

**MIL-STD-769(SHIPS)**  
**13 July 1962**

**MILITARY STANDARD**  
**THERMAL INSULATION REQUIREMENTS**  
**FOR**  
**MACHINERY AND PIPING**



**FSC 5640**

MIL-STD-769(SHIPS)  
13 July 1962

DEPARTMENT OF THE NAVY

BUREAU OF SHIPS

WASHINGTON 25, D. C.

13 July 1962

Thermal Insulation Requirements for Machinery and Piping  
MIL-STD-769(SHIPS)

1. This standard has been approved by the Bureau of Ships, and is published to establish the requirements for thermal insulation for machinery and piping on Naval ships.

2. Use of this standard by activities under the cognizance of the Bureau of Ships shall be mandatory effective on the date of issue.

3. Recommended corrections, additions, or deletions including improvements in the procedures described herein, and changes in this standard which can result in less costly installations without sacrificing the level of quality desired should be addressed to the Chief, Bureau of Ships, Department of the Navy, Washington 25, D. C.

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## 1. SCOPE

1.1 The purpose of this standard is to amplify the general requirements for insulation of piping, machinery, uptakes, and mechanical equipment covered in the General Specifications for Ships of the U. S. Navy or in ships specifications.

## 2. REFERENCED DOCUMENTS

2.1 The issues of the following documents in effect on the date of invitation for bids form a part of this standard to the extent specified herein:

### SPECIFICATIONS

#### FEDERAL

T-T-931 - Twine, Cotton, Mattress.  
 HH-C-466 - Cloth, Glass (for Membrane Waterproofing and Built-Up Roofing).  
 HH-I-525 - Insulation Board, Thermal Cork.  
 HH-I-551 - Insulation Block and Pipe Covering (Thermal Cellular Glass).  
 QQ-S-775 - Steel, Sheet, Zinc-Coated.  
 QQ-W-390 - Wire, Nickel-Chromium-Iron Alloy.  
 SS-C-192 - Cement, Portland.  
 SS-C-466 - Cloth, Thread, and Tape, Asbestos.  
 TT-P-26 - Paint, Interior, White and Tints, Fire-Retardant.  
 TT-P-320 - Pigment, Aluminum; Powder and Paste, for Paint.  
 UU-T-106 - Tape, Pressure-Sensitive Adhesive, Masking, Paper.

#### MILITARY

MIL-P-876 - Pipe-Covering, Cord, Molded (Fire Resistant Vapor-Barrier Coating).  
 MIL-I-2781 - Insulation Pipe Covering, Thermal.  
 MIL-I-2818 - Insulation Blanket, Thermal, Fibrous Mineral.  
 MIL-I-2819 - Insulation Block, Thermal.  
 MIL-C-2861 - Cement, Insulation, High-Temperature.  
 MIL-C-2908 - Cements, Finishing, Insulation.  
 MIL-A-3316 - Adhesives, Fire-Resistant, Thermal Insulation.  
 MIL-P-15006 - Paper, Sheathing, Fire-Resistant and Water-Repellent.  
 MIL-I-15091 - Insulation Sheet or Strip, Thermal, Asbestos Felt.  
 MIL-A-15199 - Adhesive, Asbestos Cloth to Pipe, Insulation.  
 MIL-P-15280 - Plastic Foam, Unicellular, Sheet and Tubular Form, Elastomeric.  
 MIL-C-15328 - Coating, Pretreatment (Formula No. 117 for Metals).  
 MIL-I-15349 - Insulation Tape, Thermal.  
 MIL-I-15475 - Insulation Felt, Thermal, Fibrous Glass, Semirigid.  
 MIL-I-16411 - Insulation Felt, Thermal, Glass Fiber (for Temperatures Up To 1200 Degrees F.)  
 MIL-A-18065 - Adhesives, High Initial Bond.  
 MIL-B-19564 - Bedding Compound, Thermal Insulation Pipe Covering.  
 MIL-C-19565 - Coating Compound, Thermal Insulation Pipe Covering - Fire-, Water-, and Weather-Resistant.  
 MIL-F-20077 - Felt, Asbestos, Roll.  
 MIL-C-20079 - Cloth, Glass, Tape, Textile, Glass, and Thread, Glass.  
 MIL-I-22023 - Insulation Felt, Thermal and Sound Absorbing Felt, Fibrous Glass, Flexible.  
 MIL-I-22344 - Insulation Pipe Covering, Fibrous Glass.

#### BUREAU OF SHIPS

General Specifications for Ships of the U. S. Navy.

#### DRAWINGS

#### BUREAU OF SHIPS

5000-S5103-841336 - Piping, Boiler Soot Blower, Typical Installation.

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(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. - The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated the issue in effect on date of invitation for bids shall apply.

AMERICAN SOCIETY FOR TESTING MATERIALS

ASTM - A167 - Specification for Corrosion-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.

ASTM - 209 - Specification for Seamless Carbon-Molybdenum Alloy-Steel Boiler and Superheater tubes.

(Application for copies should be addressed to the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Penn.)

3. GENERAL REQUIREMENTS

3.1 General requirements such as definitions, basic applications, and reasons for insulating are covered in the General Specifications for Ships of the U.S. Navy or in ships specifications, Section 9390-2. Thermal insulation and acoustic absorptive treatment of compartments, ventilating ducts and trunks are covered in the appropriate sections of the above specifications.

3.2 Minor deviations in installation which meet the intent of the requirements specified herein may be approved by the cognizant Supervisor of Shipbuilding, U.S. Naval shipyard, or the Bureau of Ships. (A copy of all such changes shall be forwarded to the Bureau of Ships, Code 648L.)

4. MATERIALS AND THICKNESSES

4.1 Minimum thicknesses. - Tables 1 to 10, inclusive specify materials for insulation and lagging and the minimum acceptable thicknesses for the temperature ranges listed.

4.2 Special conditions. - The following special conditions supplement or modify the selection of materials or thicknesses specified, when applicable:

- (a) The insulation thickness on soot blower piping between the root valve and the soot blower heads shall be reduced from that indicated for a system normally operating at the same temperature as follows:
  - (1) Where double layer insulation is used, only the inner (high temperature) insulation thickness layer need be installed.
  - (2) Where the insulation consists of a single uniform thickness layer, only one-half the total specified thickness need be installed.
- (b) The insulation thickness for hot water systems operating at a normal maximum temperature of 150°F. may be 1/2 inch thick for pipe sizes up to 3/4 inch i.p.s., in accordance with MIL-I-2781.
- (c) Compounded type insulation in accordance with MIL-I-2781: Where both class b and class e insulations are specified for a double layer insulation, class e, type I may be furnished in a uniform single thickness equal to the total thickness of both layers.
- (d) Fibrous type insulation in accordance with MIL-I-2781: Where both class c and class f insulations are specified for a double layer insulation class f may be furnished in a uniform single thickness equal to the total thickness of both layers.
- (e) Compounded type insulation conforming to MIL-I-2781, grade I, (calcium silicate only) or cellular glass insulation conforming to HH-I-551 shall be used on hot piping requiring insulation that will be exposed to the weather, and shall conform to the thicknesses shown in table 10.

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4.3 Adhesives. - The following adhesives shall be used for fastening cloth and tape lagging:

<u>Type of lagging</u>	<u>Specification</u>
Asbestos	MIL-A-15199 <sup>1/</sup> or MIL-A-3316, type II
Fibrous glass	MIL-A-3316, type I or type II

<sup>1/</sup>Not applicable for cementing to fiber-glass insulation.

4.4 Finishing cements. - Where finishing cement is specified any of the following materials are acceptable subject to any material limitations for the proposed application:

- (a) Finishing cement, MIL-C-2908.
- (b) High-temperature insulating cement, MIL-C-2861, when used under asbestos cloth.
- (c) A mixture of 80 percent high-temperature insulating cement, MIL-C-2861, and 20 percent portland cement, SS-C-192.

4.5 Metal lagging. - Where metal lagging is required, any of the following materials are acceptable, except for uptake applications (see 6.1.4):

<u>Sheet material</u>	<u>Specification</u>	<u>Nominal thickness</u> Inch
Hot-dipped galvanized steel	QQ-S-775	0.014
Aluminum	ASTM 209, Alloy 6061	.030
Corrosion-resistant steel (CRES)	ASTM A167, AISI type 304	.014

## 5. RE-USABLE COVERS

5.1 Hot-surface insulation covers. - In order to insure that the pipe covering will not interfere with the servicing of a takedown joint where a re-usable cover is installed, the permanent insulation shall stop short of the takedown joint and a short removable and re-usable section of insulation shall be installed between the permanent insulation and the takedown joint. The insulation joint formed by the permanent and re-usable sections may be square, or at an angle of 45 degrees; the joint, however, shall be tight, without any gaps between the two sections and shall incorporate means to prevent dislodging the insulation sections. Re-usable covers are not required on systems insulated with elastomeric foamed plastic insulation (MIL-P-15280).

5.2 Construction. - For sizes larger than 2 inches i. p. s., valve bonnets and valves having takedown joints at the ends shall be fitted with re-usable covers such that the bonnet joint may be removed independently of the valve covering. Valves 2 inches i. p. s. and under shall be fitted with separate covers as indicated above, or covers of a one-piece design such that they may be wrapped around the entire valve body and clipped or otherwise secured just below the handwheel.

5.3 Fabrication, piping components. - For piping components except as otherwise specified, any one of the following methods of fabrication is acceptable:

5.3.1 Covers may be made in two halves of thermal insulating felt enclosed in asbestos cloth. Each half cover shall be sewn and quilted with wire-inserted asbestos yarn conforming to SS-C-466, form II, or fastened with mechanical stapling in a manner to provide a uniform thickness, strength and rigidity.

5.3.2 Covers for use at temperatures of 850°F. and below shall be filled with asbestos felt. Wire-inserted asbestos cloth, SS-C-466, grade AAA-M, shall be used on the inside surface of covers for valves larger than 2 inches i. p. s. For valves 2 inches i. p. s. and smaller, grade AAA shall be used on inside surface of covers. For 500°F. and below, asbestos cloth, SS-C-466, grade AA, shall be used on outside surface of covers; grade AAA cloth shall be used above 500°F.

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Service	Temperature Range (°F.)	Pipe and Tubing		Valves and Fittings		Flange Joints		Machinery	
		Insulation	Lagging	Insulation	Lagging	Insulation	Lagging	Insulation	Lagging
Gases Steam Hot water Oil	125 to 1050	MIL-I-2781 MIL-I-15349 (750°F. Max.) MIL-I-22344 (370 F. Max.) MIL-P-15280 (180°F. Max.)	SS-C-466, grade UG MIL-C-20079	MIL-I-2781 MIL-I-2819 MIL-I-16411 MIL-I-15091, type A MIL-C-2861, MIL-I-22344 (370°F. Max.) MIL-P-15280 (180°F. Max.)	SS-C-466 MIL-C-20079	MIL-I-2781 MIL-I-2819 MIL-I-16411 MIL-I-15091, type A MIL-C-2861 MIL-I-22344 (370°F. Max.) MIL-P-15280 (180°F. Max.)	SS-C-466 MIL-C-20079	MIL-I-2819 MIL-I-16411 MIL-I-15091, type A MIL-I-2818 MIL-C-2861 MIL-I-22023 (370°F. Max.)	SS-C-466 MIL-C-20079
Cold water	32 to 99	MIL-I-15091 MIL-I-2781 MIL-I-22344 MIL-P-15280	SS-C-466 MIL-C-20079 MIL-P-15006	MIL-I-15091 MIL-I-2781 MIL-I-22344 MIL-I-2819 MIL-P-15280	SS-C-466 MIL-C-20079 MIL-P-15006	MIL-I-15091 MIL-I-2781 MIL-I-22344 MIL-I-2819 MIL-P-15280	SS-C-466 MIL-C-20079 MIL-P-15006	MIL-I-15091 MIL-I-22023 MIL-I-2819	SS-C-466 MIL-C-20079 MIL-P-15006
Refrigerant Chilled water	-20 to 60	HH-I-551 MIL-P-876 MIL-P-15280 (28°F. Min.)	SS-C-466 MIL-C-20079	HH-I-551 MIL-P-876 MIL-P-15280 (28°F. Min.)	SS-C-466 MIL-C-20079	HH-I-551 MIL-P-876 MIL-P-15280 (28°F. Min.)	SS-C-466 MIL-C-20079	HH-I-551 HF-I-525	SS-C-466 MIL-C-20079

<sup>1/</sup> Additional materials are covered in 4.5 (metal lagging); 6.1.4 (boiler uptakes); 6.2 (securing antisweat insulation); 6.4.1 (weather deck hot piping)

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Table II. - Insulation thicknesses for hot piping, compounded and fibrous conforming to MIL-I-2781.

Pipe size (inches i. p. s.)	Temperature range (degrees F.)	Class <sup>1/</sup>		Nominal thickness (inches)		
		Inner layer	Outer layer	Inner layer	Outer layer	Total
1/2, 1-1/2	125-388	b, c	--	1	--	1
	389-500	b, c	--	2	--	2
	501-750	c, d	--	2	--	2
	751-950	e, f	--	2	--	2
	951-1050	e, f	b, c	2	1-1/2	3-1/2
2 and 2-1/2	125-338	b, c	--	1-1/2	--	1-1/2
	339-388	b, c	--	2	--	2
	389-500	b, c	--	3	--	3
	501-750	c, d	--	3	--	3
		c, d	b, c	1-1/2	1-1/2	3
		e, f	b, c	1-1/2	1-1/2	3
3 through 4-1/2	125-338	b, c	--	1-1/2	--	1-1/2
	339-388	b, c	--	2	--	2
	389-500	b, c	--	3	--	3
	501-750	c, d	--	3	--	3
		c, d	b, c	1-1/2	2	3-1/2
		e, f	b, c	1-1/2	2	3-1/2
		e, f	b, c	2	1-1/2	3-1/2
5 and 6	125-338	b, c	--	1-1/2	--	1-1/2
	339-388	b, c	--	2	--	2
	389-500	b, c	--	3	--	3
	501-750	c, d	--	3	--	3
		c, d	b, c	1-1/2	2	3-1/2
		e, f	b, c	1-1/2	2	3-1/2
		e, f	b, c	2	1-1/2	3-1/2
7	125-338	b, c	--	1-1/2	--	1-1/2
	339-388	b, c	--	2-1/2	--	2-1/2
	389-500	b, c	--	3	--	3
	501-750	c, d	--	4	--	4
		c, d	b, c	1-1/2	2	3-1/2
		e, f	b, c	1-1/2	2	3-1/2
		e, f	b, c	2	2	4
8 and larger	125-338	b, c	--	1-1/2	--	1-1/2
	339-388	b, c	--	2-1/2	--	2-1/2
	389-500	b, c	--	3	--	3
	501-750	c, d	--	4	--	4
		c, d	b, c	2	2	4
		e, f	b, c	2	2	4
		e, f	b, c	2-1/2	2	4-1/2

<sup>1/</sup> Where considered desirable, higher temperature classes of insulation of MIL-I-2781 may be used where lower temperature classes are specified (e. g.: where class b is specified, class d or e may be used and where class c is specified, class f may be used) provided they are satisfactory in all other respects.

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Table III. - Thickness of insulation conforming to MIL-P-15280 and MIL-I-22344, for hot piping.

Temperature range (°F.)	Specification	Thickness
125 to 180	MIL-P-15280 or MIL-I-22344	Inch 1/2
181 to 250	MIL-I-22344	1/2
251 to 300	MIL-I-22344	3/4
301 to 370	MIL-I-22344	1

Table IV. - Thickness of insulating tape conforming to MIL-I-15349, for 1/4 to 3/4 inch size hot piping.

Temperature range (°F.)	Pipe size	Thickness
		Inch
125 to 250	1/4, 3/8	3/8
251 to 750	1/4, 3/8	3/8
125 to 250	1/2, 3/4	3/4

Table V. - Thickness <sup>1/</sup> of insulating materials for hot surfaces of machinery and equipment up to 850°F.

Temperature range (°F.)	Thickness (inches)	
	Asbestos felt, MIL-I-15091, MIL-I-2819, or mineral wool blanket MIL-I-2818	Insulating cement, MIL-C-2861
125-338 .....	1-1/2	1-1/2
339-388 .....	2-1/2	2-1/2
389-500 .....	3	3
501-750 .....	3-1/2	4
751-850 .....	4-1/2	5

<sup>1/</sup> Does not include finishing cement.

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Table VI. - Thickness<sup>1/</sup> of insulating materials for hot surfaces of machinery and equipment over 850°F.

Temperature range (° F.)	Thickness (inches)			
	Felt			Block MIL-I-2819
	Inner layer MIL-I-16411	Outer layer MIL-I-15091, type A	Total	
851-950 . . . . .	2	3	5	4-1/2
951-1050 . . . . .	2	3	5	5

<sup>1/</sup> Does not include finishing cement.

Table VII. - Thickness of refrigerant insulation for piping.

Pipe size (inches)	Temperature range (°F.)	Molded cork, MIL- P-876 Cellular glass, HH-I-551 Nominal <sup>1/</sup> thickness (inches)	
Up to 1-1/4	-20 to -1	2-1/4	1-1/2*
	0 to 40	2	1-1/4*
1-1/2 to 2-1/2	-20 to -1	2-1/2	1-3/4*
	0 to 40	2-1/4	1-1/2*
3 to 5	-20 to -1	3	2*
	0 to 40	2-3/4	1-3/4*

<sup>1/</sup> By nominal thickness is meant a thickness which is approximate and should only be used as a guide in determining actual thickness requirements.

\* Thickness for application in air-conditioned spaces only.

Table VIII. - Thickness of refrigerant insulation for machinery and equipment (exclusive of vapor barrier).

Temperature range (°F.)	Thickness (inches)			
	Corkboard, HH-I-525		Cellular glass, HH-I-551	
0 to 35	4	1*	5	1-1/2*

\*Thickness for application in air-conditioned spaces only.

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Table IX. - Thickness of antisweat insulation (exclusive of vapor barrier).

Temperature range (°F.)	Machinery and equipment			Piping		
	Material specification	Thickness (inches)		Material specification	Thickness (inches)	
28 to 99	MIL-I-15091 MIL-I-2819	1-1/2	3/4*	MIL-I-15091 MIL-I-2781 MIL-I-2819	1	1/2*
	MIL-I-22023	1	1/2*	MIL-P-15280 MIL-I-22344	3/4	1/2*

\*Thickness for application in air conditioned spaces only.

Table X. - Nominal thicknesses of insulation for weather deck hot piping.

Pipe size (inches i. p. s.)	Calcium silicate, MIL-I-2781 Cellular glass, HH-I-551
	Inches
1/4 to 3	1-1/2
3-1/2 to 6	2
Over 6	2-1/2

5.3.3 Covers for use at temperatures above 850°F. shall have filling consisting of inner layers of fiber-glass felt, MIL-I-16411, outer layers of asbestos felt, and shall be covered on the inside surface and on the ends with nickel-chromium alloy wire mesh, QQ-W-390 (or wire-inserted asbestos cloth, SS-C-466, grade AAA-M, for services up to 950°F.) and on the outside surface with grade AAA asbestos cloth. Asbestos roll felt, MIL-F-20077 1/8 inch thick, shall be inserted between the asbestos felt and the asbestos cloth to retain the cylindrical shape of the cover.

5.3.4 Hard asbestos millboard, 1/4 inch thick, enclosed in asbestos cloth of the type used on the outside cover, shall be sewn on ends of covers for strength and rigidity. When a more flexible cover is necessary, such as when space limitation would not permit installation of the more rigid type, the millboard will not be required. When the flange diameter is larger than the outside diameter of the adjacent pipe covering, build-up pieces made of asbestos felt encased in asbestos cloth, SS-C-466, grade AAA shall be stitched to inside of cover. Halves of covers shall be fastened together by 1/16-inch diameter galvanized, or other corrosion resistant, wire rope laced through brass or galvanized steel hooks or rings, or fastened by brass snap fasteners. Fastenings shall be securely attached to cloth lagging.

5.3.5 Covers may be made of segments of block insulation or molded pipe insulation, having the same thickness as that on the adjacent piping. Blocks shall be securely wired to frames of 1/2 inch square mesh, Number 18 gage (0.049-inch diameter) galvanized steel wire. Wire mesh frames inside and outside of blocks shall have ends bent over and joints secured with Number 18 gage black annealed iron wire woven through the mesh. Insulating cement of the same material as the blocks shall be troweled smoothly over all surfaces of the wire mesh. Asbestos roll felt may be used to build up covers when the flange diameter is larger than the outside diameter of the adjacent pipe covering. Covers shall be tightly and smoothly lagged to envelop the outside and ends. For temperatures of 500°F. and below asbestos cloth lagging conforming to SS-C-466, grade AA, shall be used; grade AAA cloth shall be used above 500°F. Lagging may be

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cemented or sewn on, except ends of covers shall always be sewn. Where double layer insulation is used the two sections of the cover shall be fitted together with a scarfed joint. Such joints shall be straight and true to reduce heat loss. Bands, eyelets, or locks of galvanized steel, or lacing with hooks, rings, washers, and wire shall be used to secure the covers.

5.3.6 When installing the above covers, spaces between inner surfaces of covers for flanges and other irregular surfaces shall be filled with pieces of asbestos felt when temperatures are 850°F. or less. Fiber-glass felt in accordance with MIL-I-16411, shall be used similarly above 850°F. Felt shall be packed loose enough to preserve air cell structure and tight enough to prevent air circulation.

5.4 Fabrication, machinery and equipment. - For re-usable covers for machinery and equipment, either of the following methods of fabrication is acceptable.

5.4.1 Covers may be similar to the flexible asbestos felt or fiber-glass felt type described for piping components.

5.4.2 Covers may be made in sections formed of insulating block held together with wire and adhesive cement, covered with 1/2-inch thickness of finishing cement, and lagged. Lacing with hooks, rings, washers, and wire, or brass snap fasteners shall be used to secure the covers.

## 6. INSTALLATION

### 6.1 Hot surface insulation. -

6.1.1 Pipe and tubing. - Each layer of molded insulation shall be installed with joints butted together. Where two layers are used all joints shall be staggered. Not less than three fastenings shall be used for securing each 3-foot section of insulation. Fastening shall be Number 18 gage (0.049-inch diameter) annealed black or hot-dipped galvanized iron wire or flat steel bands. Except as otherwise specified, lagging shall be installed over the insulation.

6.1.1.1 The installation of soot blower piping insulation shall be in accordance with drawing 5000-S5103-841336.

6.1.2 Piping components. - For valves, fittings, and accessories, welded and brazed fittings including unions may be insulated and lagged similarly to adjacent piping.

6.1.2.1 Block, felt, blanket insulating materials, or molded pipe insulation secured with hot-dipped galvanized iron wire, may be used. When insulating felts are used above 850°F. the inner layer shall be fiber-glass felt conforming to MIL-I-16411. Galvanized iron wire netting, Number 18 gage (0.049-inch diameter), shall be spread over the insulating material and secured with wire. Insulating cement shall be used to fill all crevices, smooth all surfaces, and completely cover the wire netting. A 1/2-inch thickness of finishing cement shall then be applied. Insulating material shall be the same thickness as that on adjacent piping.

6.1.2.2 For components 3-1/2 inch i. p. s. and smaller, insulating cement only conforming to MIL-C-2861, may be applied to a thickness 1/2 inch less than the adjacent pipe insulation. A 1/2 inch thickness of finishing cement shall be applied over the insulating cement.

6.1.2.3 Re-usable covers shall be fitted where required.

6.1.3 Machinery and equipment. - For machinery and equipment, block, felt, or blanket insulating materials of the required thickness shall be secured with hot-dipped galvanized iron wire. Galvanized iron wire netting 1-inch mesh and Number 18 gage (0.049-inch diameter) shall be spread over the surface and secured by wire. Insulating cement shall be used to fill all crevices, smooth all surfaces, and completely cover the wire netting.

6.1.3.1 When no insulating cement has been specified, a 1/2-inch thickness of finishing cement shall be applied.

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6.1.3.2 When an insulating cement has been specified it shall be applied in successive layers, 1/2 inch to 1 inch in thickness, until the total thickness specified has been reached. Wire netting, similar to that used for covering the insulating materials, shall be installed between layers. A 1/2-inch thickness of finishing cement shall be applied over the last layer of insulating cement.

6.1.3.3 Lagging shall be installed over finishing cements. Re-usable covers shall be installed where required.

6.1.3.4 Clips, hooks, or other fastenings for securing insulation or lagging shall not be brazed or welded to nonferrous parts of distilling plants or deaerating feed tanks.

6.1.4 Boiler uptakes. - For boiler uptakes the thermal insulation shall be 2 inches thick. Either mineral wool felt, MIL-I-2818, or fibrous glass sheet, MIL-I-15475, may be used. If acoustic absorptive treatment is found to be necessary to decrease the noise level the insulation thickness shall be increased accordingly.

6.1.4.1 Metal lagging for uptakes shall be galvanized sheet steel conforming to QQ-S-775, not less than 1/32 inch thick.

6.1.4.2 Insulation and lagging is not required on uptakes above the weather deck.

6.2 Antisweat insulation.

6.2.1 Molded pipe covering, untreated asbestos felt, water repellent asbestos felt, or fibrous glass blanket insulation shall be secured with Number 18 gage (0.049-inch diameter) hot-dipped galvanized iron wire, wire inserted asbestos yarn, or glass thread, MIL-C-20079, spirally wound on 1-inch centers. One layer of water repellent and flameproof sheathing paper, MIL-P-15006, shall be wrapped tightly around the insulation and secured with cotton twine, T-T-931, or 1-inch wide tape, UU-T-106. All joints of the paper shall be lapped and sealed with adhesive cement, MIL-A-3316, type II. The compatible lagging shall then be installed and completely covered with vapor barrier compound, MIL-P-876.

6.2.2 Application of a vapor barrier is not required on elastomeric foamed plastic insulation, MIL-P-15280, nor is lagging required except in areas where such insulation would be subject to damage.

6.3 Refrigerant insulation.

6.3.1 Molded cork insulation shall be coated on all surfaces with vapor barrier compound, MIL-P-876, at the time of installation. Insulation shall be installed with staggered end joints. On horizontal pipes the longitudinal joints shall be at the top and bottom. Insulation shall be secured with Number 18 gage (0.049-inch diameter) copper-covered steel wire spaced not greater than six loops to a 3-foot section. Molded cellular glass insulation shall be similarly coated and installed, except that fastenings shall be on 9-inch centers; 1-inch wide tape, UU-T-106, may be used instead of wire. The compatible lagging shall then be installed.

6.4 Weather deck hot piping insulation.

6.4.1 Calcium silicate or cellular glass insulation for piping exposed to the weather shall be installed as follows:

(a) Preliminary preparation of piping.

- (1) All surfaces to be clean, dry, and free of scale and grease.
- (2) Fittings, valves, flanges, pipe supporting clamp, and at least 3 inches of adjacent pipe shall be painted as follows: Apply one coat pretreatment formula 117, MIL-C-15328. After this coat dries, apply two coats of aluminum paint made by mixing two pounds of aluminum paste, TT-P-320, type II, class B, with each gallon of phenolic varnish.

(b) Installation on pipes

- (1) The bore, butt ends, and longitudinal joint surfaces of the insulating material shall be coated not more than 1/16 inch thick with commercial bedding compound, in accordance with MIL-B-19564, at time of installation.

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- (2) Longitudinal joints on horizontal piping shall be on top and bottom of pipe.
  - (3) Insulation shall be secured tightly to pipe with 1/2-inch wide U. S. Standard 22 gage galvanized steel bands on 9-inch centers. Steel bands shall be placed over a layer of fibrous glass tape, MIL-C-20079, class c, which has been dipped in the commercial finishing compound in accordance with MIL-C-19565. Steel bands shall be wrapped with a layer of masking tape, UU-T-106, type II.
  - (4) Completely coat insulation with commercial finishing compound, in accordance with MIL-C-19565, using about 2 gallons per 100 square feet. Wrap on tightly one layer of open weave fibrous glass cloth, HH-C-466, or knitted fibrous glass tape, MIL-C-20079, and then apply another coating of above-specified finishing compound, using about 4 gallons per 100 square feet. After this coat has set apply a second coat of finishing compound using the same quantities.
  - (5) Where insulation is stopped off on the piping, sufficient mineral wool, MIL-I-2818, shall be tightly tied in place with galvanized iron wire over a heavy coating of the above-specified commercial bedding compound, to provide a tapered portion from insulation surface to pipe surface. Lag and coat with same method and materials as adjacent piping.
- (c) Installation on fittings, flanges, and valves.
- (1) Before applying flange insulation weather deck piping shall be tested and secured in the following manner: After specified tests are completed, weather deck piping shall be subjected to alternate periods of full operating pressure, allowing pipe to come to maximum temperature; and then to zero gage pressure allowing pipe to cool to ambient temperature. These cycles shall be repeated a sufficient number of times, tightening and adjusting flanges where necessary until no leaks can be detected.
  - (2) Fittings, flanges, and valve covers shall be ship-fabricated from sections of molded pipe covering or cellular glass block cemented together with adhesive cement, MIL-A-18065, class 1.
  - (3) Permanent covers for fittings and valves shall be fitted snugly to fittings and adjacent pipe covering using the same materials and methods as outlined for pipe covering. Voids between insulation and fitting shall be filled with tightly packed mineral wool, MIL-I-2818.
  - (4) Where specified, rigid-type portable flange covers shall extend over the adjacent pipe covering 1-1/2 times the thickness of the insulation. The two halves of the cover should be coated and lagged separately, using the same materials and procedure as outlined for pipe covering. The galvanized steel bands used to secure the two halves together and to the adjacent pipe covering shall be applied over the lagging and then coated with the above-specified finishing compound.
- (d) Installation around supports and hangers.
- (1) Remove only enough insulation from butt edges to provide a snug fit around support brackets or hanger rods. Fill all voids between insulation and support with tightly packed mineral wool, MIL-I-2818, to within 1/4 inch from insulation surface. Fill remainder of the space with the above-specified finishing compound overlapping generously both the support member and the adjacent insulation.

6.5 Metal lagging. - Metal lagging shall be installed with lap joints, secured with hardened self-tapping screws or metal bands.

6.6 Painting. - All cloth and tape laggings shall be painted after installation with one coat of fire-retardant white paint, TT-P-26, if necessary for appearance. Elastomeric foamed plastic insulation MIL-P-15280 shall not be painted except where necessary for appearance. (For material and application requirements, see Section 9190-1 of the General Specifications for Ships of the U.S. Navy or ships specifications.)

## 7. NOTES

Notice. - When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be

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