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NOTE: MIL-STD-769 has been redesignated as a Design Criteria Standard. The cover page has been changed for Administrative reasons. There are no other changes to this Document.

INCH-POUND

MIL-STD-769J(SH)
9 OCTOBER 1990
SUPERSEDING
MIL-STD-769H (SH)
8 APRIL 1985

DEPARTMENT OF DEFENSE
DESIGN CRITERIA

THERMAL INSULATION REQUIREMENTS FOR MACHINERY AND PIPING

AMSC N/A FSC 5640

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FOREWORD

1. This Military Standard is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all departments and agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document of by letter.

3. This standard covers basic thermal insulation requirements. The information contained in this standard amplifies the requirements for insulation of piping, machinery, uptakes and mechanical equipment covered in the General Specifications for Ships of the U.S. Navy or in ship specifications for individual ships or classes of ships.

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1. SCOPE

1.1 Purpose. The purpose of this standard is to prescribe the requirements for thermal insulation of piping, machinery, uptakes and mechanical equipment for ships of the U.S. Navy.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

HH-P-31	Packing and Lagging Material, Fibrous Glass Metallic and Plain Cloth and Tape
TT-P-28	Paint, Aluminum, Heat Resisting (1200 °F)
TT-P-320	Pigment, Aluminum: Powder and Paste for Paint
UU-B-790	Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent and Fire Resistant

MILITARY

MIL-T-2118	Trap, Steam, Thermostatic, Naval Shipboard Use
MIL-I-2781	Insulation, Pipe, Thermal
MIL-I-2818	Insulation Blanket, Thermal, Fibrous Mineral
MIL-I-2819	Insulation Block, Thermal
MIL-C-2861	Cement, Insulation, High Temperature
MIL-A-3316	Adhesives, Fire-Resistant, Thermal Insulation
DOD-P-15328	Primer (Wash), Pretreatment (Formula No. 117 for Metals) (Metric)

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MIL-I-16411	Insulation Felt, Thermal, Glass Fiber
MIL-C-20079	Cloth, Glass; Tape, Textile Glass; and Thread, Glass And Wire Reinforced Glass
MIL-I-22023	Insulation Felt, Thermal and Sound Absorbing Felt, Fibrous Glass, Flexible
MIL-I-22344	Insulation, Pipe, Thermal, Fibrous Glass
MIL-C-22395	Compound, End Sealing, Thermal Insulation Pipe Covering-, Fire-, Water-, and Weather-Resistant
MIL-A-24179	Adhesive, Flexible Unicellular-Plastic Thermal Insulation
DOD-C-24596	Coating Compounds, Nonflaming, Fire-Protective (Metric)
DOD-E-24607	Enamel, Interior, Nonflaming (Dry), Chlorinated Alkyd Resin, Semigloss (Metric)
MIL-I-24703	Insulation, Pipe, Polyphosphazene Sheet and Tubular

(Unless otherwise indicated, copies of federal and military specifications and standards are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.1.2 **Other Government drawing and publication.** The following other Government drawing and publication form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DRAWING

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

NAVSHIPS 804-841336 Piping Boiler Soot Blower

(Application for copies of NAVSEA drawings should be addressed to: Commanding Officer, Naval Ordnance Station (Attn: Code 802), Louisville, KY 40214.)

PUBLICATION

NAVAL SHIP'S TECHNICAL MANUAL (NSTM), CHAPTER 635, THERMAL INSULATION (S9086-VH-STM-000)

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(Copies of NSTM required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A 167	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip, Standard Specification for; (DOD adopted)
A 526	Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality, Standard Specification for; (DOD adopted)
B 209	Aluminum and Aluminum-Alloy Sheet and Plate, Standard Specification for; (Metric) (DOD adopted)
C 449	Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement, Standard Specification for; (DOD adopted)
C 595	Blended Hydraulic Cements, Standard Specification for; (DOD adopted)
D 3400	Liquid Sodium Silicates, Standard Specification for
F 1138-88	Spray Shields for Mechanical Joints, Standard Specification for

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3. DEFINITIONS

3.1. Application of the requirements listed herein is limited only to the equipment specified in 1.1.

3.2. a. The installation of asbestos or asbestos-containing insulation and lagging materials is not permitted. Where previously installed asbestos containing materials are removed, restoration shall be with asbestos-free materials as specified herein.

b. The installation of ceramic (refractory) fiber insulation or lagging materials containing ceramic (refractory) fibers are also not permitted, unless there presently are no NAVSEA approved substitutes identified for a specific application. Where previously installed ceramic (refractory) fiber insulation or lagging materials containing ceramic (refractory) fibers are removed, restoration shall be with materials free of ceramic (refractory) fibers unless there are no NAVSEA approved substitutes identified for a specific application.

4. GENERAL REQUIREMENTS

4.1 Nominal thicknesses. Materials approved for insulation and lagging, and their nominal acceptable thicknesses for temperature ranges as listed are specified in tables I through X. The thicknesses specified in the following tables for hot surface insulation are designed to maintain the surface temperature at or below 125 degrees Fahrenheit (°F) for fluid temperature up to 650 °F with an ambient temperature of 85 °F. For fluid temperatures above 650 °F, the surface temperature shall be maintained at a maximum of 133 °F.

The selected design ambient air temperature of 85 °F does not represent maximum air temperatures in firerooms and machinery spaces; however, it is a median temperature that when combined with 125 °F surface temperature results in a heat loss of 77.4 Btu/(ft^2/h).

TABLE I. *Insulation and lagging materials.*[1]

Service	Temperature range (°F)	Pipe and tubing		Valve and fittings		Flange joints		Machinery	
		Insulation	Lagging	Insulation[2]	Lagging[3]	Insulation	Lagging[3,4]	Insulation	Lagging
Gases, steam, hot water, oil	125 to 1200	MIL-I-2781 MIL-C-20079[5,6] and MIL-I-16411 MIL-I-22344[7] (370 °F max.) MIL-I-24703 (180 °F max.)	MIL-C-20079	MIL-I-2781 MIL-I-2819 class 2 MIL-C-2861 MIL-C-20079[5] and MIL-I-16411 MIL-I-22344[7] (370 °F max.) MIL-I-24703 (180 °F max.) MIL-I-22023 (400 °F max.)	MIL-C-20079	MIL-I-2781 MIL-I-2819 class 2 MIL-C-2861 MIL-C-20079[5] and MIL-I-16411 MIL-I-22344[7] (370 °F max.) MIL-I-24703 (180 °F max.)	MIL-C-20079	MIL-I-2819 class 2 MIL-I-16411 MIL-I-2818 MIL-C-2861 MIL-I-22023 (400 °F max.)	MIL-C-20079
Cold water, chilled water	28 to 99	MIL-I-24703	MIL-C-20079	MIL-I-24703	MIL-C-20079	MIL-I-24703	MIL-C-20079	MIL-I-24703 MIL-I-22023	MIL-C-20079 UU-B-790, type III, grade F, style 10
Refrigerant	Minus 20 to plus 40	MIL-I-24703	MIL-C-20079	MIL-I-24703	MIL-C-20079	MIL-I-24703	MIL-C-20079	MIL-I-24703	MIL-C-20079

[1] Additional materials are covered in 4.5 (metal lagging); 5.3 (fabrication, piping components); 5.5.1.4 (boiler uptakes); 5.5.2 (securing antisweat insulation); 5.5.4.1 (weather deck hot piping).
[2] Alternatively, pre-formed mineral wool insulation with a hard fibrous glass cover (CADAFIT 1200 °F) or equal manufactured by Hamfab, Inc., Lehighton, PA may be used as applicable.
[3] Alternatively, silicone rubber, aluminized fibrous glass cloth may be used as applicable. NAVSEA approved sources of supply are as follows: Alpha lightweight 2337-3-AMA or equal and heavyweight 2025-2-AMA or equal, as applicable, manufactured by Alpha Associates, Inc., Woodbridge, NJ 07095; Claremont, Scuffhost or equal manufactured by The Claremont Co., Meriden, CT 06450; and 3M SRGA-0214 or equal manufactured by Minnesota Mining & Manufacturing Co., St. Paul, MN 55144.
[4] Flammable liquid flanges shall not be lagged (see Drawing 803-2145518).
[5] Used only as a laminate construction consisting of a glass fabric outer jacket with a fibrous glass felt insert. An inner jacket of 0.008-inch knitted stainless steel mesh sewn on to fibrous glass cloth is used where pads or thermal insulation tape is needed and where the temperature of the hot surface is 450 °F or above. Alternatively, the inner jacket may be made from material conforming to HH-P-31, type I, class 1. (See tables IV and V).
[6] To be used only on a temporary basis, such as replacement of permanent insulation damaged while a ship is at sea.
[7] MIL-I-22344 insulation shall not be installed on hot piping above 1 inch nominal pipe size (nps). Additionally, this insulation shall be installed only on piping with a vertical orientation or in "low traffic" areas.

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TABLE II. *Thickness of insulation for hot piping conforming to MIL-I-2781.*

Nominal pipe size (inches)	Temperature range (°F)	Nominal thickness total[1,2] (inches)
1/2, 1-1/2	125 – 388	1-1/2
	389 – 750	2-1/2
	751 – 950	3
	951 – 1050	4
2, 2-1/2	125 – 338	1-1/2
	339 – 388	2
	389 – 900	3
	901 – 1050	4
3 through 4-1/2	125 – 338	1-1/2
	339 – 388	2-1/2
	389 – 500	3
	501 – 900	3-1/2
	901 – 950	4
	951 – 1050	4-1/2
5, 6, 7	125 – 338	1-1/2
	339 – 388	2-1/2
	389 – 750	3-1/2
	751 – 900	4
	901 – 950	4-1/2
	951 – 1050	5-1/2
8 and larger	125 – 338	1-1/2
	339 – 388	2-1/2
	389 – 500	3-1/2
	501 – 750	4
	751 – 900	4-1/2
	901 – 950	5
	951 – 1050	6

[1]Does not include finishing cement.
[2]Wherever possible, double layers shall be used where temperatures exceed 600 °F. Double layers may be used at temperatures below 600 °F.

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TABLE III. *Thickness of insulation conforming to MIL-I-24703 and MIL-I-22344, for hot piping.*

Maximum operating temperature range (°F)	Specification	Nominal thickness (inches)
125 to 180	MIL-I-24703 MIL-I-22344[1,2]	1/2
181 to 250	MIL-I-22344[1,2]	1/2
251 to 300	MIL-I-22344[1,2]	3/4
301 to 370	MIL-I-22344[1,2]	1

[1]Shall only install on piping no greater than 1 inch nps (for surface ships only).
[2]Shall not be installed in designated "high traffic" areas unless in a vertical orientation.

TABLE IV. *Thickness of insulating materials for hot surfaces of valves and fittings up to 1200 degrees.*[1]

	Nominal thickness (inches) (does not include finishing cement or outer cover)		
Maximum operating temperature (°F)	MIL-C-20079, plus fibrous glass felt, MIL-I-16411[2,3]	Insulation, block MIL-I-2819	Insulating cement MIL-C-2861
125 to 338	1	1-1/2	2
339 to 388	1-1/2	2	2-1/2
389 to 500	2	2-1/2	3-1/2
501 to 750	3	4	5
751 to 850	4	5	5-1/2
851 to 950	4-1/2	5	
951 to 1050	5	5-1/2	No to be used alone for temperatures above 850 °F
1051 to 1200	6	6-1/2	

[1]Valves and fittings which are welded into the line are insulated permanently. Flanged valves and flanged fittings shall have reusable covers to permit servicing of take-down joints. The valves in main and auxiliary steam systems from the valve bonnet up to the packing gland shall be insulated with reusable covers. The packing gland shall remain visible (see 5.2 and 5.3).
[2]Alternatively, MIL-C-20079 plus CADAFIT 1200 °F or equal mineral wool insulation (with a hard fibrous glass cover) manufactured by Hamfab, Inc., Lehighton, PA may be used as applicable.
[3]Reusable covers may also be fabricated using silicone rubber aluminized fibrous glass cloth. NAVSEA sources of supply are: Alpha lightweight 2337-2-AMA or equal and heavyweight 2025-2-AMA or equal, as applicable, manufactured by Alpha Associates, Inc., Woodbridge, NJ 07095; Claremont Scuffcoat or equal manufactured by The Claremont Company, Meriden, CT 06450; and 3M SRGA-0214 or equal manufactured by Minnesota Mining & Manufacturing Co., St. Paul, MN 55514.

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TABLE V. *Thickness of insulating tape conforming to MIL-C-20079 and MIL-I-16411 for 1/4 to 3/4-inch size hot piping.*[1,2]

Maximum operating temperature range (°F)	Pipe size (inches)	Nominal thickness (inches)
125 to 250	1/4, 3/8	3/8
251 to 750	1/4, 3/8	1-1/2
125 to 350	1/2, 3/4	1/2
351 to 388	1/2, 3/4	1
389 to 500	1/2, 3/4	1-1/2
501 to 750	1/2, 3/4	2

[1]To be used only on a temporary basis, such as repair of insulation while ship is at sea. Insulation tape shall be replaced by NAVSEA approved preformed sectional pipe insulation at the earliest opportunity.

[2]Used only as a laminate construction consisting of a glass fabric outer jacket with a fibrous glass felt insert. (An inner jacket of 0.008-inch crimped stainless steel mesh is used where pads of thermal insulation tape are needed and where the temperature of the hot surface is 450 °F, or above. Alternatively, pads may be made from material conforming to HH-P-31, type I, class 1.)

TABLE VI. *Thickness of insulation materials for hot surfaces of machinery and equipment*[1]

Maximum operating temperature (°F)	Nominal thickness (inches)			
	MIL-I-16411	MIL-I-2819	MIL-I-2818	MIL-C-2861
125 to 338	1	1-1/2	1-1/2	2
339 to 388	1-1/2	2	2	2-1/2
389 to 500	2	2-1/2	2-1/2	3-1/2
501 to 750	3	4	4	5
751 to 850	4	5	5	5-1/2
851 to 950	4-1/2	5	(900 °F max.)	
951 to 1050	5	5-1/2		Not to be used alone for temperatures above 850 °F
1051 to 1200	6	6-1/2		

[1]Does not include finishing cement.

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TABLE VII. *Thickness of plastic foam, MIL-I-24703 refrigerant insulation for piping.*[1]

Pipe size (inches)	Temperature range (°F)	Nominal thickness (inches)	
		Non-air-conditioned spaces	Air-conditioned spaces
All	Minus 20 to minus 1	1-1/2	1
	0 to 40	1	3/4

TABLE VIII. *Thickness of refrigerant insulation for machinery and equipment.*

Temperature range (°F)	Military specification	Nominal thickness (inches)	
		Non-air-conditioned spaces	Air-conditioned spaces
−20 to 40	MIL-I-24703	2	1

TABLE IX. *Thickness of antisweat insulation materials for machinery and equipment (exclusive of vapor barrier).*

Temperature range (°F)	Military specification	Nominal thickness (inches)	
		Non-air-conditioned spaces	Air-conditioned spaces
28 to 99	MIL-I-24703	3/4	1/2
	MIL-I-22023, type I	1	1/2

TABLE X. *Nominal thicknesses of insulation for weather deck hot piping.*

Pipe size (inches)	Calcium silicate, MIL-I-2781 (inches)
1/4 to 3	1-1/2
3-1/2 to 6	2
Over 6	2-1/2

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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 to one-half that indicated for a system normally at the same temperature.

b. For repair or replacement of piping and machinery insulation, only the materials specified herein shall be used. Procedures for the repair and replacement of insulation are contained in Naval Ships Technical Manual (NSTM), Chapter 635.

c. Where HOT SURFACE insulation thicknesses are not specified, and for special applications, the insulation thickness shall be sufficient to reduce the insulation surface temperature to the values shown in 4.1.

d. Adhesives containing halogenated solvents shall not be used for submarine applications.

e. Insulation shall not be installed on two feet of pipe immediately upstream of thermostatic steam traps, complying with MIL-T-2118. A removable cover, consisting of two layers of glass cloth shall be installed over the uninsulated pipe and the thermostatic trap.

f. Small diameter hot piping, 1/2-inch nominal pipe size (nps) and under shall not be insulated when the operating temperatures are less than 125 °F.

g. Shielding on uninsulated hot pipes shall be provided only where such pipes are readily accessible to contact with personnel.

h. MIL-I-2781 shall be used in "high traffic" areas. "High traffic" areas are those areas where the installed insulation and lagging will be subject to wear and damage during routine operations.

4.3 Adhesives.

a. Adhesives conforming to MIL-A-3316 shall be used for fastening fibrous glass cloth and tape lagging. Rewettable lagging is acceptable, provided the end result is equivalent.
b. Adhesive conforming to MIL-A-24179 shall be used to secure EYPEL-A polyphosphazene insulation conforming to MIL-I-24703 to itself and to metals.
c. Sodium silicate solution, ASTM D 3400, shall be used as an adhesive for joining segments of calcium silicate preformed pipe insulation in accordance with MIL-I-2781.

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4.4 Finishing cements. Where finishing cement is specified, any of the following materials are acceptable. Prior to use, material compatibility with the proposed application will be verified.

a. Finishing cement in accordance with ASTM C 449.

b. High-temperature insulating cement in accordance with MIL-C-2861, when used under fibrous glass cloth.

c. A mixture of 80 percent high-temperature insulating cement in accordance with MIL-C-2861, and 20 percent cement in accordance with ASTM C 595.

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

Sheet material	Specification	Nominal thickness
Hot-dipped galvanized steel	ASTM A 526 coating designation G-115	0.014
Aluminum	ASTM B 209, 6061	0.030
Corrosion-resistant steel	ASTM A 167, type 304	0.014

4.6 Fasteners. Insulation shall be held in place by suitable wire or flat metal bands. The welding of fasteners to machinery, piping, pressure vessels or other related equipment is prohibited. Where fasteners are necessary, they shall be attached during manufacture (prior to heat treatment, stress relief and testing) by a NAVSEA approved procedure.

5. DETAILED REQUIREMENTS

5.1 Hot-surface insulation covers. In order to ensure that the pipe covering will not interfere with the servicing of a takedown joint where a reusable cover is installed, the permanent insulation shall stop short of the takedown joint and a short removable and reusable section of insulation shall be installed between the permanent insulation and the takedown joint. The insulation joint formed by the permanent and reusable sections may be square, or at an angle of 45 degrees. The reusable section shall fit tightly at the interfacing joint without gaps and shall be held in place with removable pins, clips, wire, or bands to maintain a tight joint.

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5.2 Construction. For sizes larger than 2-inch nps, valve bonnets and valves having takedown joints at the ends shall be fitted with reusable covers such that the bonnet joint may be removed independently of the valve covering. Valves, 2-inch nps 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 packing gland on the valve stem. Packing gland shall remain visible.

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 that are exposed to temperatures under 450 °F may be made in two half-sections, using fibrous glass felt in accordance with MIL-I-16411 enclosed in fibrous glass fabric conforming to MIL-C-20079, type I, class 9. Alternatively, silicone rubber coated, aluminized glass fabric[1] may be substituted for plain fibrous glass fabric for the cover material. Covers that are exposed to temperatures of 450 °F and over shall have a 0.008-inch diameter knitted stainless steel wire mesh sewn on to the fibrous glass cloth on the inside (hot) surface and on the ends. Alternatively, the inside surface and ends of pads may be fabricated of wire-reinforced fibrous glass cloth conforming to HH-P-31, type I, class 1. Each half cover shall be sewn and quilted with polytetrafluoroethylene (PTFE) coated fibrous glass yarn conforming to MIL-C-20079, type III, classes 3, 4, or 6 for hand sewing; or PTFE coated fibrous glass sewing thread (fully sintered), type III, classes 3, 5, or 6 for machine sewing. The covers may also be fastened by mechanical stapling with galvanized or stainless steel staples in a manner to provide uniform thickness, strength, and rigidity.

5.3.1.1 Knitted wire mesh shall be of 304 annealed stainless steel. The wire shall be 0.008-inch diameter. The mesh shall consist of 7-1/2 ± 1/2 courses per inch equal spacing and 10 ± 1 wales per inch equal spacing. The mesh shall be furnished in 30 ± 1/2 inch flattened tubular form and shall be crimped 0.125 to 0.150 inch deep by 5/16 inch crimp to crimp.

[1]Approved sources for silicone rubber coated, aluminized glass fabric are as follows: Alpha lightweight 2337-2-AMA or equal and heavyweight 2025-2-AMA or equal, as applicable, manufactured by Alpha Associates, Inc., Woodbridge, NJ 07095; Claremont Scuffcoat or equal manufactured by The Claremont Co., Meriden, CT 06450; and 3M SRGA-0214 or equal manufactured by Minnesota Mining & Manufacturing Co., St. Paul, MN 55144.

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5.3.2 Preformed fibrous glass valve or fitting covers may be used when temperatures are in the 125 to 370 °F range. These shall be of the same thickness as the adjacent pipe covering. Such covers, when used, shall be lagged independently of the pipe covering and in a manner which will facilitate removal and replacement.

5.3.3 Covers may be made of segments of block insulation or preformed 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 gauge (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 gauge black annealed iron wire woven through the mesh. High temperature cement in accordance with MIL-C-2861 shall be troweled smoothly over all surfaces of the wire mesh. Fibrous glass felt in accordance with MIL-I-16411 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, using fibrous glass cloth conforming to MIL-C-20079, type I, class 9. Lagging may be either cemented or sewn on, except ends of covers, which shall always be sewn. Where double layer insulation is used, the two sections of the cover shall be fitted together with 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.

5.3.4 When installing the above covers, spaces between inner surfaces of covers for flanges and other irregular surfaces shall be filled with pieces of fibrous glass insulation felt in accordance with MIL-I-16411. Felt shall be packed loosely enough to preserve air cell structure and tightly enough to prevent air circulation.

5.3.5 Preformed mineral wool insulation with a hard fibrous glass cover (CADAFIT 1200 °F) or equal may be used as applicable. For thickness of CADAFIT 1200 °F or equal mineral wool insulation refer to the thicknesses shown in table II at the appropriate temperature range.

5.4 **Fabrication, machinery and equipment.** For reusable covers for machinery and equipment, either of the following methods of fabrication is acceptable.

5.4.1 Covers similar to fibrous glass felt in accordance with MIL-I-16411 described for piping components (see 5.3.1).

5.4.2 Covers made in sections formed of insulating block held together with wire and adhesive cement, covered with 1/2-inch thickness of finishing cement, ASTM C 449 and lagged. Lacing with hooks, rings, washers and wire or brass snap fasteners shall be used to secure the covers.

5.4.3 Semi-removable turbine casing flange covers may be installed as an alternative for removable covers specified above. The permanent insulation shall be run to the casing flange, allowing for bolt removal space. The flange and bolts shall be covered with fibrous glass cloth in accordance with MIL-C-20079, type I, wire inserted fibrous glass cloth in accordance with HH-P-31, type I, class 1, or knitted wire mesh, as required by operating temperature, which shall be secured to the bolts with wire. The flange shall then be insulated with fibrous glass felt in

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accordance with MIL-I-16411, mineral wool felt in accordance with MIL-I-2818, or insulation block in accordance with MIL-I-2819, class 2 to the required thickness and shape. The insulation is then lagged with fibrous glass cloth, which shall be carried over the outer edge of the permanent insulation and secured with adhesive. The semi-removable cover shall then be sealed with adhesive in accordance with MIL-A-3316, class 1, and painted.

5.5 Installation.

5.5.1 Hot-surface insulation.

5.5.1.1 Pipe and tubing. Each layer of molded insulation shall be installed with joints butted together. Where two layers are used, 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 gauge minimum (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.

5.5.1.1.1 The installation of soot blower piping insulation shall be in accordance with Drawing 804-841336.

5.5.1.2 Piping components. Valves, fittings and accessories with welded and brazed fittings, including unions, may be insulated and lagged similarly to adjacent piping.

5.5.1.2.1 Block or felt insulating materials, or molded pipe insulation secured with hot-dipped galvanized iron or steel wire, shall be used. When insulating felts are used, the inner layer shall be fibrous glass felt conforming to MIL-I-16411. Galvanized iron or steel wire netting, number 18 gauge minimum (0.049-inch diameter), shall be spread over the insulating material and secured with wire. Insulating cement shall be used to fill crevices, smooth surfaces and completely cover the wire netting. A 1/2-inch thickness of finishing cement shall then be applied. Alternatively, wire netting may be omitted where the size of the installation does not require netting to hold the insulation cement in place during the installation process. For these installations, glass cloth may be installed over the previously finished insulation material without the intermediate layer of wire mesh. Insulating material shall be the same thickness as that on adjacent piping.

5.5.1.2.2 Reusable covers shall be fitted where required.

5.5.1.3 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 gauge minimum (0.049-inch diameter), shall be spread over the surface and secured by wire. Insulating cement shall be used to fill crevices, smooth surfaces and completely cover the wire netting.

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

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5.5.1.3.2 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.

5.5.1.3.3 Lagging shall be installed over finishing cement. Reusable covers shall be installed where required.

5.5.1.3.4 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.

5.5.1.4 Boiler uptakes. Boiler uptake thermal insulation shall be insulated with either mineral wool felt in accordance with MIL-I-2818 or fibrous glass felt in accordance with MIL-I-16411. If acoustic absorptive treatment is found to be necessary to decrease the noise level, the insulation thickness shall be increased accordingly.

5.5.1.4.1 Metal lagging for uptakes shall be galvanized sheet steel conforming to ASTM A 526, coating designation G-115, not less than 1/32 inch thick.

5.5.1.4.2 Insulation and lagging is not required on uptakes above the weather deck, except where the transfer of heat to spaces adjacent to the uptake area would be objectionable.

5.5.1.5 Unfired pressure vessels. Unfired pressure vessels, including catapult wet accumulators, shall be covered with block insulation, MIL-I-2819, or fibrous glass felt in accordance with MIL-I-16411. Insulation shall be held in place with 18 gauge galvanized wire spaced on approximately 3-inch centers or steel strapping spaced on 9-inch maximum centers. Insulation shall be covered with 1/2-inch finishing cement in accordance with ASTM C 449, lagged with fibrous glass cloth in accordance with MIL-C-20079, type I and painted as specified in 5.5.6. Insulation in the way of vessel supports shall be metal-faced to prevent insulation from wedging between the vessel and its support.

5.5.1.5.1 Removable and reusable covers shall be installed over butt-welded shell inserts for which periodic radiographic inspection of the joint is required. These covers shall extend 4 inches beyond the welded joint.

5.5.1.6 Outer boiler casing. If insulation is specified by pertinent ships' specification or contract, insulation block in accordance with MIL-I-2819, class 2 shall be secured to casing by wire netting (number 18 gauge) laced to welded notched studs on boiler casing. Finishing cement, ASTM C 449, shall be used to fill crevices, smooth surfaces and completely cover the netting to 1/2 inch thickness. Glass cloth conforming to MIL-C-20079, type I, class as applicable, shall be used to lag the insulation and shall be painted as specified in 5.5.6.

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5.5.2 **Antisweat insulation (cold and chilled water service).**

5.5.2.1 Antisweat piping insulation shall consist of preformed sectional pipe covering fabricated of EYPEL-A polyphosphazene insulation (MIL-I-24703). Thickness shall be 3/4-inch on all pipe sizes, except in air-conditioned spaces, where thickness shall be 1/2-inch. On large pipe sizes, EYPEL-A polyphosphazene insulation form S may be applied in 1/4-inch minimum thickness layers as necessary to build up to the required thickness. Glass cloth lagging shall be applied to protect insulation from damage in high traffic areas.

5.5.3 **Refrigerant insulation.**

5.5.3.1 EYPEL-A polyphosphazene insulation in accordance with MIL-I-24703 may be applied in 1/4-inch minimum thickness layers as necessary to build up the required thickness (form T or S, as applicable). Longitudinal and butt joints shall be staggered. Joints shall be sealed using adhesive conforming to MIL-A-24179. Glass cloth lagging shall be applied over elastomeric foamed plastic in high traffic areas to protect against damage.

5.5.4 **Weather deck hot piping insulation.**

5.5.4.1 Sectional preformed calcium silicate (MIL-I-2781) insulation for piping exposed to the weather shall be installed as follows:

a. Preliminary preparation of piping.

(1) All surfaces shall 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 in accordance with DOD-C-15328 to a maximum dry film thickness (DFT) of 0.0005 inch (0.5 mil). After this coat dries, apply two coats of aluminum paint made by mixing 2 pounds of aluminum paste in accordance with TT-P-320, type II, class B, with each gallon of phenolic varnish for temperatures up to 300 °F. Above 300 °F, apply two coats of paint conforming to TT-P-28.

b. Installation on pipes.

(1) Longitudinal joints on horizontal piping shall be on top and bottom of pipe; joints shall be staggered.

(2) Insulation shall be secured tightly to pipe with 1/2-inch wide 22-gauge galvanized steel bands or 18-gauge galvanized iron wire on 9-inch centers.

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(3) Fill all joints and voids in the insulation with high temperature cement in accordance with MIL-C-2861. Wrap tightly with one layer of fibrous glass lagging cloth in accordance with MIL-C-20079, type I, using adhesive in accordance with MIL-A-3316, class 1. After the adhesive has dried, the lagging shall be coated with two brush coats of end sealing compound in accordance with MIL-C-22395.

(4) Where insulation is stopped off on the piping, the preformed insulation shall be tapered. The exposed surface and 3 inches of pipe shall be coated with sealing compound in accordance with MIL-C-22395. Fibrous glass lagging cloth, in accordance with MIL-C-20079, type I, class as applicable, tailored to fit over the tapered insulation and exposed pipe shall be applied while the end sealing compound is still tacky. The lagging shall be attached to the insulation using adhesive in accordance with MIL-A-3316, and to the pipe with a 1/2-inch wide 22-gauge galvanized steel band.

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 gauge pressure allowing pipe to come to ambient temperature. These cycles shall be repeated a sufficient number of times, with 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 block cemented together with adhesive in accordance with ASTM D 3400.

(3) Permanent covers for fittings and valves shall be fitted snugly to fittings and adjacent pipe covering using the same material and methods as outlined for pipe covering. Voids between insulation and fitting shall be filled with tightly packed fibrous glass felt in accordance with MIL-I-16411. Permanent covers shall be lagged and coated in the same manner as the adjacent piping insulation.

(4) Where specified, rigid-type removable flange covers shall extend over the adjacent pipe covering 1-1/2 times the thickness of the insulation. The two halves of the cover shall be coated and lagged separately, using the same materials and procedure as outlined for weather deck hot 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 end sealing compound in accordance with MIL-C-22395.

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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 voids between insulation and support with tightly packed fibrous glass felt in accordance with MIL-I-16411 to within 1/4-inch from insulation surface. Fill remainder of space with sealing compound, in accordance with MIL-C-22395, overlapping generously both the support member and the adjacent insulation. Lag and coat with the same method and materials as adjacent piping.

5.5.5 Metal lagging. Metal lagging, where required, shall be installed with lap joints, secured with hardened self-tapping screws or metal bands. Joints shall be arranged in a manner which will facilitate run-off of impinging liquids.

5.5.6 Painting. Cloth and tape lagging shall be painted after installation with one coat of non-flaming paint conforming to formula No. 124 of DOD-E-24607 or water base DOD-C-24596 or Navy formula 25A, if necessary for appearance. Unlagged EYPEL-A polyphosphazene insulation conforming to MIL-I-24703 shall be sealed with one coat of Devoe and Raynolds "DEVLEX 1" or equal to ensure that the insulation seams remain tight. Both unlagged EYPEL-A polyphosphazene insulation sealed with "DEVFLEX 1" or equal and lagged insulation shall be painted with fire retardant paint conforming to DOD-E-24607 or water base DOD-C-24596 or Navy formula 25A.

6. NOTES

6.1 Intended use. The thermal insulation specified in this standard is used for the insulation of piping, machinery, uptakes and mechanical equipment used by the Navy for individual and classes of ships.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this standard
b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).

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6.3 Subject term (keyword) listing.

Antisweat
Boiler uptakes
Cold and chilled water
Finishing cement
Metal lagging
Refrigerant
Unfired pressure vessels

6.4 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
Navy – SH
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1. DOCUMENT NUMBER: MIL-STD-769J(SH)

2. DOCUMENT DATE (YYMMDD): 90/10/09

3. DOCUMENT TITLE: THERMAL INSULATION REQUIREMENTS FOR MACHINERY AND PIPING

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)

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c. ADDRESS (Include Zip Code)

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7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

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