, Type I, Classes —7 or 9
—126 to 1200 (52 to 649)	fibrous glass felt	MIL-I-16411	fibrous glass cloth	MIL-C-20079, Type I, Classes 7 or 9
	polyimide foam ^D 400°F (204°C) max	—C1482, Type I	glass wire, reinforced fibrous glass cloth	HH-P-31, Type I MIL-C-20079, Type I, Classes —3 through 8
	polyimide foam ^D 400°F (204°C) max	C1482, Type I	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 8
	refractory fiber blanket	—C892, Grade 6 or 8	sheet steel black commercial —or fibrous glass cloth	MIL-C-20079, Type I, Classes —3 through 9
	refractory fiber blanket	C892, Grade 6 or 8	sheet steel black commercial or fibrous glass cloth glass wire, reinforced	MIL-C-20079, Type I, Classes 3 through 9 HH-P-31, Type I
	elastomeric foam plastic (180°F [82°C] max)	—MIL-P-15280 sheet	fibrous glass cloth	MIL-C-20079, Type I, Classes —3 through 9
	elastomeric foam plastic (180°F [82°C] max)	MIL-P-15280 sheet	fibrous glass cloth	MIL-C-20079, Type I, Classes 3 through 9
	high-temperature insulating —cement ^E	—C195		
	high-temperature insulating cement ^E	C195		
	calcium silicate insulating —block	—C553		
	calcium silicate insulating block	C553		
	mineral fiber blanket (1000°F [538°C] max)	—C553, C612	sheet steel black, or fibrous —glass cloth	MIL-C-20079, Type I, Classes —3 through 9
	mineral fiber blanket (1000°F (538°C) max)	C553, C612	sheet steel black, or fibrous glass cloth glass wire, reinforced	MIL-C-20079, Type I, Classes 3 through 9 HH-P-31, Type I
	perlite	—C610	fibrous glass cloth	MIL-C-20079, Type I, Classes —3 through 9
	perlite	C610	5	MIL-C-20079, Type I, Classes 3 through 9

^A See 5.4.

^B Insulation and lagging materials are acceptable for the temperature ranges indicated; other materials are capable of being used provided the requirements of this

TABLE 4 Thickness of Cellular Glass Insulation for Piping, –20 to 800°F (–29 to 427°C)^A

Nominal Pipe Size, in. (mm)	Maximum Temperature, °F (°C) × Thickness, in. (mm)								
	–20 to 40 ^B (–29 to 4)	41 to 125 ^C (5 to 52)	250 (121)	350 (177)	450 (232)	550 (288)	650 (343)	750 (399)	850 (454)
¼ (6) and above	2½ (63) 1½ ^D (38)	1 (25) ½ ^D (13)
1½ (38) and below	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	2½ (63)	3 (76)
2 (51)	1 (25)	2 (51)	1½ (38)	2 (51)	3 (76)	3 (76)	3½ (89)
2½, 3 (63, 76)	1 (25)	1½ (38)	2 (51)	2½ (63)	3 (76)	3½ (89)	4 (102)
4 (102)	1 (25)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4 (102)
5, 6 (127, 152)	1 (25)	1½ (38)	2 (51)	3 (76)	3½ (89)	3½ (89)	4½ (114)
8 (203)	1½ (38)	1½ (38)	2 (51)	3 (76)	3½ (89)	4 (102)	5 (127)
10 (254)	1½ (38)	1½ (38)	2 (51)	3 (76)	4 (102)	4 (102)	5 (127)
12 (305)	1½ (38)	1½ (38)	2½ (63)	3 (76)	4 (102)	4½ (114)	5½ (140)
14 (356)	1½ (38)	1½ (38)	2½ (63)	3½ (89)	4 (102)	4½ (114)	5½ (140)
16 (406)	1½ (38)	1½ (38)	2½ (63)	3½ (89)	4½ (114)	4½ (114)	5½ (140)
18 (457)	1½ (38)	1½ (38)	2½ (63)	3½ (89)	4½ (114)	4½ (114)	5½ (140)

^A Thickness of cellular glass, in accordance with Specification C552, Type II.

^B For refrigerant piping.

^C For antisweat applications.

^D Thickness for applications in air-conditioned spaces only.

TABLE 5 Thickness of Elastomeric Foam Plastic Insulation Piping, –20 to 180°F (–29 to 82°C)^A

Nominal Size, in. (mm)	Temperature Range, °F (°C)	Nominal Thickness, in. (mm)	
		Non-conditioned spaces	Air conditioned spaces only
¼ (6) and above	–20 to 40 (–29 to 4) ^B	1½ (38)	1 (25)
	41 to 125 (5 to 52) ^C	¾ (19)	½ (13)
	126 to 180 (53 to 82)	½ (13)	½ (13)

^A Thickness of elastomeric foam plastic insulation, conforming with MIL-P-15280, Form T, EB 4013 or C534, Type I.

^B For refrigerant piping.

^C For antisweat applications.

TABLE 6 Thickness of Polyimide Foam Insulation Piping, –20 to 400°F (–29 to 204°C)^A

Nominal Size, in. (mm)	Temperature Range, °F (°C)	Nominal Thickness, in. (mm)	
		Non-conditioned spaces	Air conditioned spaces only
¼ (6) and above	–20 to 40 (–29 to 4) ^B	1½ (38)	1 (25)
	41 to 125 (5 to 52) ^C	¾ (19)	½ (13)
	126 to 180 (53 to 82)	½ (13)	½ (13)
	181 to 250 (83 to 121)	¾ (19)	¾ (19)
	251 to 350 (122 to 177)	1 (25)	1 (25)
	351 to 400 (178 to 204)	1½ (38)	1½ (38)

^A Thickness of polyimide foam insulation conforming with Specification C1482.

^B For refrigerant piping.

^C For antisweat applications.

5.2 The insulation thicknesses specified in this practice are designed to maintain the surface temperature at or below 125°F (52°C) for fluid temperatures up to 650°F (343°C) with an ambient temperature of 85°F (29°C). For fluid temperatures above 650°F, the surface will be maintained at a maximum of 133°F (56°C).

5.2.1 Insulation thicknesses have been calculated in accordance with the computer programs in Practice C680.

5.3 Piping and units of equipment with designated internal temperatures of 300°F (149°C) and over shall be insulated from their supports or the supports insulated from the structures to which they are attached where the heat transmitted is objectionable on the opposite side of the structure.

5.4 Insulated piping passing through accommodation, service, and control spaces must be covered with approved noncombustible materials, which meet 46 CFR, Sections 164.009 and 164.012, or USCG Type Approval 164.109 and 164.112 as issued by

TABLE 7 Thickness of Mineral Fiber Insulation for Hot Piping, 850°F (454°C) Maximum^{A,B}

Nominal Pipe Size, in. (mm)	Maximum Temperature, °F (°C) × Thickness, in. (mm)							
	150 (66)	250 (121)	350 (177)	450 (232)	550 (288)	650 (343)	750 (399)	850 (454)
1½ (38) and below	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2 (51)	2½ (63)	3 (76)
2 (51)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3 (76)	3½ (89)
2½, 3 (63, 76)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	3 (76)	3½ (89)	4 (102)
4 (102)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	3 (76)	3½ (89)	4 (102)
5, 6 (127, 152)	1 (25)	1 (25)	1 (25)	2 (51)	2½ (63)	3 (76)	3½ (89)	4 (102)
8 (203)	1 (25)	1 (25)	1 (25)	2 (51)	2½ (63)	3 (76)	3½ (89)	4½ (114)
10 (254)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4½ (114)
12 (305)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3½ (89)	4½ (114)	4½ (114)
14, 16, 18 (356, 406, 457)	1 (25)	1 (25)	1½ (38)	2 (51)	3 (76)	3½ (89)	4½ (114)	5 (127)

^A Commercially known as fibrous glass.

^B Thickness of mineral fiber insulation in accordance with Specification C547, Class 2.

TABLE 8 Thickness of Mineral Fiber Insulation for Hot Piping, 1050°F (566°C) Maximum^{A,B}

Nominal Pipe Size, in. (mm)	Maximum Temperature, °F (°C) × Thickness, in. (mm)									
	150 (66)	250 (121)	350 (177)	450 (232)	550 (288)	650 (343)	750 (399)	850 (454)	950 (510)	1050 (566)
1½ (38) and below	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2 (51)	2 (51)	2½ (63)	3 (76)	3½ (89)
2 (51)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	2½ (63)	3 (76)	3½ (89)	4 (102)
2½, 3 (63, 76)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4 (102)	4½ (114)
4 (102)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3 (76)	3½ (89)	4 (102)	4½ (114)
5, 6 (127, 152)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3 (76)	3 (76)	3½ (89)	4½ (114)	5½ (140)
8 (203)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3 (76)	3 (76)	4 (102)	4½ (114)	5½ (140)
10 (254)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3 (76)	3½ (89)	4 (102)	5 (127)	6 (152)
12 (305)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4 (102)	5 (127)	6 (152)
14 (356)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4½ (114)	5½ (140)	6½ (165)
16 (406)	1 (25)	1 (25)	1½ (38)	2 (51)	3 (76)	3½ (89)	3½ (89)	4½ (114)	5½ (140)	6½ (165)
18 (457)	1 (25)	1 (25)	1½ (38)	2 (51)	3 (76)	3½ (89)	4 (102)	4½ (114)	5½ (140)	6½ (165)

^A Commercially known as mineral wool.

^B Thickness of mineral fiber insulation, in accordance with Specification C547, Class 3.

TABLE 9 Thickness of Calcium Silicate Insulation (Specification C533) for Hot Piping, 1050°F (566°C) Maximum^A

Nominal Pipe Size, in. (mm)	Maximum Temperature, °F (°C) × Thickness, in. (mm)									
	150 (66)	250 (121)	350 (177)	450 (232)	550 (288)	650 (343)	750 (399)	850 (454)	950 (510)	1050 (566)
1½ (38) and below	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	2½ (63)	2½ (63)	3 (76)	3½ (89)
2 (51)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	2½ (63)	3 (76)	3½ (89)	4 (102)
2½, 3, 4 (63, 76, 102)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3 (76)	3 (76)	3½ (89)	4 (102)	5 (127)
5, 6 (127, 152)	1½ (38)	1½ (38)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4 (102)	4½ (114)	5½ (140)
8 (203)	1½ (38)	1½ (38)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4 (102)	5 (127)	5½ (140)
10 (254)	1½ (38)	1½ (38)	1½ (38)	2 (51)	3 (76)	3½ (89)	3½ (89)	4½ (114)	5 (127)	6 (152)
12 (305)	1½ (38)	1½ (38)	1½ (38)	2 (51)	3 (76)	3½ (89)	3½ (89)	4½ (114)	5½ (140)	6 (152)
14 (356)	1½ (38)	1½ (38)	1½ (38)	2½ (63)	3 (76)	4 (102)	4 (102)	4½ (114)	5½ (140)	6½ (165)
16, 18 (406, 457)	1½ (38)	1½ (38)	1½ (38)	2½ (63)	3 (76)	4 (102)	4 (102)	5 (127)	5½ (140)	6½ (165)

^A Thickness of calcium silicate insulation, in accordance with Specification C533.

the USCG. Elastomeric foam plastic insulation shall not be used in these spaces.

5.5 Special consideration shall be given to the insulation of integral piping supplied with and mounted on equipment or machinery. In these cases, alternative materials and methods of installation shall be considered provided that they comply with the performance requirements of this practice.

5.6 Minimum insulation requirements have not been established for those surfaces or applications in which insulations had not been specified in past practices. In effect, the following surfaces are excluded from insulation requirements:

5.6.1 Surfaces where application of insulation will affect proper operation.

5.6.2 Equipment, components, and systems designed for the dispersion of heat.

5.6.3 Thermostatic steam traps and 24 in. (620 mm) of piping upstream of traps, which shall not be insulated. When located

TABLE 10 Thickness of Perlite Insulation (Specification C610) for Hot Piping, 1050°F (566°C) Maximum^A

Nominal Pipe Size, in. (mm)	Maximum Temperature, °F (°C) × Thickness, in. (mm)									
	150 (66)	250 (121)	350 (177)	450 (232)	550 (288)	650 (343)	750 (399)	850 (454)	950 (510)	1050 (566)
1½ (38) and below	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	2½ (63)	2½ (63)	3 (76)	3½ (89)
2 (51)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	2½ (63)	3 (76)	3½ (89)	4 (102)
2½, 3, 4 (63, 76, 102)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3 (76)	3 (76)	3½ (89)	4 (102)	5 (127)
5, 6 (127, 152)	1½ (38)	1½ (38)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4 (102)	4½ (114)	5½ (140)
8 (203)	1½ (38)	1½ (38)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4 (102)	5 (127)	5½ (140)
10 (255)	1½ (38)	1½ (38)	1½ (38)	2 (51)	3 (76)	3½ (89)	3½ (89)	4½ (114)	5 (127)	6 (152)
12 (305)	1½ (38)	1½ (38)	1½ (38)	2 (51)	3 (76)	3½ (89)	3½ (89)	4½ (114)	5½ (140)	6 (152)
14 (356)	1½ (38)	1½ (38)	1½ (38)	2½ (63)	3 (76)	4 (102)	4 (102)	4½ (114)	5½ (140)	6½ (163)
16, 18 (406, 457)	1½ (38)	1½ (38)	1½ (38)	2½ (63)	3 (76)	4 (102)	4 (102)	5 (127)	5½ (140)	6½ (165)

^A Thickness of perlite insulation, in accordance with Specification C610.

TABLE 11 Thickness of Antisweat Insulation for Machinery and Equipment

Temperature Range, °F (°C)	Material Specification	Nominal Thickness, in. (mm) ^A	
		Unconditioned Spaces	Conditioned Spaces
-20 to +40 (-29 to +4)	elastomeric foam plastic, C534, Type II	2 (51)	1 (25) ^B
	polyimide foam, C1482, Type I with vapor retarder	2 (51)	1 (25) ^B
41 to 125 (5 to 51)	cellular glass, C552 Type I	3 (76)	1½ (38) ^B
	elastomeric foam plastic, C534, Type II	¾ (19)	½ (13) ^B
	polyimide foam, C1482, Type I with vapor retarder	1 (25)	¾ (19) ^B
	cellular glass, C552, Type I	1 (25)	½ (13) ^B
	mineral fiber blanket, C553, C612	1 (25)	¾ (19) ^B

^A Nominal thickness exclusive of vapor retarder.

^B Thickness for application in air-conditioned spaces only.

TABLE 12 Thickness of Insulating Materials for Hot Surfaces of Machinery and Equipment, 126 to 1200°F (52 to 649°C)

Material	Maximum Temperature, °F (°C) × Thickness, in. (mm) ^A									
	150 (66)	250 (121)	350 (177)	450 (232)	550 (288)	650 (343)	750 (399)	850 (454)	950 (510)	1050 (566)
Fibrous glass felt, MIL-I-16411, Type II	1 (25)	1 (25)	1½ (38)	2½ (63)	3 (76)	4 (102)	4 (102)	5 (127)	5½ (140)	6½ (165)
Fibrous glass felt, MIL-I-16411	1 (25)	1 (25)	1½ (38)	2½ (63)	3 (76)	4 (102)	4 (102)	5 (127)	5½ (140)	6½ (165)
Block calcium silicate, C533	1½ (38)	1½ (38)	2 (51)	2½ (63)	4 (102)	4 (102)	4 (102)	5 (127)	5 (127)	5½ (140)
Block perlite, C610	1½ (38)	1½ (38)	2 (51)	2½ (63)	4 (102)	4 (102)	4 (102)	5 (127)	5 (127)	5½ (140)
Refractory fiber, C892, Grade 6	1 (25)	1 (25)	2 (51)	2½ (63)	3½ (89)	4½ (114)	4½ (114)	5½ (140)	6 (152)	7½ (191)
Refractory fiber, C892 Grade 8	1 (25)	1 (25)	1½ (38)	2½ (63)	3 (76)	4 (102)	4 (102)	5 (127)	6 (152)	7 (178)
Mineral fiber, ^B C553	1½ (38)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	3½ (89)	4 (102)	4½ (114)	5 (127)
Elastomeric foam, ^C C534, Type II	½ (13)	½ (13)								
Polyimide foam, C1482 ^D	¾ (19)	1 (25)	1½ (38)	2 (51)						
Insulating cement, ^E C195	2 (51)	2 (51)	2½ (63)	3½ (89)	5 (127)	5 (127)	5 (127)	5½ (140)		

^A Does not include finishing cement.

^B 1000°F (537°C) maximum temperature.

^C 180°F (82°C) maximum temperature.

^D Shall not be used alone above 850°F (454°C).

^E See Supplementary Requirements S1.15.

in areas in which personnel protection is required, expanded metal shields or multilayer glass cloth shall be provided.

5.6.4 Mechanical joints exposed to subatmospheric pressures and those included in the fuel oil service piping from heaters to burners.

5.6.5 Fuel oil piping between headers and burners.

5.6.6 Piping above 125°F (52°C) in bilges, not within watertight enclosures.

5.6.7 Piping in locations in which sweating and resultant rust is not objectionable such as voids, bilges, and shaft alleys, plus plumbing fixtures and associated supply and drain piping immediately adjacent thereto.

5.6.8 Deadend hot water piping ¾ in. (10 mm) and smaller.

5.6.9 Pressure-gage piping.

5.6.10 Soot-blower valve units and soot-blower flanges.

TABLE 13 Metal Lagging Materials^A

Material	Specification	Nominal Thickness, in. (mm)
Hot-dipped galvanized steel	D962 Coating designation G-115	0.014 (0.356)
Aluminum	B209, 6061	0.030 (0.762)
Corrosion-resistant steel	A167, Type 304	0.014 (0.356)

^A For use on piping and machinery insulation in locations where insulation is subject to abuse, except for uptake applications in which metal lagging shall be galvanized steel. Specification D962, Coating Designation G-115, not less than 1/32 in. (0.795 mm) thick.

TABLE 14 Thickness of Fiberglass Felt for Removable Insulation Blankets^A

Nominal Pipe Size, in. (mm)	Maximum Temperature, °F (°C) × Thickness, in. (mm)									
	150 (66)	250 (121)	350 (177)	450 (232)	550 (288)	650 (343)	750 (399)	850 (454)	950 (510)	1050 (566)
1/2 (13)	1 (25)	1 (25)	1 1/2 (38)	1 1/2 (38)	2 (51)	2 (51)	2 1/2 (63)	2 1/2 (63)	3 (76)	3 1/2 (89)
1 (25)	1 (25)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 (51)	2 1/2 (63)	3 (76)	3 (76)	3 1/2 (89)
1 1/2 (38)	1 (25)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 1/2 (63)	2 1/2 (63)	3 (76)	3 1/2 (89)	4 (102)
2 (51)	1 (25)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 1/2 (63)	2 1/2 (63)	3 (76)	3 1/2 (89)	4 (102)
3 (76)	1 (25)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 1/2 (63)	3 (76)	3 1/2 (89)	4 (102)	4 1/2 (114)
4 (102)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 1/2 (63)	3 (76)	3 (76)	3 1/2 (89)	4 (102)	5 (127)
6 (152)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 1/2 (63)	3 (76)	3 (76)	4 (102)	4 1/2 (114)	5 1/2 (140)
8 (203)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 1/2 (63)	3 (76)	3 1/2 (89)	4 (102)	5 (127)	5 1/2 (140)
10 (254)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 1/2 (63)	3 1/2 (89)	3 1/2 (89)	4 (102)	5 (127)	6 (152)
12 (305)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 1/2 (63)	3 1/2 (89)	3 1/2 (89)	4 1/2 (114)	5 (127)	6 (152)
14 (356)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 1/2 (63)	3 1/2 (89)	3 1/2 (89)	4 1/2 (114)	5 1/2 (140)	6 (152)
16 (406)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	3 (76)	3 1/2 (89)	3 1/2 (89)	4 1/2 (114)	5 1/2 (140)	6 1/2 (165)
18 (457)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	3 (76)	3 1/2 (89)	4 (102)	4 1/2 (114)	5 1/2 (140)	6 1/2 (165)

^A Thickness of fiberglass felt, in accordance with MIL-I-16411, Type II.

TABLE 15 Thickness of 8-lb/ft³ (128-kg/m³) Refractory Fiber Blanket for Removable Insulation Blankets^A

Nominal Pipe Size, in. (mm)	Maximum Temperature, °F (°C) × Thickness, in. (mm)									
	150 (66)	250 (121)	350 (177)	450 (232)	550 (288)	650 (343)	750 (399)	850 (454)	950 (510)	1050 (566)
1/2 (13)	1 (25)	1 (25)	1 (25)	1 1/2 (38)	1 1/2 (38)	2 (51)	2 (51)	2 1/2 (63)	3 (76)	3 (76)
1 (25)	1 (25)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 (51)	2 1/2 (63)	3 (76)	3 (76)	3 1/2 (89)
1 1/2 (38)	1 (25)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 1/2 (63)	2 1/2 (63)	3 (76)	3 1/2 (89)	4 (102)
2 (51)	1 (25)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 1/2 (63)	2 1/2 (63)	3 (76)	3 1/2 (89)	4 (102)
3 (76)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 1/2 (63)	3 (76)	3 (76)	3 1/2 (89)	4 (102)	4 1/2 (114)
4 (102)	1 (25)	1 (25)	1 1/2 (38)	2 (50)	2 1/2 (63)	3 (76)	3 (76)	3 1/2 (89)	4 (102)	4 1/2 (114)
6 (152)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 1/2 (63)	3 (76)	3 (76)	4 (102)	4 1/2 (114)	5 (127)
8 (203)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	2 1/2 (63)	3 1/2 (89)	3 1/2 (89)	4 (102)	4 1/2 (114)	5 1/2 (140)
10 (254)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	3 (76)	3 1/2 (89)	3 1/2 (89)	4 (102)	5 (127)	5 1/2 (140)
12 (305)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	3 (76)	3 1/2 (89)	3 1/2 (89)	4 1/2 (114)	5 (127)	6 (152)
14 (356)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	3 (76)	3 1/2 (89)	3 1/2 (89)	4 1/2 (114)	5 (127)	6 (152)
16 (406)	1 (25)	1 (25)	1 1/2 (38)	2 (51)	3 (76)	3 1/2 (89)	3 1/2 (89)	4 1/2 (114)	5 (127)	6 (152)
18 (457)	1 (25)	1 (25)	1 1/2 (38)	2 1/2 (63)	3 (76)	3 1/2 (89)	4 (102)	4 1/2 (114)	5 1/2 (140)	6 (152)

^A Thickness of 8-lb/ft³ (128-kg/m³) refractory fiber blanket in accordance with Specification C892, Grade 8.

5.6.11 Piping in voids and cofferdams except where omitting insulation is detrimental to system operation, such as catapult steam.

5.6.12 Safety valve bodies, springs, and lifting gear.

5.6.13 Piping over shower stalls and behind and under lavatories.

5.6.14 Valves or flanges in the collection holding tank (CHT) system.

5.7 Higher-temperature-type insulations are capable of being used where lower-temperature-type insulations are specified, provided that they are satisfactory in all other respects.

5.8 In “high traffic” locations in which the completed insulation and lagging is liable to abuse, such as shipping, unshipping, and maintenance areas, protective sheet metal lagging shall be installed. Where metal lagging is required, any of the materials listed in Table 13 are acceptable, except for boiler uptake applications in which metal lagging shall be galvanized sheet steel, in accordance with Specification A653/A653M, with Coating Designation G-115, and not less than 1/32 in. (0.8 mm) thick.

5.9 Before installing insulation, surface preparation of the piping is to be accomplished in accordance with the ship’s painting schedule.

5.10 Lacing hooks shall be welded to the structure or equipment (with permission of the vendor of the equipment) for securing insulation to the equipment.

5.11 For bends, fittings, and so forth, where molded sections of pipe insulation cannot be used, mitered sections of the pipe insulation or premolded fittings and covers shall be used, provided that they are suitable for the temperature and that the

TABLE 16 Thickness of 6-lb/ft³ (96-kg/m³) Refractory Fiber Blanket for Removable Insulation Blankets^A

Nominal Pipe Size, in. (mm)	Maximum Temperature, °F (°C) × Thickness, in. (mm)									
	150 (66)	250 (121)	350 (177)	450 (232)	550 (288)	650 (343)	750 (399)	850 (454)	950 (510)	1050 (566)
½ (13)	1 (25)	1 (25)	1 (25)	1½ (38)	1½ (38)	2 (51)	2 (51)	2½ (63)	2½ (63)	3 (76)
1 (25)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	2½ (63)	2½ (63)	3 (76)	3½ (89)
1½ (38)	1 (25)	1 (25)	1½ (38)	1½ (38)	2 (51)	2½ (63)	2½ (63)	2½ (63)	3 (76)	4 (102)
2 (51)	1 (25)	1 (25)	1½ (38)	1½ (38)	2 (51)	2½ (63)	2½ (63)	3 (76)	3½ (89)	4 (102)
3 (76)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3 (76)	3 (76)	3½ (89)	4 (102)	4½ (114)
4 (102)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3 (76)	3 (76)	3½ (89)	4½ (114)	5 (127)
6 (152)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4 (102)	4½ (114)	5½ (140)
8 (203)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4 (102)	5 (127)	5½ (140)
10 (254)	1 (25)	1 (25)	1½ (38)	2 (51)	3 (76)	3½ (89)	3½ (89)	4½ (114)	5 (127)	6 (152)
12 (305)	1 (25)	1 (25)	1½ (38)	2½ (63)	3 (76)	3½ (89)	4 (102)	4½ (114)	5½ (140)	6 (152)
14 (356)	1 (25)	1 (25)	2 (51)	2½ (63)	3 (76)	3½ (89)	4 (102)	4½ (114)	5½ (140)	6½ (165)
16 (406)	1 (25)	1 (25)	2 (51)	2½ (63)	3 (76)	3½ (89)	4 (102)	4½ (114)	5½ (140)	6½ (165)
18 (457)	1 (25)	1 (25)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4 (102)	5 (127)	6 (152)	6½ (165)

^A Thickness of 6-lb/ft³ (96-kg/m³) refractory fiber blanket in accordance with Specification C892, Grade 6.

TABLE 17 Thickness of Fiberglass Blanket for Removable Insulation Blankets^A

Nominal Pipe Size, in. (mm)	Maximum Temperature, °F (°C) × Thickness, in. (mm)							
	150 (66)	250 (121)	350 (177)	450 (232)	550 (288)	650 (343)	750 (399)	850 (454)
½ (13)	½ (13)	½ (13)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3 (76)
1 (25)	½ (13)	½ (13)	1 (25)	1½ (38)	2 (51)	2 (51)	2½ (63)	3 (76)
1½ (38)	½ (13)	½ (13)	1 (25)	1½ (38)	2 (51)	2 (51)	3 (76)	3½ (89)
2 (51)	½ (13)	½ (13)	1 (25)	1½ (38)	2 (51)	2 (51)	3 (76)	4 (102)
3 (76)	½ (13)	½ (13)	1 (25)	1½ (38)	2 (51)	2 (51)	3 (76)	4 (102)
4 (102)	½ (13)	½ (13)	1 (25)	1½ (38)	2½ (63)	2½ (63)	3½ (89)	4½ (114)
6 (152)	½ (13)	½ (13)	1 (25)	2 (51)	2½ (63)	2½ (63)	3½ (89)	5 (127)
8 (203)	½ (13)	½ (13)	1 (25)	2 (51)	2½ (63)	2½ (63)	4 (102)	5 (127)
10 (254)	½ (13)	½ (13)	1½ (38)	2 (51)	2½ (63)	2½ (63)	4 (102)	5½ (140)
12 (305)	½ (13)	1 (25)	1½ (38)	2 (51)	2½ (63)	2½ (63)	4 (102)	5½ (140)
14 (356)	½ (13)	1 (25)	1½ (38)	2 (51)	3 (76)	4 (102)	4 (102)	5½ (140)
16 (406)	½ (13)	1 (25)	1½ (38)	2 (51)	3 (76)	4 (102)	4½ (114)	5½ (140)
18 (457)	½ (13)	1 (25)	1½ (38)	2 (51)	4 (102)	4 (102)	4½ (114)	6 (152)

^A Thickness of fiberglass blanket, in accordance with Specification C612, Type II, C553, Type IV.

requirements of this practice are satisfied (see 4.1 and 5.4). Fittings in sizes under 2-in. (51-mm) nominal pipe size (NPS) shall be insulated with insulating cement, in accordance with Specification C449/C449M.

5.12 Where insulation specifications listed in Tables 1 and 3 provide for the use of nonmetal “jacketed”-type insulation, separate lagging material shall be omitted.

5.13 Single-layered insulation construction shall be permitted on all surfaces operating at temperatures below 600°F (316°C). Double-layered insulation construction shall be used with all joints staggered on all surfaces operating at temperatures of 600°F and above, except single-layered construction will be permitted when the total insulation thickness is 3 in. (75 mm) or less or the pipe size is NPS 2 in. (50 mm) or below.

6. Selection Requirements, Piping

6.1 *Interior Piping, Temperature Range from -20 to +40°F (-29 to +4°C)*—Use for air conditioning and ship’s stores refrigerant piping and other services within the temperature range.

6.1.1 For insulation and lagging materials, see Table 1.

6.1.2 For insulation thickness, see Table 4 or Table 5.

6.1.3 For installation details, see Fig. 1, Fig. 2, or Fig. 3 as applicable.

6.2 *Interior Piping, Temperature Range from 41 to 125°F (5 to 52°C)*—Use for cold freshwater, plumbing drains, firemain, main and auxiliary, saltwater circulating, and saltwater cooling, piping, and other services within the temperature range.

6.2.1 For insulation and lagging materials, see Table 1.

6.2.2 For insulation thickness, see Table 2, Table 3, or Table 4.

6.2.3 For installation details, see Fig. 1, Fig. 2, or Fig. 3 as applicable.

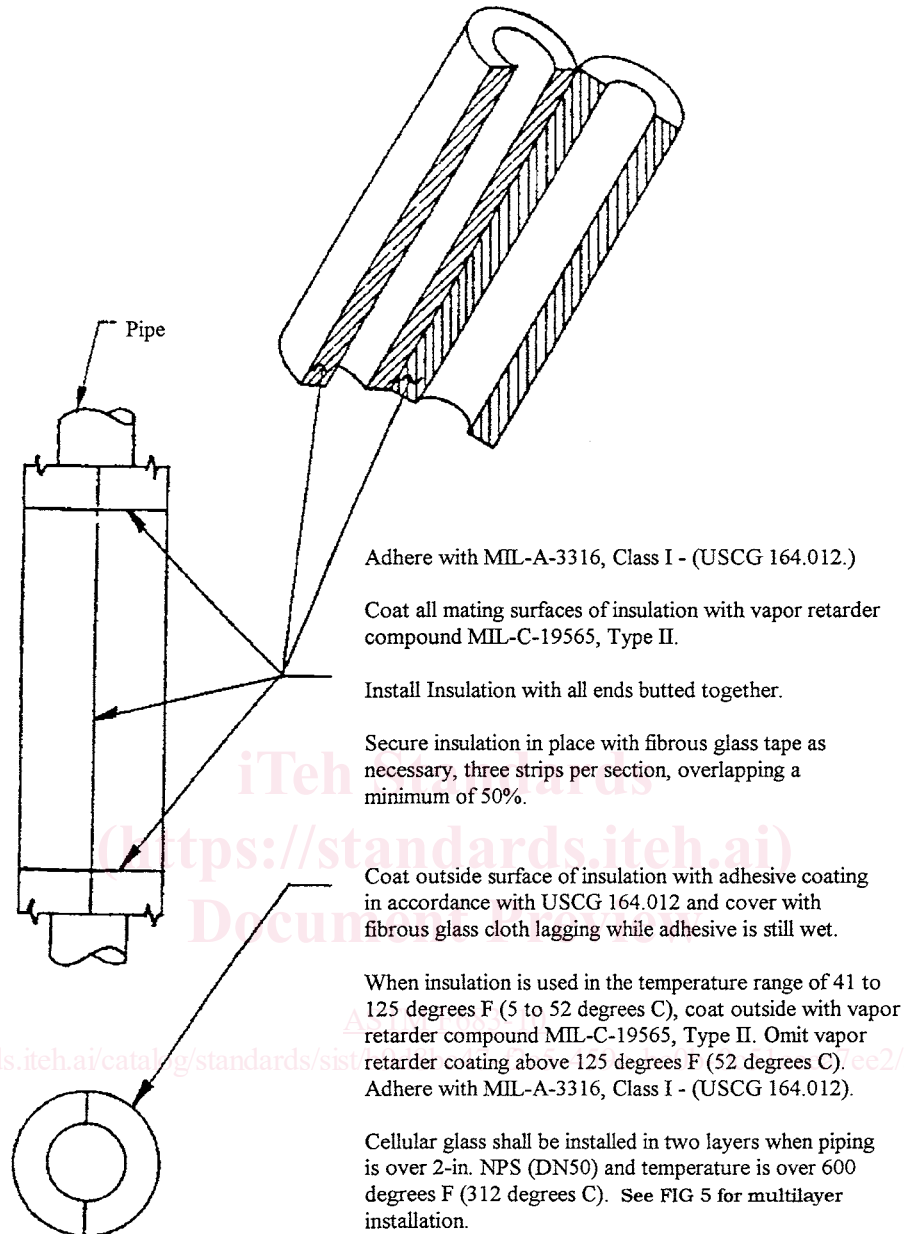


FIG. 1 Installation of Cellular Glass Pipe Insulation (Specification C552)

6.2.4 *Special Conditions:*

6.2.4.1 Piping systems operating in this temperature range including water closet drain piping do not require insulation except where damage or discomfort will result from condensation.

6.2.4.2 Dry firemain need only be insulated above ceilings and in areas in which damage or discomfort from condensation is a problem.

6.2.4.3 If cold, fresh, or potable water tanks (not having a side integral with the shell) are installed in a heated area, the piping to the pumps and therefore to the services need not be insulated. If this water is being used for flushing water closets, the drain piping need not be insulated.

6.2.4.4 Freshwater fill piping inside the ship shall be insulated.

6.2.4.5 Drains from drinking water chillers shall be insulated.

6.3 *Interior Piping, Temperature Range from 126 to 450°F (52 to 232°C)*—Use for hot freshwater, hot-water heating, fuel oil service discharge from heaters to headers, condensate, and air ejector piping, boiler feed, high- and low-pressure steam drain piping, and other services within the temperature range.

6.3.1 For insulation and lagging materials, see Table 1.

6.3.2 For insulation thickness, see Table 4, Table 5, Table 7, Table 8, or Table 9.

6.3.3 For installation details, see Fig. 1, Fig. 2, Fig. 3, Fig. 4, Fig. 5, or Fig. 6, as applicable.