This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: F683 – 23a

An American National Standard

Standard Practice for Selection and Application of Thermal Insulation for Piping and Machinery[1]

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 U.S. Department of Defense.

1. Scope

1.1 This practice covers the selection of types and thicknesses of thermal insulation materials for piping, machinery, and equipment for nonnuclear shipboard applications within the temperature ranges specified in Tables 1-16. Methods and materials for installation, including lagging, are also detailed.

1.2 This practice addresses operating temperatures from a low of –20 °F (–29 °C) up to 1200 °F (649 °C).

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents[2]

2.1 *ASTM Standards:*[3]

A240 Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

B209/B209M Specification for Aluminum and Aluminum-Alloy Sheet and Plate

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

C1086 Specification for Glass Fiber Mechanically Bonded Felt Thermal Insulation

C1729 Specification for Aluminum Jacketing for Insulation

C1767 Specification for Stainless Steel Jacketing for Insulation

D962 Specification for Aluminum Powder and Paste Pigments for Paints

2.2 *Federal Specifications:*[4]

HH-P-31 Packing and Lagging Material, Fibrous Glass Metallic and Plain Cloth and Tape

2.3 *Military Specifications:*[4]

MIL-C-20079 Cloth, Glass, Tape, Textile Glass and Thread, Glass

[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.

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[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.

[4] Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, http://quicksearch.dla.mil.

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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,D]	Specification
–20 to +40 (–29 to +4)	cellular glass	ASTM C552, Type II	Woven glass fiber cloth	MIL-C-20079, Type I, Classes 3 through 9
			Knitted glass fiber tape Table 12 materials	MIL-C-20079, Type II, Class 3
	elastomeric cellular[A]	MIL-PRF-32514, Type I, (ASTM C534, Grade 3), ASTM C534, Grades 1, 2, and 3	Woven glass fiber cloth	MIL-C-20079, Type I, Classes 3 through 9
			Knitted glass fiber tape Table 12 materials	MIL-C-20079, Type II, Class 3
41 to 125 (5 to 51)	cellular glass	ASTM C552, Type II	Woven glass fiber cloth	MIL-C-20079, Type I, Classes 3 through 9
			Knitted glass fiber tape Table 12 materials	MIL-C-20079, Type II, Class 3
	elastomeric cellular[A]	MIL-PRF-32514, Type I, (ASTM C534, Grade 3), ASTM C534, Grades 1, 2, and 3	Woven glass fiber cloth	MIL-C-20079, Type I, Classes 3 through 9
			Knitted glass fiber tape Table 12 materials	MIL-C-20079, Type II, Class 3
	mineral fibers	ASTM C547, Types I through IV	Woven glass fiber cloth	MIL-C-20079, Type I, Classes 3 through 9
			Knitted glass fiber tape Table 12 materials	MIL-C-20079, Type II, Class 3
126 to 450 (52 to 232)	cellular glass	ASTM C552, Type II	Woven glass fiber cloth	MIL-C-20079, Type I, Classes 3 through 9
			Knitted glass fiber tape Table 12 materials	MIL-C-20079, Type II, Class 3
	elastomeric cellular 220 °F (104 °C) max	MIL-PRF-32514, Type I (ASTM C534, Grade 3), ASTM C534 Grades 1, 2, and 3	Woven glass fiber cloth	MIL-C-20079, Type I, Classes 3 through 9
			Knitted glass fiber tape Table 12 materials	MIL-C-20079, Type II, Class 3
	calcium silicate	ASTM C533, Type I	Woven glass fiber cloth	MIL-C-20079, Type I, Classes 3 through 9
			Knitted glass fiber tape Table 12 materials	MIL-C-20079, Type II, Class 3
	expanded perlite	ASTM C610	Woven glass fiber cloth	MIL-C-20079, Type I, Classes 3 through 9
			Knitted glass fiber tape Table 12 materials	MIL-C-20079, Type II, Class 3
	mineral fiber	ASTM C547, Types I through IV	Woven glass fiber cloth	MIL-C-20079, Type I, Classes 3 through 9
			Knitted glass fiber tape Table 12 materials	MIL-C-20079, Type II, Class 3
451 to 1200 (233 to 649)	cellular glass, 800 °F (427 °C) max	ASTM C552, Type II	Woven glass fiber cloth	MIL-C-20079, Type I, Classes 3 through 9
			Knitted glass fiber tape Table 12 materials	MIL-C-20079, Type II, Class 3
	mineral fiber	ASTM C547, Types I to IV for up to 1000 °F (538 °C)	Woven glass fiber cloth Table 12 materials	MIL-C-20079, Type I, Classes 3 through 9
	mineral fiber	ASTM C547, Types II and III for up to 1200 °F (649 °C)	Knitted glass fiber tape Table 12 materials	MIL-C-20079, Type II, Class 3
	calcium silicate	ASTM C533, Type I	Woven glass fiber cloth	MIL-C-20079, Type I, Classes 3 through 9
			Knitted glass fiber tape Table 12 materials	MIL-C-20079, Type II, Class 3
	expanded perlite	ASTM C610	Woven glass fiber cloth	MIL-C-20079, Type I, Classes 3 through 9
			Knitted glass fiber tape Table 12 materials	MIL-C-20079, Type II, Class 3

[A] See 5.4.
[B] Insulation and insulation covering 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] Factory applied aluminum foil lagging may be used in areas not requiring a paintable surface, such as behind drop ceilings and joiner panels and the lagging meets all regulatory requirements.

MIL-C-22395 Compound, End Sealing, Thermal Insulation Pipe Covering—Fire, Water, and Weather Resistant

MIL-DTL-32585 Insulation, Thermal and Acoustic Fibrous Glass

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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	Specification
–20 to +40 (–29 to +15)	cellular glass	ASTM C552, Type II	Woven glass fiber cloth with outdoor mastic, Table 12 materials	MIL-C-20079, Type I Class 7, Class 9
	elastomeric cellular	MIL-PRF-32514, Type I (ASTM C534, Grade 3), ASTM C534, Grades 1, 2, and 3	Woven glass fiber cloth with outdoor mastic, Table 12 materials	MIL-C-20079, Type I Classes 3 through 9
41 to 100 (5 to 37)	cellular glass	ASTM C552, Type II	Woven glass fiber cloth with outdoor mastic, Table 12 materials	MIL-C-20079, Type I Class 7, Class 9
	elastomeric cellular	MIL-PRF-32514 , Type I (ASTM C534, Grade 3), ASTM C534, Grades 1, 2, and 3	Woven glass fiber cloth with outdoor mastic, Table 12 materials	MIL-C-20079 , Type I, Classes 3 through 9
	perlite	ASTM C610	Woven glass fiber cloth with outdoor mastic, Table 12 materials	MIL-C-20079, Type I Class 7, Class 9
	calcium silicate	ASTM C533, Type I	Woven glass fiber cloth with outdoor mastic, Table 12 materials	MIL-C-20079, Type I Class 7, Class 9
	mineral fiber	ASTM C547, Types I through IV	Woven glass fiber cloth with outdoor mastic, Table 12 materials	MIL-C-20079, Type I Class 7, Class 9
101 to 450 (38 to 232)	cellular glass	ASTM C552, Type II	Woven glass fiber cloth with outdoor mastic, Table 12 materials	MIL-C-20079, Type I Class 7, Class 9
	perlite	ASTM C610	Woven glass fiber cloth with outdoor mastic, Table 12 materials	MIL-C-20079, Type I Class 7, Class 9
	calcium silicate	ASTM C533, Type I	Woven glass fiber cloth with outdoor mastic, Table 12 materials	MIL-C-20079, Type I Class 7, Class 9
	mineral fiber	ASTM C547, Types I to IV	Woven glass fiber cloth with outdoor mastic, Table 12 materials	MIL-C-20079, Type I Class 7, Class 9
	elastomeric cellular 220 °F (104 °C) Max	MIL-PRF-32514, Type I, (ASTM C534, Grade 3), ASTM C534, Grades 1, 2, and 3	Woven glass fiber cloth with outdoor mastic, Table 12 materials	MIL-C-20079, Type I, Classes 3 through 9

[A] Insulation and lagging materials listed are acceptable for the temperature ranges indicated; other materials are capable of being used provided the requirements of this practice are satisfied.

MIL-I-16411 Insulation, Felt, Thermal, Glass Fiber
MIL-P-15280 Plastic Material, Unicellular (Sheets and Tubes)
MIL-PRF-24596 Coating Compounds, Nonflaming, Fire-Protective (Metric)
MIL-PRF-32514 Insulation, Anti-Sweat, Refrigerant, and Thermal Foam
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]
USCG Type Approval 164.109 IMO FTP Code Annex 1, Part 1[5]
USCG Type Approval 164.112 IMO FTP Code Annex 1, Parts 2 and 5[5]
Fire Test Procedures Code IMO Resolution MSC 307 (88) Annex 1 Part 1 and Part 5 and Annex 2[5]
IMO SOLAS 1974 as amended through 2014[5]

[5] Available from International Maritime Organization (IMO), 4, Albert Embankment, London SE1 7SR, United Kingdom, http://www.imo.org.

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms relating to insulating materials used in this practice, refer to Terminology C168.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *lagging, n*—a covering installed over thermal insulation.

3.2.1.1 *Discussion*—Lagging can consist of a sheet or film vapor retarder, metal jacket, a non-metallic jacket, or a woven or knitted fabric combined with a durable mastic.

3.2.2 *objectionable areas, n*—locations where the formation of condensation will be objectionable from at least one of the following standpoints; (*a*) personnel; (*b*) electrical and electronic equipment, ladder steps, and walkways; (*c*) stores or supplies; or (*d*) machinery, equipment, or painted surfaces of bulkheads or decks which are normally kept in ship shape condition.

3.2.3 *high traffic area, n*—an area subject to wear and damage during normal, routine operations.

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TABLE 3 Insulation and Lagging Materials for Machinery and Equipment[A,B]

Temperature Range °F (°C)	Insulation	Specification	Lagging[C]	Specification
–20 to +40 (–29 to +4)	elastomeric cellular[A]	MIL-PRF-32514, Type I, (ASTM C534, Grade 3), ASTM C534, Grades 1, 2, and 3	woven glass fiber cloth with outdoor mastic, Table 12 materials	MIL-C-20079, Type I, Classes 3 through 9
	cellular glass	ASTM C552, Type II	woven glass fiber cloth, Table 12 materials	MIL-C-20079, Type I, Classes 3 through 9
41 to 125 (5 to 51)	elastomeric cellular[A]	MIL-PRF-32514, Type I, (ASTM C534, Grade 3), ASTM C534, Grades 1, 2, and 3	woven glass fiber cloth with outdoor mastic, Table 12 materials	MIL-C-20079, Type I, Classes 3 through 9
	cellular glass	ASTM C552	woven glass fiber cloth, Table 12 materials	MIL-C-20079, Type I, Classes 1, 3, 5, 7, and 9
	mineral fiber blanket	ASTM C553	woven glass fiber cloth, Table 12 materials	MIL-C-20079, Type I, Classes 3 through 9
126 to 1200 (52 to 649)	glass fiber felt	MIL-I-16411	woven glass fiber cloth, Table 12 materials glass wire, reinforced	MIL-C-20079, Type I, Classes 3 through 9 HH-P-31, Type I
	High Temperature fiber blanket	ASTM C892, Grade 6 or 8	woven glass fiber cloth, Table 12 materials glass wire, reinforced	MIL-C-20079, Type I, Classes 3 through 9 HH-P-31, Type I
	high-temperature insulating cement[D]	ASTM C195		
	Mineral Fiber Hydraulic-Setting cement	ASTM C449/C449M		
	calcium silicate insulating block	ASTM C533, Type I		
	mineral fiber blanket (1000 °F (538 °C) max))	ASTM C553, Types V through VII;C612, Types III, IV A, and IV B, and V	woven glass fiber cloth, Table 12 materials	MIL-C-20079, Type I, Classes 3 through 9
	mineral fiber blanket or board (1200 °F (649 °C) max))	ASTM C553, Type VII; C612, Type IV A, IV B, and V	woven glass fiber cloth, Table 12 materials glass wire, reinforced	MIL-C-20079, Type I, Classes 3 through 9 HH-P-31, Type I
	perlite	ASTM C610	woven glass fiber cloth, Table 12 materials	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 practice are satisfied.
[C] Factory applied aluminum foil lagging may be used in areas not requiring a paintable surface, such as behind drop ceilings and joiner panels and the lagging meets all regulatory requirements.
[D] When insulating cement is used, it shall be applied in successive layers, ½ in. to 1 in. (13 mm to 25 mm) in thickness, until the total thickness specified in Table 6 has been reached. Galvanized iron wire netting, 1 in. (13 mm) mesh, shall be installed between layers. A ½ in. (13 mm) thickness of finishing cement, in accordance with Specification C449/C449M, shall be applied over the last layer of insulating cement.

TABLE 4 Minimum Thickness of Cellular Glass Insulation for Piping, –20 °F to 800 °F (–29 °C 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)	1½ (38) 1½ [D] (38)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
1½ (38) and below	. . .	. . .	1½ (38)	1½ (38)	1½ (38)	2 (51)	2½ (63)	2½ (63)	3 (76)
2 (51)	. . .	. . .	1½ (38)	2 (51)	1½ (38)	2 (51)	3 (76)	3 (76)	3½ (89)
2½, 3 (63, 76)	. . .	. . .	1½ (38)	1½ (38)	2 (51)	2½ (63)	3 (76)	3½ (89)	4 (102)
4 (102)	. . .	. . .	1½ (38)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4 (102)
5, 6 (127, 152)	. . .	. . .	1½ (38)	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.

4. Materials and Manufacture

4.1 *Insulation and Lagging Material Specifications,* as listed in Tables 1-16, 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

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TABLE 5 Minimum Thickness of Elastomeric Cellular Insulation Piping, –20 °F to +220 °F (–29 °C to 104 °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 60 (–29 to 4)[B]	1½ (38)	1 (25)

[A] Thickness of elastomeric cellular insulation, conforming with, MIL-PRF-32514, Type I or Type II or Specification C534.
[B] For refrigerant piping.

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 °F to 125 °F (13 °C to 52 °C) during normal operation, shall be insulated except as otherwise stated herein.

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 the USCG. Elastomeric cellular insulation shall not be used in these spaces except where allowed by SOLAS.

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, except when located in areas in which personnel protection is required insulation, shall be installed in accordance with the requirements identified in 5.2.

5.6.3 Thermostatic steam traps and 24 in. (620 mm) of piping upstream of traps, which shall not be insulated. When located 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 sub-atmospheric 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 or equipment that will form condensation in non-objectionable areas.

5.6.8 Dead-end hot water piping ⅜ in. (10 mm) and smaller.

5.6.9 Pressure-gauge piping.

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

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 and within 4 ft (1.2 m) of the deck, such as shipping, unshipping, and maintenance areas, the insulation shall be suitably protected from mechanical damage.

NOTE 1—The following are suitable protection suggestions:

(1) In way of foot traffic insulation with high compressive strength with a durable jacketing such as heavy cloth or materials listed in Table 12 can be used. Examples include calcium silicate, cellular glass but are not limited to. If insulation with a high compressive strength is not used, then a jacketing material compliant with materials listed in Table 12 are recommended.

(2) In way of forklift or other machinery operations, guards or bumpers should be used to prevent contact. Installing mechanical protection on the insulation system will not protect it from this type of impact and will only increase the cost to repair.

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

5.10 Fasteners 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 pre-formed fittings and covers shall be used, provided that they are suitable for the temperature and that the requirements of this practice are satisfied (see 4.1 and 5.4). When using calcium silicate fittings in sizes under 2 in. (51 mm) nominal pipe size (NPS) shall be insulated with insulating cement, in accordance with Specification C449/

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TABLE 6 Minimum 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)	2½ (63)	3½ (89)
2½, 3 (63, 76)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	3 (76)	3½ (89)	3½ (89)
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 glass fiber.
[B] Thickness of mineral fiber insulation in accordance with Specification C547.

TABLE 7 Minimum 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.

TABLE 8 Minimum 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)[B]	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.
[B] For indoor use only.

TABLE 9 Minimum 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.

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TABLE 10 Minimum 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 cellular, ASTM C534, Type II	2 (51)	1 (25)[B]
	cellular glass, ASTM C552, Type I	3 (76)	1½ (38)[B]
41 to 125 (5 to 51)	elastomeric cellular, ASTM C534, Type II	¾ (19)	½ (13)[B]
	cellular glass, ASTM C552, Type I	1 (25)	½ (13)[B]
	mineral fiber blanket, ASTM C553, C612	1 (25)	¾ (19)[B]

[A] Nominal thickness exclusive of vapor retarder.
[B] Thickness for application in air-conditioned spaces only.

C449M or stuffed out with Type 1, Form 3, in accordance with MIl-DTL-32585 and covered with hydraulic setting insulating cement

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 °F to +40 °F (−29 °C 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 or Fig. 2, as applicable.

6.2 *Interior Piping, Temperature Range from 41 °F to 60 °F (15.6 °C 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.

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 61 °F to 450 °F (16.1 °C 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 6, Table 7, or Table 8.

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

6.3.4 *Special Conditions*—On piping, tubing, and fittings sized less than NPS ⅜ in., insulation need be applied only where required for personnel protection.

6.4 *Interior Piping, Temperature Range from 451 °F to 1050 °F (233 °C to 566 °C)*—Use for main steam, auxiliary steam, exhaust and bleed steam, gland seal steam and exhaust, high- and low-pressure steam drains, soot blower steam, boiler blow, safety and relief valve escape steam heating, diesel exhaust piping, and other services within the temperature range.

6.4.1 For insulation and lagging materials, see Table 1.

6.4.2 For insulation thickness, see Table 4, Table 6, Table 7, or Table 8, as applicable.

6.4.3 For installation details, see Fig. 1, Fig. 3, Fig. 4, or Fig. 5, as applicable.

6.4.4 *Special Conditions:*

6.4.4.1 The soot blower piping between the root valve and the soot blower heads shall have an insulation thickness of one half of that indicated for a continually operating system at the same temperature.

6.4.4.2 Main steam piping insulation shall be arranged with removable pads to bare sections for audio gaging when required.

6.4.4.3 Turbo-generator exhaust to main and auxiliary condensers do not require insulation except in areas susceptible to personnel contact.

6.4.4.4 Safety and relief valve escape piping need not be insulated except in areas susceptible to contact by personnel.

6.4.4.5 Boiler blow piping need not be insulated except in areas susceptible to contact by personnel.

6.4.4.6 On piping, tubing, and fittings sizes less than NPS ⅜ in. (10 mm), insulation need be applied only where required for personnel protection.

6.4.4.7 Steam smothering and steam to the sea chests need be insulated only in those areas susceptible to personnel contact.

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TABLE 11 Minimum Thickness of Insulating Materials for Hot Surfaces of Machinery and Equipment, 126 °F to 1050 °F (52 °C to 566 °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)
Woven glass fiber, MIL-DTL-32585	1 (25)	1 (25)	1½ (38)	2½ (63)	3 (76)	4 (102)	4 (102)	5 (127)	5½ (140)	6½ (165)
Block calcium silicate, Specification C533, Type I	1½ (38)	1½ (38)	2 (51)	2½ (63)	4 (102)	4 (102)	4 (102)	5 (127)	5 (127)	5½ (140)
Block perlite, Specification C610	1½ (38)	1½ (38)	2 (51)	2½ (63)	4 (102)	4 (102)	4 (102)	5 (127)	5 (127)	5½ (140)
High temperature fiber, Specification C892, Grade 6	1 (25)	1 (25)	2 (51)	2½ (63)	3½ (89)	4½ (114)	4½ (114)	5½ (140)	6 (152)	7½ (191)
High temperature fiber, Specification 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] Specification C553	1½ (38)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3 ½ (89)	3½ (89)	4 (102)	4½ (114)	5 (127)
Elastomeric cellular,[C] Specification C534	½ (13)	½ (13)								
Insulating cement, Specification 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.

TABLE 12 Metal and Non-Metallic Cladding Materials[A]

Material	Specification	Minimum Thickness, in. (mm)
Aluminum	ASTM C1729[C]	0.016 (0.40)
Corrosion-resistant steel	ASTM C1767[C]	0.010 (0.25)
Non-metallic systems[B]	In accordance with manufacturer	In accordance with manufacturer

[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.
[B] For use on systems in the weather unless the product meets the flame, smoke and toxicity requirements of Ship Specifications and Regulatory Body.
[C] These standard specifications incorporate by reference the appropriate metal alloy standards (Specifications B209/B209M for aluminum and A240 for stainless steel).

6.5 *Weather-Exposed Piping, Temperature Range from −20 °F to +60 °F (−29 °C to +15.6 °C)*—Use for low-temperature piping exposed to the weather.

6.5.1 For insulation and lagging materials, see Table 2.

6.5.2 For insulation thickness, see Table 4.

6.5.3 For installation details, see Figs. 1-4.

6.5.4 *Special Conditions:*

6.5.4.1 Piping exposed to the weather shall also be effectively insulated against freezing, condensation control and for system integrity. The thickness of insulation required to meet these requirements is determined by calculation based on the system fluid, system velocity, type of insulation to be used, and climatic conditions involved. This does not apply to systems that are secured and drained.

6.5.4.2 At pipe supports, remove only enough insulation to provide a snug fit. Fill voids between insulation and support with tightly packed woven glass fiber felt, conforming with MIL-I-16411 to within ¼ in. (6 mm) of the insulation surface. Fill the remainder with end-sealing compound, conforming with MIL-C-22395, overlapping both the support member and the adjacent insulation. Lag and coat with the same materials as the adjacent pipe.

6.5.4.3 Alternatively, the lagged insulation and ends are permitted to be clad with metal lagging in lieu of end sealing compound.

6.6 *Weather-Exposed Piping, Temperature Range from 61 °F to 450 °F (15.6 °C to 232 °C)*—Use for hot piping systems exposed to weather.

6.6.1 For insulation and lagging materials, see Table 2.

6.6.2 For insulation thickness, see Table 4, Table 6, Table 7, or Table 8.

6.6.3 For installation details, see Fig. 3, or Fig. 7.

6.6.4 *Special Conditions:*

6.6.4.1 Piping exposed to the weather shall be effectively insulated against at least one of the following: freezing, condensation control, system integrity, or combination thereof. The thickness of insulation required to meet these requirements is determined by calculation based on the system fluid, system velocity, type of insulation to be used, and climatic conditions involved. This does not apply to systems that are secured and drained.

6.6.4.2 At pipe supports, remove only enough insulation to provide a snug fit. Fill voids between the insulation and support with tightly packed woven glass fiber felt, conforming with MIL-I-16411 to within ¼ in. (6 mm) of the insulation surface. Fill the remainder with end-sealing compound, conforming with MIL-C-22395, overlapping both the support member and the adjacent insulation. Lag and coat with the same materials as the adjacent pipe.

6.6.4.3 Alternatively, the lagged insulation and ends are permitted to be clad with metal lagging in lieu of end sealing compound.

7. Selection Requirements, Machinery and Equipment

7.1 *Temperature Range from −20 °F to +40 °F (−29 °C to +4 °C)*—Use for refrigerant and other equipment within the temperature range.

7.1.1 For insulation and lagging materials, see Table 3.

7.1.2 For insulation thickness, see Table 10.

7.1.3 For installation details, see Fig. 6 or Fig. 7, as applicable.

7.2 *Temperature Range from 41 °F to 125 °F (5 °C to 52 °C)*—Use for low-temperature machinery and equipment within the temperature range.

7.2.1 For insulation and lagging materials, see Table 3.

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TABLE 13 Minimum Thickness of Glass Fiber Felt for Removable/Reusable 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)	1½ (38)	1½ (38)	2 (51)	2 (51)	2½ (63)	2½ (63)	3 (76)	3½ (89)
1 (25)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2 (51)	2½ (63)	3 (76)	3 (76)	3½ (89)
1½ (38)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	2½ (63)	3 (76)	3½ (89)	4 (102)
2 (51)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	2½ (63)	3 (76)	3½ (89)	4 (102)
3 (76)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	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)	4 (102)	5 (127)
6 (152)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3 (76)	3 (76)	4 (102)	4½ (114)	5½ (140)
8 (203)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3 (76)	3½ (89)	4 (102)	5 (127)	5½ (140)
10 (254)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4 (102)	5 (127)	6 (152)
12 (305)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4½ (114)	5 (127)	6 (152)
14 (356)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4½ (114)	5½ (140)	6 (152)
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] Thickness of glass fiber felt, in accordance with MIL-DTM-32585 or Specification C1086.

TABLE 14 Minimum Thickness of Nominal 8 lb/ft^3 (128 kg/m^3) High Temperature Fiber Blanket for Removable/Reusable 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)	3 (76)	3 (76)
1 (25)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2 (51)	2½ (63)	3 (76)	3 (76)	3½ (89)
1½ (38)	1 (25)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	2½ (63)	3 (76)	3½ (89)	4 (102)
2 (51)	1 (25)	1 (25)	1 (25)	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 (50)	2½ (63)	3 (76)	3 (76)	3½ (89)	4 (102)	4½ (114)
6 (152)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3 (76)	3 (76)	4 (102)	4½ (114)	5 (127)
8 (203)	1 (25)	1 (25)	1½ (38)	2 (51)	2½ (63)	3½ (89)	3½ (89)	4 (102)	4½ (114)	5½ (140)
10 (254)	1 (25)	1 (25)	1½ (38)	2 (51)	3 (76)	3½ (89)	3½ (89)	4 (102)	5 (127)	5½ (140)
12 (305)	1 (25)	1 (25)	1½ (38)	2 (51)	3 (76)	3½ (89)	3½ (89)	4½ (114)	5 (127)	6 (152)
14 (356)	1 (25)	1 (25)	1½ (38)	2 (51)	3 (76)	3½ (89)	3½ (89)	4½ (114)	5 (127)	6 (152)
16 (406)	1 (25)	1 (25)	1½ (38)	2 (51)	3 (76)	3½ (89)	3½ (89)	4½ (114)	5 (127)	6 (152)
18 (457)	1 (25)	1 (25)	1½ (38)	2½ (63)	3 (76)	3½ (89)	4 (102)	4½ (114)	5½ (140)	6 (152)

[A] Thickness of 8-lb/ft^3 (128-kg/m^3) high temperature fiber blanket in accordance with Specification C892, Grade 8.

TABLE 15 Minimum Thickness of Nominal 6 lb/ft^3 (96 kg/m^3) High Temperature Fiber Blanket for Removable/Reusable 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/ft^3 (96 kg/m^3) high temperature fiber blanket in accordance with Specification C892, Grade 6.

7.2.2 For insulation thickness, see Table 10.

7.2.3 For installation details, see Fig. 6, Fig. 7, or Fig. 8, as applicable.

7.2.4 *Special Conditions*—Machinery or equipment operating in this temperature range does not require insulation except where damage or discomfort will result from condensation.

7.3 *Temperature Range from 126 °F to 1050 °F (52 °C to 566 °C)*—Use for medium- and high-temperature machinery and equipment within the temperature range.

7.3.1 For insulation and lagging materials, see Table 3.

7.3.2 For insulation thickness, see Table 11.

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