INCH-POUND
MIL-STD-769K(SH)
29 June 2015

SUPERSEDING
MIL-STD-769J(SH)
9 October 1990

DEPARTMENT OF DEFENSE STANDARD PRACTICE

INSULATION REQUIREMENTS FOR U.S. NAVAL VESSELS

AMSC N/A FSC 5640

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
1333 ISAAC HULL AVE SE
WASHINGTON NAVY YARD DC 20376-0001

IN REPLY REFER TO
4121
Ser 05P/099
JUN 2 9 2015

From: Commander, Naval Sea Systems Command (SEA 05, CHENG)

Subj: CHENG'S INTENT FOR IMPLEMENTATION OF INSULATION REQUIREMENTS FOR U.S. NAVAL VESSELS

Ref: (a) MIL-STD-769K(SH), Insulation Requirements for U.S. Naval Vessels
(b) NAVSEAINST 4120.8, NAVSEA Policy for Commonality of Systems, Subsystems, and Components

1. Purpose. The NAVSEA Chief Engineer's (CHENG's) intent for issuing a revision to the Insulation Requirements for U.S. Naval Vessels, reference (a), is to create a comprehensive governing standard for all types of insulation materials and applications.

2. Discussion. Currently, Fleet maintenance activities follow guidance in letters and Fleet advisory messages, which has caused confusion and inaccurate application of approved materials for anti-sweat pipe insulation to bulkheads or compartments. Reference (a) updates requirements for piping, equipment, and machinery insulation materials; thermal, acoustic, transmission loss, fire, and anti-sweat treatments for compartments, hulls, vent ducts, and overheads; and their respective installation requirements. NAVSEA's commonality and variation reduction program, per reference (b), determined a revised military standard was needed.

3. Action. NAVSEA expects this specification to reduce labor and material costs for U.S. Naval Vessels for the Fleet.

4. Point of Contact. For information pertaining to insulation requirements, please contact the Materials - Non-Metallic - Ships Technical Warrant Holder, David Owen, SEA 05P2, commercial (202) 781-0651, email: david.owen@navy.mil.

L. B. FULLER
By direction

Affixed to: MIL-STD-769K(SH)

FOREWORD

1. This standard is approved for use by the Department of the Navy and is available for use by all Departments and Agencies of the Department of Defense.

2. This standard covers the insulation requirements for U.S. Naval vessels. The information contained in this standard amplifies the requirements and provides standard installation practices for insulation of piping, machinery, uptakes, mechanical equipment, refrigerated spaces, vent ducts, and compartments covered in ship specifications for individual ships or classes of ships.

3. Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla mil.

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1. SCOPE

1.1 Scope. This standard provides the insulation requirements and installation procedures for insulation on piping, machinery, uptakes, mechanical equipment, refrigerated spaces, vent ducts and compartments on U.S. Naval vessels.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL SPECIFICATIONS

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

COMMERCIAL ITEM DESCRIPTIONS

A-A-59551	-	Wire, Electrical, Copper (Uninsulated)

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-I-742	-	Insulation Board, Thermal, Fibrous Glass
MIL-S-901	-	Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for
MIL-Y-1140	-	Yarn, Cord, Sleeving, Cloth, and Tape - Glass
MIL-T-2118	-	Trap, Steam, Angle, Thermostatic
MIL-I-2781	-	Insulation, Pipe, Thermal
MIL-PRF-2818	-	Insulation Blanket, Thermal
MIL-PRF-2819	-	Insulation Block, Thermal
MIL-C-2861	-	Cement, Insulation, High Temperature
MIL-D-3134	-	Deck Covering Materials
MIL-A-3316	-	Adhesives, Fire-Resistant, Thermal Insulation
MIL-PRF-6855	-	Rubber, Synthetic, Sheets, Strips, Molded or Extruded Shapes
MIL-P-15280	-	Plastic, Material, Unicellular (Sheets and Tubes)
MIL-I-16411	-	Insulation Felt, Thermal, Glass Fiber
MIL-P-17549	-	Plastic Laminates, Fibrous Glass Reinforced, Marine Structural

MIL-L-19140	-	Lumber and Plywood, Fire-Retardant Treated
MIL-PRF-19565	-	Coating Compounds, Thermal Insulation, Fire - and Water-Resistant, Vapor Barrier
MIL-C-20079	-	Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass
MIL-R-21607	-	Resins, Polyester, Low Pressure Laminating, Fire Retardant
MIL-I-22023	-	Insulation Felt, Thermal and Sound Absorbing Felt, Fibrous Glass, Flexible
MIL-PRF-22344	-	Insulation, Pipe, Thermal
MIL-C-22395	-	Compound, End Sealing, Thermal Insulation Pipe Covering-, Fire-, Water-, and Weather-Resistant
MIL-A-23054	-	Acoustic Absorptive Board, Fibrous Glass Perforated Fibrous Glass Cloth Faced
MIL-PRF-23377	-	Primer Coatings: Epoxy, High-Solids
MIL-S-24149	-	Studs Welding and Arc Shields (Ferrules), General Specification for
MIL-S-24149/1	-	Stud, Welding, and Arc Shields (Ferrules); Type I, Class 1, 2, 3, and Type II, Class 1, 4, 5, 5a, 6, Carbon Steel, For Direct Energy, Arc Welding
MIL-S-24149/2	-	Studs, Welding, and Arc Shields (Ferrules); Type III, Class 1, 2, 3, and Type IV, Class 1, 2, 3, 4, 5, 6, Aluminum Alloy, for Direct Energy Arc Welding
MIL-S-24149/4	-	Studs, Welding, Type VI, Class 1, 2, 3, Carbon Steel, for Stored Energy (Capacitor Discharge) Arc Welding
MIL-S-24149/5	-	Studs, Welding, Type VII, Class 1, 2, 3, Aluminum Alloy, for Stored Energy (Capacitor Discharge) Arc Welding
MIL-PRF-24172	-	Insulation, Plastic, Cellular Foam, Rigid, Preformed and Foam-In-Place
MIL-A-24179	-	Adhesive, Flexible Unicellular – Plastic Thermal Insulation
MIL-I-24391	-	Insulation Tape, Electrical, Plastic Pressure-Sensitive
MIL-DTL-24441	-	Paint, Epoxy-Polyamide, General Specification for
MIL-A-24456	-	Adhesive for Plastic Vibration-Damping Tile
MIL-PRF-24596	-	Coating Compounds, Nonflaming, Fire-Resistant (Metric)
MIL-DTL-24607	-	Enamel, Interior, Nonflaming (Dry), Chlorinated Alkyd Resin, Semigloss
MIL-DTL-24688	-	Insulation, Thermal and Acoustic Absorptive, Cellular Polyimide Foam
MIL-PRF-24699	-	Acoustical Transmission Loss Barrier Material
MIL-PRF-32161	-	Insulation, High Temperature Fire Protection, Thermal and Acoustic
MIL-PRF-32514	-	Anti-Sweat, Refrigerant, and Thermal Foam Insulation

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1689 - Fabrication, Welding, and Inspection of Ships Structure

MIL-STD-3020 - Fire Resistance of U.S. Naval Surface Ships

(Copies of these documents are available online at http://quicksearch.dla.mil/.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF COMMERCE VOLUNTARY PRODUCT STANDARD

Voluntary Product Standard PS-1 - Structural Plywood

(Copies of this document are available online at http://gsi.nist.gov/.)

DEPARTMENT OF THE NAVY

NUC SPECIFICATION. NO. 120569MA-R2 - Acoustical Barrier Material

(Copies of this document are available from Naval Ocean Systems Center, Code 523, San Diego, CA 92152.)

OPNAV INSTRUCTIONS

OPNAVINST 5100.19 - Navy Safety and Occupational Health Program Manual for Forces Afloat

OPNAVINST 5100.23 - Navy Safety And Occupational Health Program Manual

(Copies of these documents are available online at https://doni.daps.dla mil.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

803-2145518 - Sprayshields for Mechanical Joints

803-5184182 - Insulation, Passive Fire Protection – Installation Details

804-841336 - Piping Boiler Soot Blower

804-1385781 - Hangers, Pipe, for Surface Ships

804-5773931 - Insulation for Compartments, Acoustic and Thermal – Installation Details

804-5773932 - Insulation for Ducts, Acoustic and Thermal, Installation Details

804-5959212 - Surface Ship Machinery Insulation – Installation Details

804-5959214 - Piping Insulation – Installation Details

S4823-1385782 - Hangers, Pipe, for Submarines

(Copies of these documents are available from the applicable repositories listed in S0005-AE-PRO-010/EDM, which can be obtained online at https://nll.ahf nmci.navy.mil, may be requested by phone at 215-697-2626, or may be requested by email at nllhelpdesk@navy.mil. Copies of these documents may also be obtained from the Naval Ships Engineering Drawing Repository (NSEDR) online at https://199.208.213.105/webjedmics/index.jsp. To request an NSEDR account for drawing access, send an email to NNSY_JEDMICS_NSEDR_HELP_DESK@navy.mil.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

S9086-GY-STM-010 - NSTM Chapter 221, Boilers

S9086-RK-STM-010	-	NSTM Chapter 505, Piping Systems
S9086-VH-STM-010	-	NSTM Chapter 635, Thermal, Fire, and Acoustic Insulation
S9510-AB-ATM-010	-	Nuclear Powered Submarine Atmosphere Control Manual, Chapter "Material Control Program"
T9074-AD-GIB-010/1688	-	Requirements for Fabrication, Welding, and Inspection of Submarine Structure

(Copies of these documents are available online at https://nll.ahf.nmci navy mil.)

(Copies of the chapter titled "Material Control Program" are available by email request to commandstandards@navy mil.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) STANDARD ITEM

Standard Item 009-32 - Cleaning and Painting Requirements; accomplish

(Copies of this document are available online at http://www.navsea.navy.mil/CNRMC/SERMC/SSRAC1/standard.aspx or ssrac.navy mil.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN WOOD-PRESERVERS ASSOCIATION

AWPA-P5 - Standard for Waterborne Preservatives

(Copies of this document are available online at www.awpa.com.)

ASTM INTERNATIONAL

ASTM A108	-	Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished
ASTM A240/A240M		Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A390	-	Standard Specification for Zinc Coated (Galvanized) Steel Poultry Fence Fabric (Hexagonal and Straight Line)
ASTM A641/A641M	-	Standard Specification for Zinc Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	-	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B209	-	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C449	-	Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C474	-	Standard Test Methods for Joint Treatment Materials for Gypsum Board Construction
ASTM C547	-	Standard Specification for Mineral Fiber Pipe Insulation
ASTM C595/C595M	-	Standard Specification for Blended Hydraulic Cements

ASTM C610	-	Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation
ASTM D412	-	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D1002	-	Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)
ASTM D1062	-	Standard Test Method for Cleavage Strength of Metal-to-Metal Adhesive Bonds
ASTM D1781	-	Standard Test Method for Climbing Drum Peel for Adhesives
ASTM D3953	-	Standard Specification for Strapping, Flat Steel and Seals
ASTM D6123/D6123M	-	Standard Specification for Pressure-Sensitive Tape for Light Duty Packaging and General Purpose Masking
ASTM D6411/D6411M	-	Standard Specification For Silicone Rubber Room Temperature Vulcanizing Low Outgassing Materials
ASTM F683	-	Standard Practice for Selection and Application of Thermal Insulation for Piping and Machinery
ASTM F1267	-	Standard Specification for Metal, Expanded, Steel

(Copies of these documents are available online at www.astm.org.)

SAE INTERNATIONAL

SAE-AMS-QQ-A-250/3	-	Aluminum Alloy Alclad 2014, Plate and Sheet
SAE-AMS-QQ-A-250/8	-	Aluminum Alloy 5052, Plate and Sheet

(Copies of these documents are available online at www.sae.org.)

UNDERWRITERS LABORATORIES, INC. (UL)

UL 1709	-	Standard for Rapid Rise Fire Tests of Protection Materials for Structural Steel.

(Copies of this document are available online at www.comm-2000.com.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, 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.

3. DEFINITIONS

3.1 Anti-sweat insulation. A type of thermal insulation applied on components to either prevent formation of condensation on their external surfaces or to limit absorption of external heat which would be detrimental to the system operation.

3.2 Blanket insulation. A flexible, coherent insulation supplied flat or in roll form.

3.3 Blanket insulation, metal mesh. A blanket insulation covered by flexible metal-mesh facings attached on one or both sides.

3.4 Block insulation. Rigid insulation pre-formed into rectangular or square units.

3.5 Board insulation. Semi-rigid insulation pre-formed into rectangular or square units having a degree of suppleness particularly related to their geometrical dimensions.

3.6 Calcium silicate. Insulation composed principally of hydrous calcium silicate, and which usually contains reinforcing fibers.

3.7 Cellular elastomeric. Insulation composed principally of natural or synthetic elastomers, or comprised of a blend of both, processed to form flexible, semi-rigid, or rigid foam which has a predominantly closed-cell structure.

3.8 Cement, finishing. A mixture of dry fibrous or powdery materials, or both, that when mixed with water develops a plastic consistency, and when dried in place forms a hard, protective surface.

3.9 Cement, insulating. A mixture of dry granular, flaky, fibrous, or powdery materials that when mixed with water develops a plastic consistency, and when dried in place forms a coherent covering that affords substantial resistance to heat transmission.

3.10 Closed cell foam. A material comprised predominantly of individual non-interconnecting cellular voids.

3.11 Constraining layer. Constraining layer is a medium strength steel or aluminum alloy plate which varies in thickness according to the thickness of the steel structure that is to be damped. A constraining layer generally is used on steel structures that are ¾ inch or greater in thickness. The purpose of the constraining layer is to limit extensional distortion of the damping tile when undergoing mechanical deformation, thereby increasing shear distortion with consequent improvement in damping efficiency. The constraining layer always is bonded to the damping tile.

3.12 Corrosion. Deterioration by chemical action, such as rust on steel.

3.13 Damping. Damping is the process of reducing the amplitude of vibrations as they travel through a structure. This reduction is accomplished by applying to the structure a material that has an inherent viscous loss.

3.14 Dry film thickness (DFT). The thickness of a paint or coating after it has dried or cured, measured in mils.

3.15 Fibrous glass. A synthetic vitreous fiber insulation made by melting predominantly silica sand and other inorganic materials, and then physically forming the melt into fibers.

3.16 High traffic area. An area subject to wear and damage during normal, routine operations.

3.17 Hot surface insulation. A type of thermal insulation applied on external surfaces of components which are 125 °F or higher to protect personnel and limit undesirable heat transfer.

3.18 Lagging. A protective covering, such as fibrous-glass cloth or tape, applied over the insulation material.

3.19 Mineral fiber. Insulation composed principally of fibers manufactured from rock, slag, or glass, with and without binders.

3.20 Mineral wool. A synthetic vitreous fiber insulation made by melting predominantly igneous rock, and or furnace slag, and other inorganic materials, and then physically forming the melt into fibers.

3.21 N-class division. N-class divisions are fire-resistant divisions formed by bulkheads and decks (overheads) that are designed to protect against structural failure a prevent the passage of flame or hot gases when exposed to a rapid rise hydrocarbon fire exposure (Class B), described in “Method of Fire Tests for Fire Resistance of Bulkheads and Decks (Overheads)” of MIL-STD-3020, after shock testing in accordance with MIL-S-901. The minimum fire test duration is 30 minutes.

3.22 Polyimide. Insulation composed of the reaction product in which the bonds formed between monomers during polymerization are essentially imide units forming a cellular structure.

3.23 Refrigerant insulation. A type of thermal insulation applied on external surfaces of components conveying cold fluids, such as refrigerant or brine, to limit absorption of heat by the refrigerant and to prevent ice formation on the surfaces.

3.24 Reusable covers. Machinery covering or pipe covering which can be removed without being damaged and easily replaced for continued use.

3.25 Sheathing. A protective covering of sheet metal applied over the insulation material to protect it from being damaged.

3.26 Temperature rise. The difference between the actual temperature and the initial temperature.

3.27 Template. A gauge or pattern, such as a thin plate or board, used as a guide during fabrication or cutting of a piece or component to ensure that it conforms to the shape or contour desired.

3.28 Thermal conductivity (k-factor). The rate of heat flow through one inch of a homogeneous material.

3.29 Thermal insulation. A material used to provide resistance to heat flow.

3.30 Thermal insulation system. Applied or installed thermal insulation complete with adhesive, lagging, and vapor barrier or paint.

3.31 Vapor barrier. A covering or coating applied to the surface of insulation to prevent the penetration of water vapor.

4. GENERAL REQUIREMENTS

4.1 General requirements. The general requirements specified herein shall apply to insulation materials, their applications, temperature ranges, thicknesses, and installation procedures used on piping, machinery, uptakes, mechanical equipment, refrigerated spaces, vent ducts and compartments on U.S. Naval vessels.

4.1.1 Discussion. Specific areas to be insulated, along with the type and thickness of insulation materials to be installed, are as specified (see 6.2). In the absence of those specific details, the following requirements describe the general areas of usage and the considerations governing use of insulation materials.

4.2 Materials and nominal thicknesses. Materials approved for insulation and lagging, and their nominal acceptable thicknesses for their specific applications and temperature ranges, shall be as specified in tables I through XII.

4.3 Surface temperature. The thicknesses specified in this document for hot surface insulation are designed to maintain the surface temperature of the insulation at or below 125 °F for fluid temperatures up to 650 °F. For fluid temperatures above 650 °F, the surface temperature of the insulation shall be maintained at a maximum of 133 °F.

4.4 Design temperature. The selected design ambient air temperature of 85 °F does not represent maximum air temperatures in engine rooms 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).

4.5 Health and safety precautions. Health and safety precautions shall be rigidly adhered to when handling dust and fiber-producing materials. When work is performed on older ships, extra care shall be exercised to ensure that personnel do not come into contact with asbestos-containing products. Permissible levels of exposure, hygienic control measures, protective equipment, medical surveillance requirements and other pertinent data governing occupational hazards involved in applying, removing, using, handling, storing, processing, disposing of, or transporting insulation materials are addressed in OPNAVINST 5100.19 and OPNAVINST 5100.23.

4.6 Prohibited materials.

4.6.1 Asbestos and ceramic (refractory) fiber. The installation of asbestos and ceramic (refractory) fiber containing insulation and lagging materials shall be prohibited. Where previously installed asbestos or ceramic (refractory) fiber containing insulation and lagging materials are removed, restoration shall be with non-asbestos or non-ceramic (refractory) containing insulation and lagging materials, as specified herein. Asbestos guidance concerning safety and health policy issues and requirements on asbestos for forces afloat is contained in OPNAVINST 5100.19.

4.6.2 Mercury and polychlorinated biphenyls. Insulation materials shall be free of mercury and polychlorinated biphenyls.

4.6.3 Plastic, unicellular insulation, conforming to MIL-P-15280. Plastic, unicellular insulation conforming to MIL-P-15280 shall not be installed. Where previously installed insulation material conforming to MIL-P-15280 is removed from anti-sweat piping, machinery, and ventilation ducting, restoration shall be with the approved materials conforming to MIL-PRF-32514. Where previously installed insulation conforming to MIL-P-15280 is removed from submarine hulls (prior to SSN 21 class), restoration shall be with the approved fire-resistant, anti-sweat submarine hull insulation materials (see 5.8.a.(1) and 5.8.a.(2)).

4.6.4 Hydrochlorofluorocarbons . Hydrochlorofluorocarbons shall not be used as a component of or blowing agent for any type of insulation used aboard U.S. Naval vessels.

4.7 Recycled, recovered, environmentally preferable, or biobased materials. Recycled, recovered, environmentally preferable, or biobased materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promote economically advantageous life cycle costs.

4.8 Insulation requirements. Insulation, in general, should be used on all components, piping, machinery, and equipment having external surface temperatures of 125 °F and higher.

4.8.1 Insulation special conditions. The following special conditions shall supplement or modify the selection of insulation materials, thicknesses, and installation procedures specified herein, when applicable:

a. Apply insulation only when pipes are clean, dry, and unheated.

b. Do not compress the insulation. The insulating properties of the material can be greatly reduced when the insulation is compressed.

c. Do not exceed the maximum recommended service temperatures for each type of insulation as specified in table IV.

d. Fibrous glass and mineral wool pipe insulations shall not be used in high-traffic areas in horizontal orientations 4 feet or less above the deck unless in a vertical orientation.

e. Ensure all voids and joints in calcium silicate insulation are filled with cement conforming to MIL-C-2861. Allow the cement to dry completely in accordance with manufacturer's instructions prior to applying lagging.

f. Follow all manufacturers' instructions with regard to application temperature and cure times for cements and adhesives.

g. Pre-formed piping insulation shall be utilized wherever possible in order to reduce installation time and effort.

h. Calcium silicate pre-formed sectional pipe insulation conforming to MIL-I-2781 and block insulation conforming to MIL-PRF-2819 are recommended for use in "high traffic" areas.

i. Reduce the insulation thickness on soot blower piping between the root valve and the soot blower heads to one-half that indicated for a system normally at the same temperature.

j. Use the materials specified in S9086-VH-STM-010 for repair or replacement of piping and machinery insulation. Procedures for the repair and replacement of insulation are specified in S9086-VH-STM-010.

k. Where hot surface insulation thicknesses are not specified, and for special applications, ensure that the insulation thickness is sufficient to reduce the insulation surface temperature to the values specified in 4.3.

l. Do not use adhesives containing halogenated solvents for submarine applications.

m. Do not install insulation on 2 feet of pipe immediately upstream of thermostatic steam traps, conforming to MIL-T-2118. Install a removable cover, consisting of two layers of fibrous-glass cloth conforming to MIL-C-20079, over the uninsulated pipe and the thermostatic trap.

n. Do not insulate small diameter hot piping or ½-inch iron pipe size (IPS) and under when the operating temperatures are less than 125 °F.

o. Provide sheathing on un-insulated hot pipes only where such pipes are readily accessible to contact with personnel.

p. Certify insulation materials installed in submarines and assign a usage category of "limited" or "permitted" in accordance with the off-gassing requirements of S9510-AB-ATM-010.

q. Install fibrous-glass cloth lagging conforming to MIL-C-20079 to protect insulation in high traffic areas where the insulation is subject to wear and damage from routine operations.

r. Do not braze or weld clips, hooks, or other fastenings for securing insulation or lagging to nonferrous parts of distilling plants or deaerating feed tanks.

4.9 Exceptions to insulation requirements. Exceptions to the insulation requirements specified in 4.8 shall be as follows:

a. Any hot surface for which freedom from insulation is essential for its proper operation, such as a boiler gauge glass.

b. Relief valves, and piping beyond the valve discharge, except as required for personnel protection.

c. Pressure gauge piping.

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

e. Piping in bilges.

f. Piping in voids and cofferdams except where omitting insulation may be detrimental to system operation, such as catapult steam.

g. Safety-valve bodies, springs, and lifting gear.

h. Mechanical joints exposed to sub-atmospheric pressures.

i. Piping over shower stalls, behind, and under lavatories.

j. Steam and water piping under and around kettles in galley wet deck area. Where there is danger of personnel coming into contact with hot piping, provide protection with a perforated corrosion-resistant steel (CRES) or aluminum sheathing that surrounds the pipe with approximately a ½-inch standoff from the pipe.

k. Valves or flanges on sewage collection, holding, and transfer system.

4.10 Lagging. Lagging conforming to MIL-C-20079 (standard or rewettable) shall be applied over insulation where necessary to protect it from wear and abuse during routine operations as follows:

a. Apply a coat of adhesive conforming to MIL-A-3316 to the outer surface of the insulation.

b. Apply fibrous-glass cloth lagging conforming to MIL-C-20079 over the adhesive conforming to MIL-A-3316 and insulation.

c. Apply a coat of adhesive conforming to MIL-A-3316 over the lagging prior to painting.

d. Use a lagging system if lagging was required to pass the fire test of MIL-PRF-32514, in all cases where adhesive, flexible unicellular conforming to MIL-A-24179 is used.

4.11 Painting. Insulation shall be painted in accordance with Standard Item 009-32 as applicable, and as follows:

a. Insulation within laundries, sculleries, galleys, drying rooms, storerooms, wash rooms, on the warm side of refrigerated stores spaces and anti-sweat insulation shall be painted as follows:

(1) Apply three brush coats of vapor barrier compound conforming to MIL-PRF-19565. Ensure that the vapor barrier compound is pigmented orange and white and the three coats are applied as white/orange/white.

(2) After the vapor barrier compound has dried, apply one coat of paint conforming to MIL-PRF-24596 (use Type I, Grade C, Classes 1 or 2 when ambient or surface temperatures are less than 50 °F) or MIL-DTL-24607, 2 to 4 mils dry film thickness (DFT), over the vapor barrier conforming to MIL-PRF-19565. Apply a second coat of paint conforming to MIL-PRF-24596 or MIL-DTL-24607, 2 to 4 mils DFT.

b. Thermal insulation on hull, ventilation ducting, and piping shall be painted as follows:

(1) Apply one coat of paint 2 to 4 mils DFT conforming to MIL-PRF-24596 (use Type I, Grade C, Classes 1 or 2 when ambient or surface temperatures are less than 50 °F) or MIL-DTL-24607.

(2) Apply a second coat of paint conforming to MIL-PRF-24596 or MIL-DTL-24607, 2 to 4 mils DFT only for hiding, if required.

c. Acoustic absorptive insulation shall be painted as follows:

(1) Apply one thin coat of paint conforming to MIL-PRF-24596 (use Type I, Grade C, Classes 1 or 2 when ambient or surface temperatures are less than 50 °F) or MIL-DTL-24607.

(2) The paint shall be sprayed in a thin coat and care taken to prevent the paint from bridging or sealing the perforations in the acoustical treatment.

4.12 Metal sheathing. Metal sheathing is generally required to protect the insulation from being subjected to damage in high traffic areas, as well as for personnel protection for prevention of burn hazards. The following are approved materials:

a. CRES, conforming to ASTM A240/A240M, Type 304, with a nominal thickness of 28 gauge.

b. Hot-dipped galvanized steel, conforming to ASTM A653/653M, coating designation G-115, with a nominal thickness of 28 gauge, or with a nominal thickness of 22 gauge for use on uptakes only.

c. Aluminum, conforming to ASTM B209, Alloy 6061, or aluminum alloy, plate and sheet, conforming to ASTM B209, with a nominal thickness of 22 gauge.

d. Aluminum, conforming to ASTM B209, Alloy 5052, or aluminum alloy, plate and sheet, conforming to SAE-AMS-QQ-A-250/8, with a nominal thickness of 22 gauge.

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

4.13 Surface preparation. All surfaces to which insulation is applied shall be prepared in accordance with the requirements of Standard Item 009-32 as applicable or as specified (see 6.2) prior to installation of insulation.

4.13.1 Surfaces clean and dry. All surfaces to which insulation is applied shall be clean, free of grease and oil, and dry.

4.14 Non-corrosive insulation. All insulation materials shall be non-corrosive to metals on U.S. Naval vessels.

5. DETAILED REQUIREMENTS

5.1 Requirements for anti-sweat and refrigerant insulation. Anti-sweat and refrigerant insulation shall conform to the insulation, adhesives, fasteners, lagging, vapor barrier, and paint materials as follows:

a. Insulation, anti-sweat and refrigerant, thermal foam conforming to MIL-PRF-32514.

b. Insulation felt, thermal and sound absorbing, fibrous glass, flexible conforming to MIL-I-22023.

c. Insulation felt, thermal, glass fiber conforming to MIL-I-16411.

d. Adhesive, flexible unicellular conforming to MIL-A-24179. In all cases, the adhesive used to install the insulation shall be equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, the same lagging system shall be used.

e. Adhesives, fire-resistant, thermal insulation conforming to MIL-A-3316.

f. Coating compounds, thermal insulation, fire and water-resistant, vapor barrier conforming to MIL-PRF-19565.

g. Zinc-coated (galvanized) carbon steel wire conforming to ASTM A641/A641M.

h. Wire, electrical, copper (uninsulated) conforming to A-A-59551.

i. Mineral fiber hydraulic setting thermal insulating and finishing cement conforming to ASTM C449.

j. Light-duty packaging and general purpose masking conforming to ASTM D6123/6123M.

k. Cloth, glass; tape, textile glass; and thread, glass, and wire-reinforced glass conforming to MIL-C-20079.

l. Building paper, vegetable fiber: kraft, waterproofed, water repellent and fire resistant conforming to UU-B-790.

m. Enamel, interior, nonflaming (dry), chlorinated alkyd resin, semigloss conforming to MIL-DTL-24607.

n. Coating compounds, nonflaming, fire-protective resistant conforming to MIL-PRF-24596.

5.1.1 Thickness. Anti-sweat and refrigerant insulation shall be of the materials and thicknesses specified in tables I and II.

TABLE I. Thickness of anti-sweat and refrigerant insulation for piping conforming to MIL-PRF-32514.

Pipe Size (inches)	Temperature Range (°F)	Nominal Thickness (inches)		
		Non-Air Conditioned Spaces	Air Conditioned Spaces	Air Conditioned Spaces Open to Weatherdeck 1/
All	-20 to -1	1½	1	2
	0 to 40	1	¾	1½
	41 to 125	¾	½	1
NOTE: Wherever possible, double layers or double thickness of insulation shall be used where piping is exposed to high humidity conditions. An example is a space that is in close proximity to the weather deck or outside doors and subject to outside air exposure.				

TABLE II. Thickness of anti-sweat and refrigerant insulation for machinery and equipment.

Temperature Range (°F)	Defense Specification	Nominal Thickness (inches)	
		Non-Air Conditioned Spaces	Air Conditioned Spaces
-20 to 40	MIL-PRF-32514	2	1
41 to 125	MIL-PRF-32514	¾	½
	MIL-I-22023, Type I	1	½
NOTE: In some cases, fibrous-glass thermal and sound absorbing insulation felt conforming to MIL-I-22023, Type I, Class 6 is used as an anti-sweat insulation for submarine tank tops.			

5.1.2 Anti-sweat and refrigerant insulation installation requirements. Unless otherwise specified in this section, components and piping handling fluids in the 28 to 99 °F temperature range shall be insulated with anti-sweat insulation conforming to MIL-PRF-32514 and lagged with fibrous-glass cloth conforming to MIL-C-20079 where required. Flexible hoses shall be insulated with removable and reusable insulation without any lagging. When installing anti-sweat insulation, the following requirements apply:

a. Anti-sweat insulation shall be installed on systems which are not in operation. Anti-sweat insulation shall be installed on clean, dry lines.

b. The insulation shall not be compressed. On cold pipes, condensation may occur where the insulation is compressed.

c. The insulation shall not be stretched. The insulation should be pushed rather than pulled in order avoid reduction in thickness and stress on the insulation. There shall be no straining of the surface and joints. The proper size shall be used according to the application parameters such as pipe size, fluid temperature, air-conditioned or non-conditioned space as specified in tables I and II.

d. All seams shall be sealed as follows:

(1) Seal all butt joints and longitudinal seams with adhesive conforming to MIL-A-24179. Before using the adhesive, follow the precautionary information printed on the can label and follow the instructions accordingly.

(2) Stir the adhesive before using, and apply only to clean, dry, oil-free surfaces.

(3) Apply adhesive conforming to MIL-A-24179, Type II, at air temperatures above 40 °F.

(4) Apply adhesive conforming to MIL-A-24179, Type I, at air temperatures above 65 °F.

(5) Apply the adhesive in a thin, uniform coat to both surfaces. Allow the adhesive to set until dry to the touch but tacky under slight pressure before joining surfaces. Join pieces together accurately as the adhesive bonds instantly on contact.

(6) Press joints together firmly, making sure that a bond is achieved all the way through the joint, not just at the outer edges.

(7) In all cases, ensure that the adhesive used to install the insulation is equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

e. Wherever possible, double layers or double thickness of anti-sweat insulation shall be used where piping is exposed to high humidity conditions. An example is a space that is in close proximity to the weather deck or outside doors and subject to outside air exposure.

f. Anti-sweat piping insulation that passes through joiner bulkheads or hull structures, where there is sufficient clearance, shall pass through intact (see figure 1). Where there is insufficient clearance, the insulation shall be fit against the bulkhead or structure and seal the joint with adhesive conforming to MIL-A-24179 adhesive.

g. When a refrigerant pipe passes through an insulated bulkhead into a refrigerated space, the anti-sweat piping insulation shall extend into the room at least 1 inch beyond the bulkhead. Anti-sweat insulation conforming to MIL-PRF-32514 shall be installed on refrigerant piping systems, including valves, fittings, and flanges, in the same manner as it is installed for anti-sweat treatments. The insulation shall run up to and be carefully fitted around clamp, hanger rod and support straps, and sealed adhesive conforming to with MIL-A-24179.

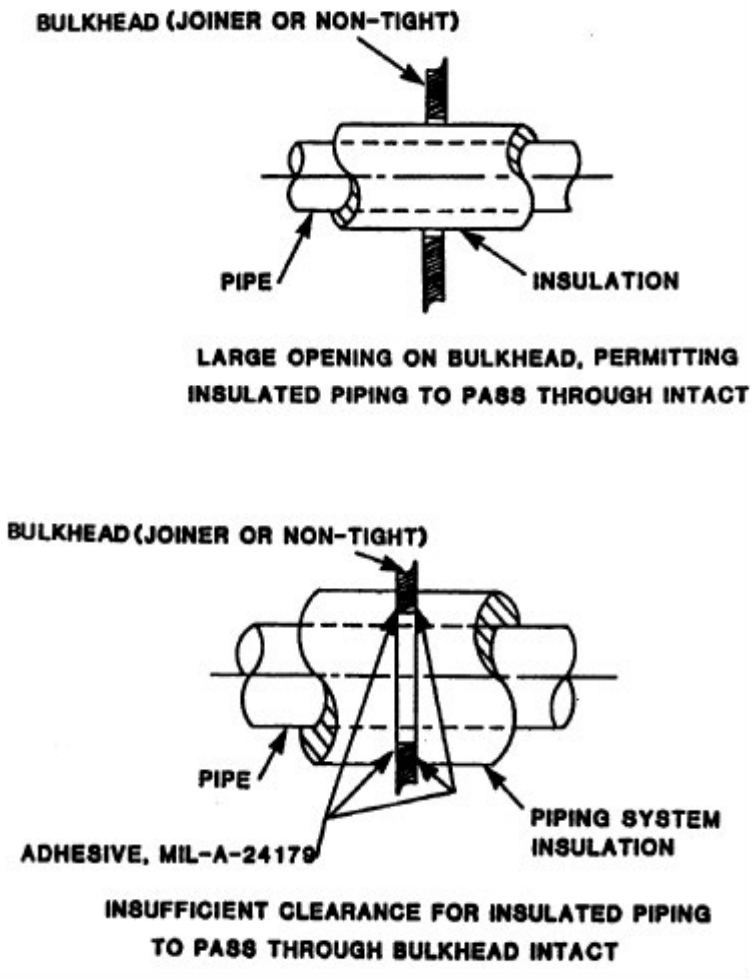

FIGURE 1. Anti-sweat piping insulation penetrating bulkheads.

h. Fluid system components and piping, except soil and waste drain piping in the sewage pump rooms or any VCHT valves or flanged joints in the system, shall be insulated with anti-sweat insulation as follows:

(1) To limit absorption of heat from an external source which could be detrimental to the system, such as a chilled water and refrigerant system.

(2) To prevent formation of condensation on surfaces of components, which would be objectionable from:

(a) A habitability standpoint, such as condensation dripping on personnel.

(b) A danger standpoint, such as condensation dripping on electrical and electronic equipment, ladder steps, or walkways.

(c) A damage standpoint, such as condensation dripping on stores or supplies.

(d) A maintenance standpoint, such as condensation dripping on machinery, equipment, or painted surfaces of bulkheads or decks which are normally kept in shipshape condition.

5.1.3 Anti-sweat insulation exceptions. For the following applications, anti-sweat insulation shall not be required:

a. Any cold surface for which freedom of insulation is essential for its proper operation.

b. Only in an emergency condition does fluid flow in the system cause sweating, such as dry pipe systems and parts of wet systems, such as the piping between sprinkling control valves and their root cutout valves.

c. When sweating would not be objectionable, such as in voids, shaft alleys, and bilges, and on plumbing fixtures and the supply and drain piping immediately adjacent to and serving these fixtures.

5.1.4 Tubular form and sheet form anti-sweat and refrigerant insulation. Tubular form insulation conforming to MIL-PRF-32514 shall be used for anti-sweat and refrigerant pipe insulation for piping 5-inch IPS and below. Sheet form insulation conforming to MIL-PRF-32514 shall be used on piping larger than 5-inch IPS.

5.1.5 Anti-sweat and refrigerant cellular elastomeric insulation (tubular form) on 5-inch IPS piping and below. Anti-sweat and refrigerant cellular elastomeric insulation (tubular form) shall be installed on 5-inch IPS piping and below as follows:

a. Use a sharp knife to slit the tubular form insulation lengthwise on one side.

b. Snap the insulation over the clean, dry pipe.

c. Brush coat both slit surfaces completely with adhesive conforming to MIL-A-24179. Push the insulation down over the pipe to hold adhesive coated surfaces apart. Allow the adhesive to dry until dry to the touch but tacky under slight pressure before joining surfaces. Press the surface nearest to the pipe together first and evenly before joining the entire surface. In all cases, ensure that the adhesive used to install the insulation is equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

d. If the insulation should become stuck to the pipe after applying adhesive, break the insulation loose by running a finger down the pipe, between the insulation and the pipe.

e. When the adhesive has air-dried, apply moderate pressure to the entire joint to assure a vapor-tight bond.

f. In double layer work, apply the anti-sweat insulation with the butt and longitudinal seams staggered where possible. Glue the first and second layers over the entire surface. Do not apply spots or strips of adhesive.

g. If in a high traffic area or if required to qualify to and pass the fire test in MIL-PRF-32514, lag the insulation as specified (see 4.10).

h. Paint the insulation in accordance with the requirements for anti-sweat insulation (see 4.11).

5.1.6 Elbows. Tubular form or sheet form insulation conforming to MIL-PRF-32514 shall be used for anti-sweat insulation on elbows. When available, templates for insulating elbows shall be used.

5.1.6.1 45-degree elbow for 5-inch IPS piping and below (tubular form insulation). A 45-degree elbow shall be insulated on 5-inch IPS piping and below with tubular form insulation as follows:

a. Cut across the diameter of the tubular form insulation at a 22.5-degree angle (see figure 2).

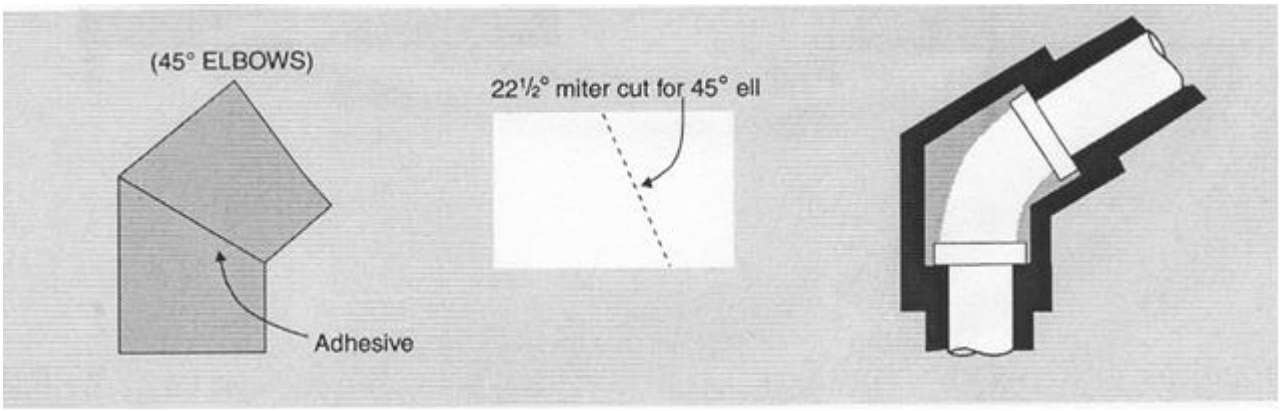

FIGURE 2. 45-degree elbow installation with tubular form insulation on 5-inch IPS piping and below.

b. Cut the insulation lengthwise on one side on both cut sections. Snap one section of the insulation over the pipe so that the mitered cut corresponds to the center of the elbow.

c. Brush coat both slit surfaces and the ends of the tubular insulation completely with adhesive conforming to MIL-A-24179.

d. Snap the other mitered section over the pipe so that the sections together form a 45-degree angle.

e. Brush coat both slit surfaces and the ends of the second tubular insulation completely with adhesive conforming to MIL-A-24179. In all cases, ensure that the adhesive used to install the insulation is equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system shall be used.

f. Allow the adhesive to dry until dry to the touch but tacky under slight pressure before joining surfaces.

g. Join the slit surfaces and the mitered butt ends together. Ensure all seams are sealed and there is a tight fit around the pipe.

h. If in a high traffic area or if required to qualify to and pass the fire test in MIL-PRF-32514, lag the insulation as specified (see 4.10).

i. Paint the insulation in accordance with the requirements for anti-sweat insulation (see 4.11).

5.1.6.2 90-degree elbow for 5-inch IPS piping and below (tubular form insulation). A 90-degree elbow shall be insulated on 5-inch IPS piping and below with tubular form insulation as follows:

a. Cut across the diameter of the tubular form insulation at a 45-degree angle (see figure 2). An alternative method is to cut the tube into three sections, first cutting partway through the diameter of the tube, and then cutting the rest of the way at ±45-degree angles creating a triangular section (see figure 3).

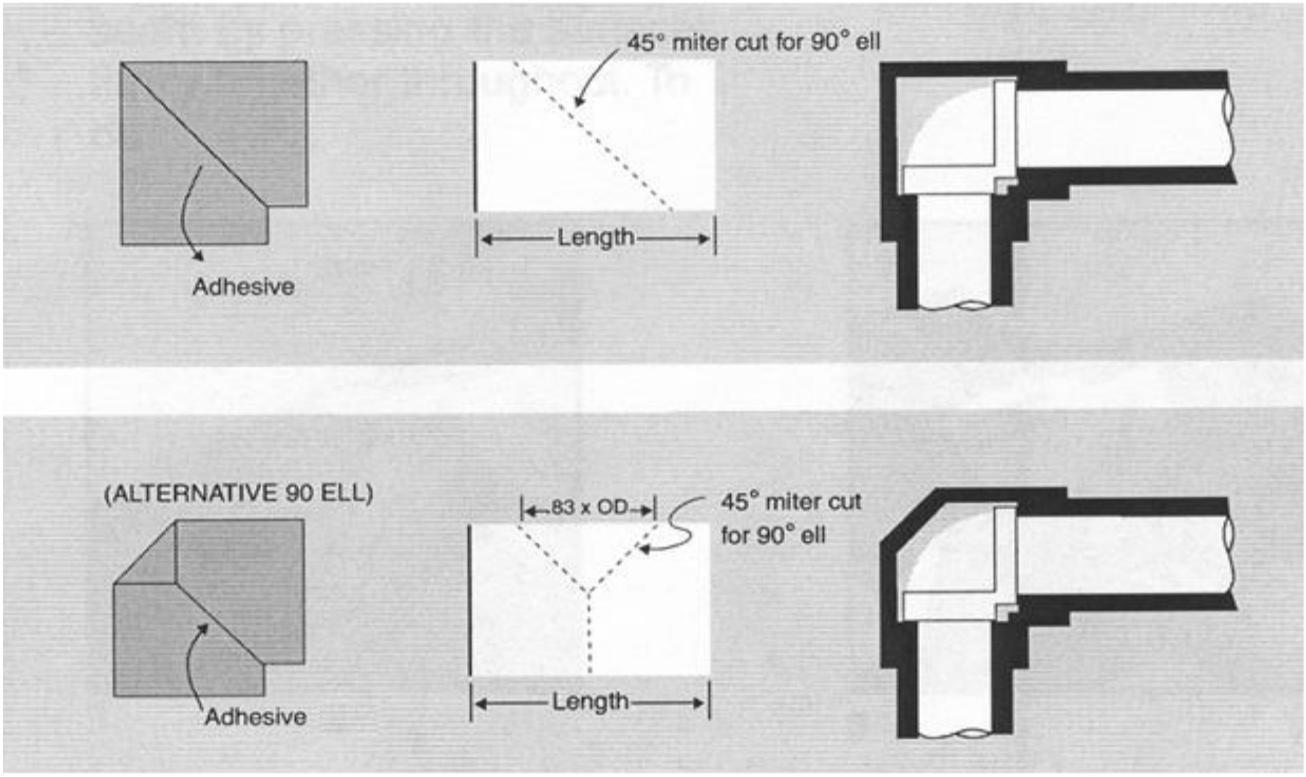

FIGURE 3. 90-degree elbow installation with tubular form insulation on 5-inch IPS piping and below.

b. Cut the insulation lengthwise on one side on both cut sections. Snap one section of the insulation over the pipe so that the mitered cut corresponds to the center of the elbow.

c. Brush coat both slit surfaces and the ends of the tubular insulation completely with adhesive conforming to MIL-A-24179.

d. Snap the other mitered section and the triangular section over the pipe so that the sections together form a 90-degree angle.

e. Brush coat both slit surfaces and the ends of the second tubular insulation and the triangular section completely with MIL-A-24179 adhesive. In all cases, ensure that the adhesive used to install the insulation is equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

f. Allow the adhesive to dry until dry to the touch but tacky under slight pressure before joining surfaces.

g. Join the slit surfaces and the mitered butt ends together. Ensure all seams are sealed and there is a tight fit around the pipe.

h. If in a high traffic area or if required to qualify to and pass the fire test in MIL-PRF-32514, lag the insulation as specified (see 4.10).

i. Paint the insulation in accordance with the requirements for anti-sweat insulation (see 4.11).

5.1.7 Anti-sweat and refrigerant cellular elastomeric insulation (sheet form) on piping greater than 5-inch IPS. Anti-sweat and refrigerant cellular elastomeric insulation (sheet form) shall be installed on piping greater than 5-inch IPS as follows:

a. Determine the circumference of the pipe.

b. Cut the sheet insulation to proper width, permitting it to fit snug without stretching around the pipe.

c. Brush coat both surfaces of the lengthwise seam with adhesive conforming to MIL-A-24179.

d. Allow the adhesive to dry until dry to the touch but tacky under slight pressure before joining surfaces.

e. Wrap the sheet around the pipe, and seal the seam by pressing the surfaces firmly together. Press together at the ends and then in the middle. Close the entire seam starting from the middle.

f. Join butt joints between individual sections using adhesive conforming to MIL-A-24179. In all cases, ensure that the adhesive used to install the insulation is equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

g. In double layer work, apply the anti-sweat insulation with butt and longitudinal seams staggered where possible. Glue the first and second layers shall be glued over the entire surface. Do not apply spots or strips of adhesive.

h. If in a high traffic area or if required to qualify to and pass the fire test in MIL-PRF-32514, lag the insulation as specified (see 4.10).

i. Paint the insulation in accordance with the requirements for anti-sweat insulation (see 4.11).

5.1.8 45- and 90-degree elbows on piping greater than 5-inch IPS (sheet form insulation). 45- and 90-degree elbows shall be insulated on piping greater than 5-inch IPS with sheet form insulation as follows:

a. Cut the sheet insulation into two symmetrical half-sections as shown on figure 4 for 45-degree elbows and figure 5 for 90-degree elbows (with the larger curve being the radius of the outer bend of the elbow and the smaller curve the radius of the inner bend of the elbow).

b. The straight edge pieces shall be half the length of the circumference of the pipe.

c. Brush coat all curved surfaces completely with adhesive conforming to MIL-A-24179.

d. Allow the adhesive to dry until dry to the touch but tacky under slight pressure before joining surfaces.

e. Wrap both sections around the pipe and seal both seams together around the elbow as shown on figures 3 and 4 by pressing the surfaces firmly together. Press together at the ends and then in the middle. Close the entire seam starting from the middle.

f. Brush coat end surfaces completely with adhesive conforming to MIL-A-24179 and press together firmly to butt against the straight sections of pipe insulation. In all cases, ensure that the adhesive used to install the insulation is equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

g. If in a high traffic area or if required to qualify to and pass the fire test in MIL-PRF-32514, lag the insulation as specified (see 4.10).

h. Paint the insulation in accordance with the requirements for anti-sweat insulation (see 4.11).

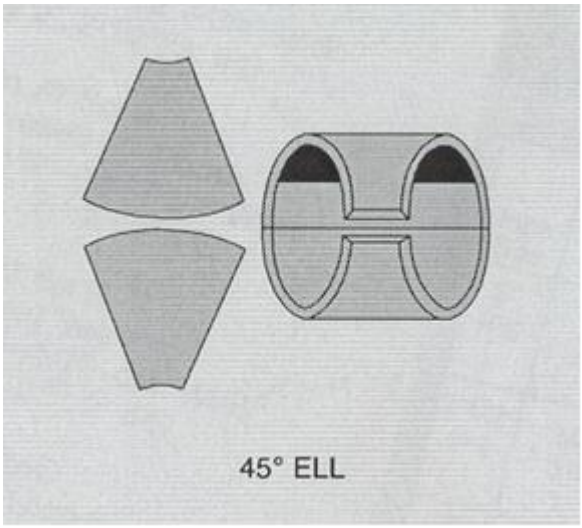

FIGURE 4. 45-degree elbow installation with sheet form insulation on piping greater than 5-inch IPS.

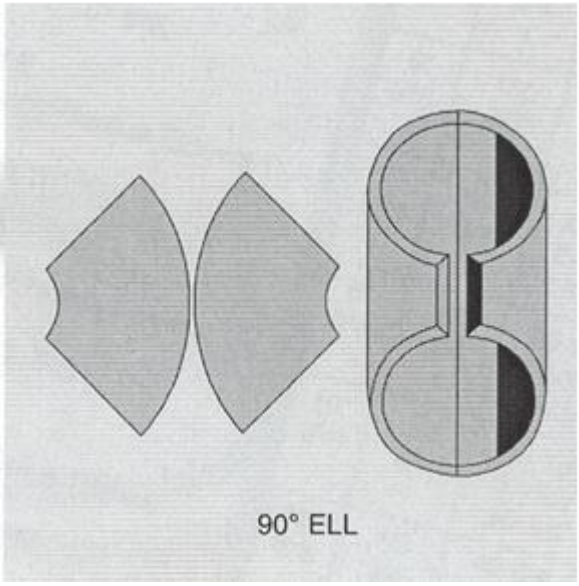

FIGURE 5. 90-degree elbow installation with sheet form insulation on piping greater than 5-inch IPS.

5.1.9 Tees. Tubular form anti-sweat insulation conforming to MIL-PRF-32514 shall be used for anti-sweat insulation of tees as follows:

a. Cut the length of section of tubular form insulation into two separate pieces.

b. Cut a triangle out of one section of tubular form insulation by cutting at ±45-degree angles halfway into the tube (see figure 5).

c. Cut a triangle into the other section of tubular form insulation by miter cutting at ±45-degree angles so that the end of the second mitered tube shall fit into the cut triangle of the first mitered tube (see figure 6).

d. Slit one side of each tube and place over the pipe.

e. Brush coat all seam surfaces and the ends of the tubular insulation and the triangular sections completely with adhesive conforming to MIL-A-24179.

f. Join the seam surfaces and the mitered butt ends together sealing all seams. In all cases, ensure that the adhesive used to install the insulation is equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

g. If in a high traffic area or if required to qualify to and pass the fire test in MIL-PRF-32514, lag the insulation as specified (see 4.10).

h. Paint the insulation in accordance with the requirements for anti-sweat insulation (see 4.11).

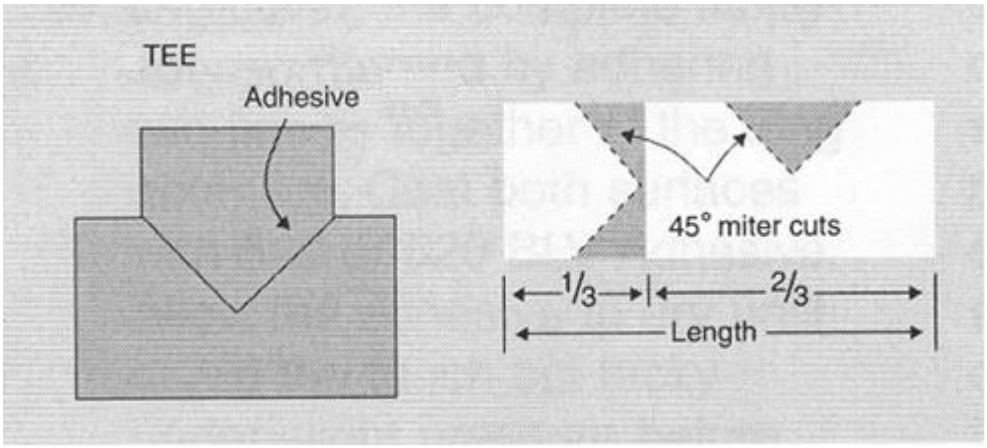

FIGURE 6. Tee assembly.

5.1.10 Crosses. Tubular form insulation conforming to MIL-PRF-32514 shall be used for anti-sweat and refrigerant insulation of crosses as follows:

a. Cut the length of the tubular form insulation in half across the diameter into two sections.

b. Cut two 45-degree miter cuts perpendicular to each other and crossing at the midpoint of the tubular insulation. Remove the triangular sections from the tube. Make these cuts on both sections of pipe (see figure 7).

c. Cut one side of each tubular section and place over the pipe in the configuration shown on figure 6 to create a cross.

d. Brush coat all slit surfaces and the ends of the tubular insulation and the triangular sections completely with adhesive conforming to MIL-A-24179.

e. Join the seam surfaces and the mitered butt ends together sealing all seams. In all cases, ensure that the adhesive used to install the insulation is equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

f. If in a high traffic area or if required to qualify to and pass the fire test in MIL-PRF-32514, lag the insulation as specified (see 4.10).

g. Paint the insulation in accordance with the requirements for anti-sweat insulation (see 4.11).

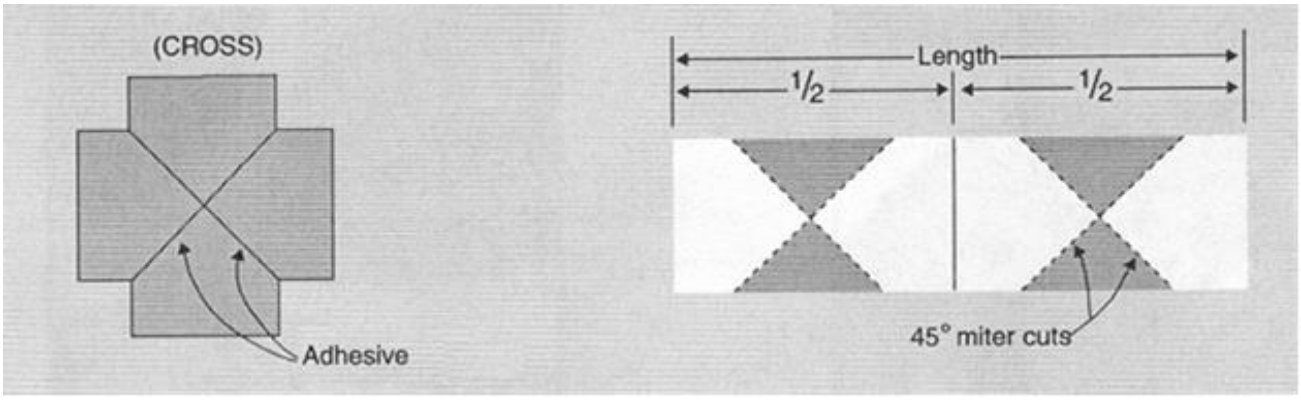

FIGURE 7. Cross assembly.

5.1.11 Pipe hangers. Tubular form or sheet form insulation conforming to MIL-PRF-32514 shall be used for anti-sweat pipe hanger insulation as follows:

a. When rubber pipe hangers are used on anti-sweat piping, install the insulation so that it butts against the rubber blocks.

b. Seal the joints between the rubber block and pipe insulation material with liberal amounts of adhesive conforming to MIL-A-24179.

c. When rubber-lined pipe hanger assemblies are used, be sure the insulation butts up to and is carefully fitted around the clamp and hanger rod and support strap.

d. Bond a layer of tubular form insulation or sheet form insulation around the pipe hanger, overlapping the pipe insulation and clamp.

e. Apply fibrous-glass cloth conforming to MIL-C-20079 adhered with adhesive conforming to MIL-A-3316 fibrous-glass cloth (rewettable) and lagging conforming to MIL-C-20079 and seal the hanger rod/support strap to the lagging with vapor barrier coating conforming to MIL-C-19565.

f. Seal all joints where hanger clamps and support straps penetrate the insulation with adhesive conforming to MIL-A-24179. In all cases, ensure that the adhesive used to install the insulation is equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

g. If in a high traffic area or if required to qualify to and pass the fire test in MIL-PRF-32514, in accordance with the requirements in 4.10.

h. Paint the insulation in accordance with the requirements for anti-sweat insulation (see 4.11).

5.1.12 Flanges. Sheet form insulation conforming to MIL-PRF-32514 shall be used for anti-sweat and refrigerant insulation on flanges as follows:

a. Determine the diameters of the pipe with the anti-sweat insulation installed and the flange. Transfer these measurements to a piece of sheet insulation to make two concentric circles and cut the circles out.

b. Cut through the rings at one side, place over the insulated pieces immediately adjacent to the flange and join together with adhesive conforming to MIL-A-24179.

c. Pack the gaps between the nuts with strips of sheet insulation conforming to MIL-PRF-32514.

d. Determine the circumference of the flange and cut out a central strip of insulation that measures the circumference of the ring by the width of the flange (enough to cover the previously installed rings).

e. Apply adhesive conforming to MIL-A-24179 to the edge of the strip and press the joints together around the flange. Apply adhesive conforming to MIL-A-24179 to all seams of the flange insulation to insure a complete seal. In all cases, ensure that the adhesive used to install the insulation is equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

f. If in a high traffic area or if required to qualify to and pass the fire test in MIL-PRF-32514, lag the insulation as specified (see 4.10).

g. Paint the insulation in accordance with the requirements for anti-sweat insulation (see 4.11).

5.1.13 Valves. The bodies, flanges, and bonnets of valves on piping systems shall be insulated with carefully mitered and fitted pieces of cellular elastomeric insulation conforming to MIL-PRF-32514 (see figure 8). All joints shall be sealed and bonded using adhesive conforming to MIL-A-24179. One-hundred percent bonding between the valve cover and the adjacent pipe covering shall be required in order to ensure that there is a continuous vapor barrier. Void areas shall be filled with small pieces of cellular elastomeric insulation material conforming to MIL-PRF-32514. The valve shall be lagged and covered in the same manner as the adjacent pipe covering as specified (see 4.10). The valve shall be painted and covered as specified (see 4.11).

5.1.13.1 Sheet form insulation for anti-sweat and refrigerant insulation of valves. Sheet form insulation conforming to MIL-PRF-32514 shall be used for anti-sweat and refrigerant insulation of valves as follows:

a. Insulate the pipe as far as the flange.

b. Cut sheet rings the same diameter as the flanges and install at the pipe/flange and valve stem areas.

c. Build up the body of the valves using strips of sheet insulation until it is the same dimension as the outer diameter of the flanges.

d. Use a strip of sheet insulation to wrap around the flange to measure the circumference or length of the sheet needed for the valve cover.

e. Cut out the valve cover, leaving a semi-circle cut out to fit around the valve throat.

f. Install the sheet insulation around the valve body, adhering all seams with adhesive conforming to MIL-A-24179.

5.1.13.1.1 Measurements for insulating the bonnet section of valve covering. Insulate the bonnet section of the valve as follows:

a. C is the overall length determined by wrapping a strip of sheet insulation around the bonnet flange (see figure 7).

b. Y is the difference between L1 and L2 (see figure 9).

c. L1 is the distance from the outer surface of the insulation ring to the middle of the valve body insulation (see figure 8).

d. L2 is the distance from the outer surface of the insulation ring to the closest surface of the valve body insulation (see figure 10).

e. Transfer these measurements to the sheet insulation as shown on figure 9 and cut out.

f. Install the bonnet around the valve. Adhere the two ends to each other; adhere the bonnet insulation to the body insulation; and adhere the bonnet insulation to the ring.

g. Seal all seams with adhesive conforming to MIL-A-24179 for maximum anti-sweat protection. In all cases, ensure that the adhesive used to install the insulation is equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

h. If in a high traffic area or if required to qualify to and pass the fire test in MIL-PRF-32514, lag the insulation as specified (see 4.10).

i. Paint the insulation in accordance with the requirements for anti-sweat insulation (see 4.11).

5.1.14 Fittings. Fittings shall be insulated with pre-formed pipe insulation. Insulation shall be sized to match adjacent straight run piping insulation conforming to MIL-PRF-32514. A step type junction with the straight run piping shall be provided when the outside diameter of the fitting is smaller than the adjacent straight run piping insulation. Where the fitting outside diameter is larger than the adjacent pipe insulation, circumferential spacers of cellular elastomeric insulation conforming to MIL-PRF-32514 shall be used to build up to the required diameter. Void areas shall be filled with pieces of cellular elastomeric insulation conforming to MIL-PRF-32514. All component pieces of fitting insulation covers fabricated from sectional cellular elastomeric insulation conforming to MIL-PRF-32514 shall be bonded together and to the adjacent pipe insulation with adhesive conforming to MIL-A-24179. In all cases, the adhesive used to install the insulation shall be equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, the same lagging system shall be used. The insulation shall be lagged as specified (see 4.10). The insulation shall be painted as specified (see 4.11).

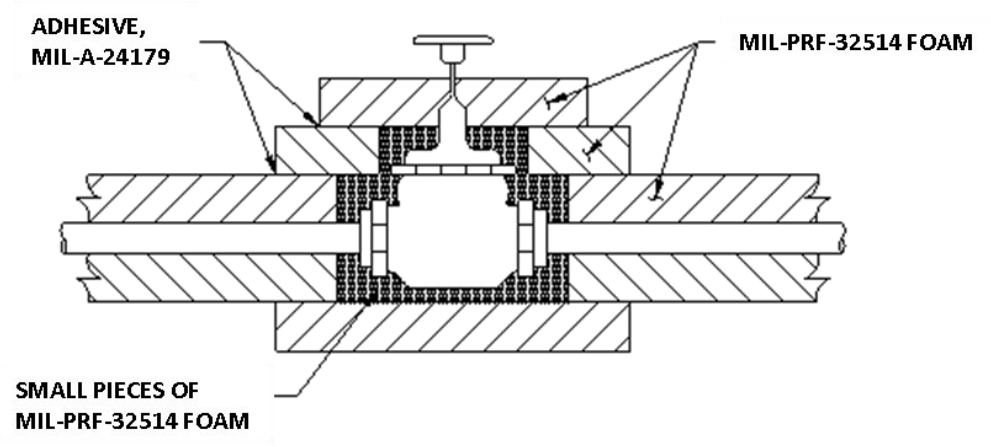

FIGURE 8. Typical method of insulating cold water valve with pre-formed sectional pipe insulation.

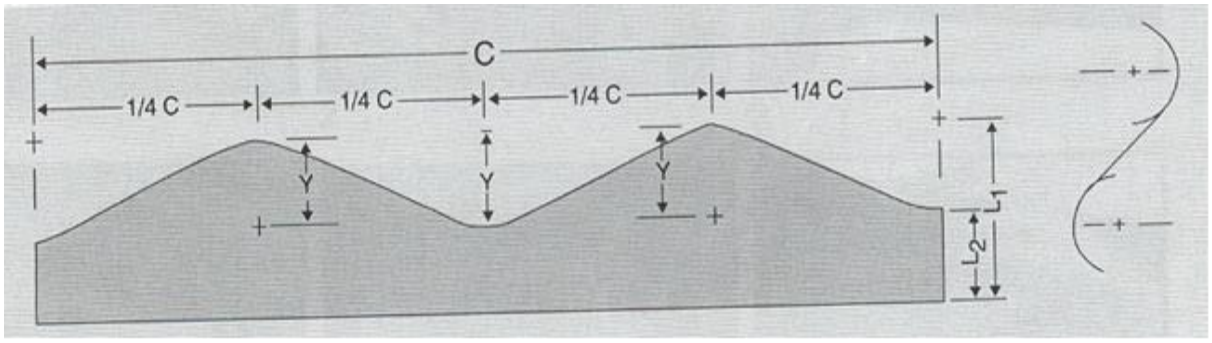

FIGURE 9. Bonnet section of valve covering.

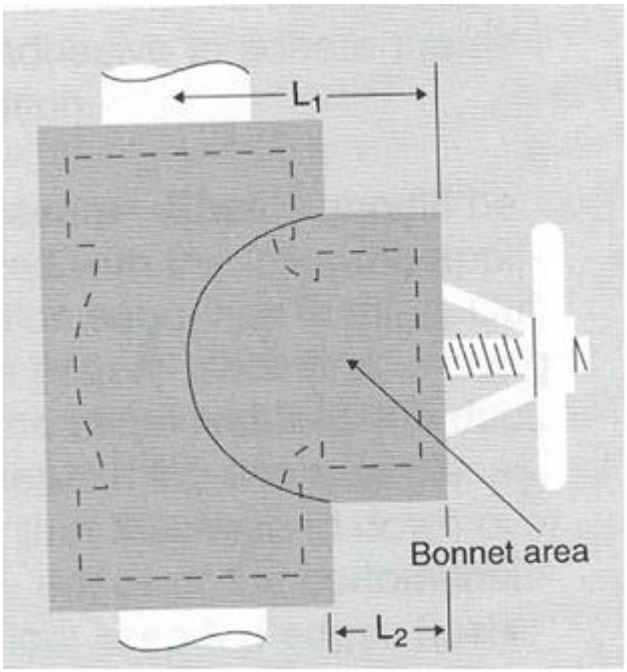

FIGURE 10. Valve body and bonnet sections of valve covering.

5.1.15 Sealing. If the insulation conforming to MIL-PRF-32514 is not lagged (in non-high traffic areas), it shall be painted in accordance with the requirements for anti-sweat insulation as specified (see 4.11).

5.1.16 Anti-sweat and refrigerant insulation for machinery and equipment. Machinery and equipment shall be insulated with cellular elastomeric insulation conforming to MIL-PRF-32514, or fibrous-glass felt conforming to MIL-I-22023, in the thicknesses specified in table II.

5.1.16.1 Insulation conforming to MIL-PRF-32514 (sheet form) on anti-sweat and refrigerant machinery and equipment. Sheet form insulation conforming to MIL-PRF-32514 shall be installed on machinery and equipment as follows:

a. Determine the dimensions of the equipment.

b. Cut the sheet insulation to proper dimensions to fit the equipment, permitting it to fit loosely without stretching around the equipment.

c. Brush coat the surface of the equipment and one surface of the sheet insulation with adhesive conforming to MIL-A-24179.

d. Allow the adhesive to dry until dry to the touch but tacky under slight pressure before attaching sheet insulation to the equipment surface.

e. Ensure that all seams and butt joints between individual sections are sealed using adhesive conforming to MIL-A-24179. In all cases, ensure that the adhesive used to install the insulation is equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

f. In double layer work, apply the sheet insulation with joints staggered where possible. The first and second layers shall be glued over the entire surface. Do not apply spots or strips of adhesive.

g. If in a high traffic area, subject to damage, or if required to qualify to and pass the fire test in MIL-PRF-32514, lag the insulation as specified (see 4.10).

h. Paint the insulation in accordance with the requirements for anti-sweat insulation as specified (see 4.11).

5.1.16.2 Fibrous-glass felt insulation conforming to MIL-I-22023 on anti-sweat and refrigerant machinery and equipment. Fibrous-glass felt insulation conforming to MIL-I-22023, Type I shall be installed on machinery and equipment as follows:

a. Secure fibrous-glass felt conforming to MIL-I-22023 to the machinery or equipment with 18-gauge hot-dipped galvanized iron wire conforming to ASTM A641/A641M or 18-gauge soft copper conforming to A-A-59551.

b. Cover the fibrous-glass felt with ½-inch thick layer of finishing cement conforming to ASTM C449.

c. Apply water-repellent and fire-resistant kraft paper, UU-B-790, Type III, over the cement, ensuring that all seams are overlapped. Secure kraft paper in place with masking tape conforming to ASTM D6123/D6123M.

d. Seal all joints and overlaps of the kraft paper with adhesive conforming to MIL-A-3316.

e. Apply a coat of adhesive conforming to MIL-A-3316 to the outer surface of the kraft paper.

f. Apply fibrous-glass lagging conforming to MIL-C-20079 over the adhesive conforming to MIL-A-3316.

g. Paint the insulation in accordance with the requirements for anti-sweat insulation (see 4.11).

5.1.17 Acoustic insulation treatment on anti-sweat and refrigerant machinery and equipment. Acoustic insulation treatment on anti-sweat and refrigerant machinery and equipment shall be installed where acoustic noise transmission loss is required (see 5.10). Fibrous-glass insulation felt conforming to MIL-I-22023, Class 6 or polyimide foam conforming to MIL-DTL-24688, shall be applied to the machinery or equipment. Barium sulfate-loaded vinyl sheet conforming to MIL-PRF-24699 shall then be applied over the fibrous-glass felt or polyimide foam. Spans between adjacent sections of barium sulfate-loaded vinyl shall overlap a minimum of 3 inches. All seams in each layer of the treatment shall be sealed with duct tape. All penetrations of the treatment shall be sealed with sealing compound conforming to ASTM D6411/D6411M.

5.1.18 O_2N_2 plant. Liquid oxygen and liquid nitrogen plants shall be insulated as follows:

a. Apply three alternate layers of 1-inch thick fibrous-glass felt conforming to MIL-I-16411 and 0.003-gauge aluminum foil to a total thickness of at least 3 to 4 inches. Pack the insulation tightly around and in between system components, piping, and plant outer casing to prevent air and moisture intrusion so as to prevent subsequent freezing of system components. Ensure that each layer is vapor sealed with vapor barrier compound conforming to MIL-PRF-19565 on the exterior after application to the pipe, prior to application of the next layer, and on the exterior of the third layer.

b. After the third layer, apply a 1-inch thick calcium silicate pre-formed sectional pipe insulation conforming to MIL-I-2781.

c. Apply a coat of adhesive conforming to MIL-A-3316 to the outer surface of the calcium silicate pre-formed sectional pipe insulation conforming to MIL-I-2781.

d. Apply fibrous-glass cloth lagging conforming to MIL-C-20079 over the adhesive conforming to MIL-A-3316.

e. Paint the insulation in accordance with the requirements for anti-sweat insulation (see 4.11).

5.2 Requirements for refrigerated stores spaces. On nearly all ships, built-in refrigerated stores spaces (as distinguished from reach-in refrigerators used in ship pantries and galleys) are provided, although the number and size of the individual spaces vary from ship to ship. The temperatures within typical refrigerated stores spaces are 33 °F for chill rooms, 0 °F for freeze rooms, and 0 to 33 °F for multipurpose spaces that can be used for either chill or freeze rooms. In some cases, refrigerated stores space vestibules are used as thaw spaces and are insulated in accordance with the requirements for refrigerated stores spaces (see 5.2.1).

5.2.1 Refrigerated stores spaces insulation. The insulating materials currently used in the construction of naval shipboard refrigerated spaces shall be cellular plastic foam conforming to MIL-PRF-24172, either Type I (pre-formed) or Type II (foamed-in-place). The cellular plastic foam insulation may be poured or froth foamed-in-place, pre-formed blocks, or prefabricated webbed panels consisting of sheathing and insulation. For bulkheads, stiffeners, deep webs, girders, and overheads, the cellular plastic foam insulation density shall be a nominal 2 pounds per cubic foot. Unless otherwise specified by NAVSEA, the density for decks shall be a nominal 4 pounds per cubic foot. During the application of foamed-in-place material, there shall be no voids or air pockets that would impair the insulation effectiveness. Sheathing shall be supported to resist pressures associated with foamed-in-place installation. Pre-formed block, where used, shall be secured to the deck, stiffeners, bulkheads, overhead, and adjacent blocks with adhesive. Where more than one layer is used, butt joints shall be staggered. Where pre-formed blocks are used on the decks, the top surface of the deck insulation shall be mopped with odorless asphalt.

5.2.2 Insulation thickness. The insulation thickness shall be sufficient to maintain the specified space temperatures without sweating on the exterior surfaces of the refrigerated space boundaries at shipboard ambient conditions, with an outside ambient temperature of 100 °F and a relative humidity of 80 percent. Insulation shall be flush over stiffeners and they shall be covered with at least 1½-inch thick insulation. Deep webs and girders, which project beyond the stiffeners, shall be boxed-in or otherwise covered with not less than 2-inches thick insulation.

5.2.3 Interior sheathing. Interior sheathing shall be glass fiber reinforced polyester resin laminate or CRES sheet as follows:

a. The glass fiber reinforced polyester laminate shall conform to MIL-P-17549, Grade W, with a smooth and glossy gel coat finish 0.01- to 0.03-inch thick. The gel coat finish for deck sheathing shall have imbedded non-skid material. The plastic laminate sheathing shall be 3/16 inch thick for bulkheads and overheads and ¼-inch thick for decks, except that the plastic laminate sheathing forming part of prefabricated webbed panels shall have a minimum thickness of 3/32 inch.

b. CRES shall be Type 302 or 304. Bulkhead and overhead sheathing shall be minimum United States Standard Gauge (USSG) 18. Deck sheathing shall be minimum USSG 12.

c. Sheathing for bulkheads and overhead shall be supported by a system of furring and framing. Sheathing lap joints shall be secured with both adhesive- and countersunk- or dome head-type CRES blind rivets. As an alternative method, butt joints of panels shall be covered with CRES joint strips and Z shapes, as developed, and fastened through the panels to the wood furring with CRES wood screws. Other mechanical fasteners shall be CRES. Bulkhead sheathing shall be made splash tight, except that deck sheathing shall be made watertight by solid welding. The joint between the deck and bulkheads shall be made watertight. Bulkheads shall be watertight 12 inches up from the deck.

5.2.4 Prefabricated panels. Prefabricated panels of insulation and sheathing shall have spaced glass fiber reinforced plastic laminate structural webs. Webs shall be not less than 1/16 inch thick and spaced not greater than 3 inches in deck areas and not greater than 6 inches in bulkheads and overheads. Each prefabricated panel shall be fastened to decks, bulkheads, overheads, or supporting structure and to each other with adhesive as specified in 5.2.5.b.

5.2.5 Adhesives. The adhesives to be used for bonding cellular plastic foam or for bonding metal-to-metal, glass fiber reinforced plastic laminate to metal, and glass fiber reinforced plastic laminate to glass fiber reinforced plastic laminate shall be as follows:

a. The adhesive for bonding cellular plastic foam insulation shall comply with MIL-A-24179.

b. The adhesives for bonding metal-to-metal, glass fiber reinforced plastic laminate-to-metal, and glass fiber reinforced plastic laminate-to-glass-fiber reinforced plastic laminate shall be a two component, room temperature cured, thixotropic paste adhesive. Where bonding metal-to-metal with adhesive, the metal surfaces shall have a dry film coat of 1½ to 3 mil-thick of primer conforming toMIL-PRF-23377. Where bonding glass reinforced plastic laminates having a gel coat finish, the contact areas shall be lightly sanded prior to bonding. The minimum physical properties of the cured adhesive over a temperature range of 100 to -20 °F shall be as follows:

(1) Lap shear (ASTM D1002): 1000 lb/in^2

(2) Tensile (ASTM D412): to 1000 lb/in^2

(3) 100 percent elongation

(4) Peel (ASTM D1781): 25 lb/in

(5) Cleavage (ASTM D1062): 1000 lb/in

5.2.6 Deck covering. Refrigerated space deck insulation shall be protected with a covering of extruded aluminum panels, and may be covered using concrete with a latex mastic coating, conforming to MIL-D-3134, Type II, or be protected with a concrete-mastic mix consisting of one part Portland cement, one part mastic, two parts sand, and three parts grit (gravel).

5.2.7 Furring and framing. Furring and framing shall be Douglas Fir, Western Hemlock, Spruce, or Southern Pine, No. 1 Structural Joists and Planks or No. 1 Structural Light Framing, or better, of West Coast Lumber Inspection Bureau, Western Wood Products Association, or Southern Pine Inspection Bureau standard grading rules, as specified in table III. Lumber shall be pressure-treated in accordance with American Wood-Preservers Association (AWPA) Book of Standards, AWPA-P5. Prior to installation, lumber shall be dried to a moisture content of 12±3 percent. Where treated wood is cut, bored, or faired, it shall be given a heavy brush coat of preservative in accordance with AWPA-P5. The materials specified in 5.2.2 through 5.2.5 shall be specified on all ships, except that non-magnetic materials shall be specified for use on minesweepers.

5.2.8 Refrigerated stores spaces installation requirements. Before any insulation or sheathing is installed in refrigerated stores spaces, the external boundary of all refrigerated spaces, whether it be structural bulkheads and decks or self-supported sheathing shall be tested for air tightness and shall be made airtight where necessary. In addition, the ship structure and sheathing supports shall be painted or otherwise treated in accordance with Standard Item 009-32 as applicable before installing insulation.

TABLE III. Furring and framing materials.

Use	Wood	Grade [1/]	Preservation [2/]
Framing	Southern Pine, Douglas Fir, Larch Western Hemlock, Spruce	No. 1 Structural Joists and Planks or No. 1 Structural Light Framing or better	Pressure-treated in accordance with AWPA-P5 with one of the waterborne salt preservatives only to the retentions specified. For use in fresh water, ground contact or for important structural members.
Sheathing (under course and outer course if covered by a surface sheathing)	Southern Pine T & G, West-Coast Hemlock, Douglas Fir, Larch T & G, Plywood T & G	No. 1 Boards Select Merchantable Structural I C-D	Same as above
Sheathing (exposed course)	Southern Pine T & G Douglas, Fir Larch West-coast Hemlock, T & G Plywood	C Flooring C and better Flooring B-C Exterior or better	MIL-L-19140, Type II MIL-L-19140, Type II MIL-L-19140, Type II

NOTES:

1/ Southern Pine Inspection Bureau, West Coast Lumber Inspection Bureau, or Western Wood Products Association Standard grading rules shall apply, as appropriate.

2/ Prior to installation, lumber shall be dried to a moisture content of 12±3 percent.

5.2.8.1 Bulkheads and overheads. Furring and framing to support sheathing and equipment shall be installed first, thermally isolated, and shall be bolted directly to deck beams, frames, stiffeners, or to flat bar clips welded to ship structure. Fastenings such as bolts, lag screws, and wood screws, shall be hot-dipped galvanized and so arranged to prevent metal-to-metal contact between sheathing and structure. Where metal furring and framing is used, it shall be isolated from the ship structure by use of phenolic or fibrous-glass-reinforced resin laminate blocks. Furring shall be used, as required, to serve as supports for such items as coils, piping, and lighting fixtures.

a. Framing for each side of non-structural division bulkheads between refrigerated spaces shall be made independent of the other side by staggering frames. No through-framing shall be permitted.

b. Supports for coils shall be integrated with the system of furring and framing. Supports for unit coolers shall be attached directly to the ship's structure. Supports shall be independent of lining.

c. Insulation shall be closely fitted and held in place, usually with skewers until the sheathing is installed. No studs or pins shall be permitted. Pre-formed polyurethane block insulation conforming to MIL-PRF-24172, Type I, where used, shall be secured to the structure and to adjacent blocks with adhesive conforming to MIL-A-24179. The entire space between the sheathing panels and ship structure shall be filled with insulation and installed in such a manner as to eliminate voids. Where insulation is installed in multiple courses, the butts and seams of each course shall be staggered against the preceding course.

d. Sheathing for bulkheads and overheads shall be fastened to the furring and framing with stainless steel screws. Seams between sheathing panels shall be in the vertical plane only and covered with 2-inch wide seam straps fastened with stainless steel screws. A 1- by 1- by 1-inch Z-shape shall be fitted between the sheathing bottom and the deck cove. All inside and outside corner seams of the sheathing shall be covered with 1- by 1-inch angles, fastened with stainless steel screws. Where reinforced-resin laminate sheathing conforming to MIL-P-17549, Grade W, is already installed, the seam straps, Z-shape, and corner angles shall be 0.081-inch aluminum.

e. Sheathing shall be made splash tight, except that deck sheathing and bulkhead sheathing to a height of 12 inches above the deck shall be made watertight.

5.2.8.2 Deck underfoot. For decks underfoot, the insulation shall be fibrous-glass conforming to MIL-I-22023, Type I, Class 5, or pre-formed cellular plastic foam insulation conforming to MIL-PRF-24172, Type I. Where pre-formed block insulation is used, the cellular plastic foam insulation shall be installed in at least two courses. Before installing the first course of cellular plastic foam block insulation, the deck shall be coated with odorless asphalt emulsion. The top of each course of block, including the final course, shall be coated with the asphalt emulsion. Each course shall be staggered against the preceding course, with two adjacent edges of each block being coated with the asphalt emulsion. The block-type insulation shall extend up the sides 12 inches above the full deck insulation. A three-layer vapor seal membrane of 15-pound felt paper, each layer laid in and covered with asphalt emulsion, shall be applied over the insulation and extend up the sides to completely cover the block insulation. Metal and concrete-mastic-mix decking shall be installed as follows:

a. When metal deck sheathing is installed, it shall be fastened to a system of furring and framing isolated from the ship structure. When fibrous-glass-reinforced laminate is used, it shall be laid in two $\frac{3}{16}$-inch thick layers, completely bonded to each other with staggered joints flush with the deck. The joint between the bulkhead and deck sheathing shall be made watertight.

b. When a concrete-mastic mix deck covering is specified, it shall be at least 2 inches thick, and shall be applied over the emulsion-covered, felt paper vapor seal membrane.

c. The finished decking shall be coved up the sides 6 inches so as to be flush with the bottom of the sheathing.

d. Reinforcement shall be 2- by 2-inch by 14-gauge, galvanized steel wire mesh. The method of laying the finished decking shall be such as to prevent cracking or shrinking while setting. The finished decking shall be thoroughly set before the spaces are cooled down in temperature. Where rat proofing is required, the cover shall be reinforced with ½-inch by 18-gauge galvanized wire mesh 4 inches out on the deck and up to the bottom of the bulkhead sheathing.

e. Deck drains and heating cables shall be provided in all spaces as needed to facilitate space cleaning and condensate removal.

5.2.8.3 Breather openings. Water vapor in warm air exhibits a pronounced tendency to migrate to colder air. Whenever the temperature at any point within a partition becomes lower than the dew point of the air, condensation of the water vapor tends to occur at that point. In refrigerated stores spaces, the dew point is usually located somewhere in the insulation. The presence of water in the insulation is undesirable since it reduces the efficiency of the insulation. To mitigate the accumulation of water in the insulation, breather openings and breather plugs shall be inserted as follows:

a. Since the coldest air is at the coils, moisture, if present in the insulation, migrates to the coils, provided a path of migration is available. In ships where the inner sheathing in refrigerated spaces is welded watertight, breather openings with plugs or caps shall be provided in the sheathing. Where the joints between sheathing panels are butted together and panel edges are held to the furring by screws, there shall be sufficient opening to provide a natural migration path for the moisture.

b. The breather plugs shall be inserted in the breather openings when defrosting or washing down the spaces in order to seal the sheathing, to prevent moisture from entering the fibrous-glass insulation, and when conducting air tests to determine the tightness of the sheathing. Breather plugs shall be kept out when conducting air tests of structural boundaries, and at all other times, in order to permit the migration of moisture from the fibrous-glass insulation.

5.2.8.4 Refrigerated space doors. Refrigerated space doors shall be of the following types:

a. Type A. Front and back panels shall consist of ⅜-inch (minimum) exterior grade plywood, with a facing of USSG 20 (minimum) CRES, Type 302, No. 4 finish, all bonded together and to the insulation. Plywood shall be of Grade B-C or better, in accordance with Voluntary Product Standard PS-1, and CRES facing shall be bonded to the better plywood face by a process using heat and pressure. The door shall be filled with a minimum of 4-inch cellular plastic foam insulation conforming to MIL-PRF-24172, Type II, foamed-in-place to form a bonded structure with plywood facing and Douglas Fir stiffeners. The edge perimeter shall consist of either ¾-inch exterior grade plywood with an overlay of extruded synthetic rubber, all bonded together to the insulation or USSG 20 CRES Sheathing, Type 302, No. 4 finish. The synthetic rubber extrusion shall form the door overlap to which the air seal gasket shall be secured. The gasket at the door lip shall be a grease-resistant synthetic skin with resilient core. Heating cable shall be installed in the top and sides of the frame and across the bottom inside of the front door panel to prevent condensation and frost accumulation. The frame component shall consist of ¾-inch (minimum) Douglas Fir, equal to or better than the grade for framing in table III, face casing, and a jamb sheathed with USSG 20 CRES, Type 302, No. 4 finish. Exposed wood shall be given a heavy brush coat of clear catalyzed polyester resin. Soldered or welded joints shall be ground smooth and polished.

b. Type B. Front and back panels, including perimeter edges and frame, shall consist of glass-fiber reinforced plastic laminate with fire-resistant resin conforming to MIL-R-21607, ⅛-inch minimum thickness. The frame component shall consist of a ¾-inch (minimum) exterior grade plywood jamb and a 1⅝-inch Douglas Fir face casing. Both the jamb and the casing shall be sheathed with glass-fiber-reinforced plastic laminate, 1/16-inch thick (minimum). The weight of the glass fiber reinforcement shall be a minimum of 40 ounces per square yard. Front and back panels, including perimeter edges and frame, shall be permanently bonded into a single unit with the above resin or an epoxy adhesive. The finish shall be flat and smooth and shall consist of a molded white gel coat 0.01 to 0.03-inch thick. Except for the gasketed edge, the corners, and edges shall be rounded. Clearance between the door and frame shall not exceed ½-inch.

(1) The doors shall be factory assembled and aligned complete with frames, hinges, hardware, gaskets, and thermal breaks, so that they shall be installed onboard ship without distortion to the plane of the frames or disturbing the gasket seals. The doors shall be operable from both sides. A locking device with an inside emergency release shall be provided for each door. It shall permit the door to be opened from the inside, even if padlocked. The inside release push rod shall be Monel, CRES, or copper-nickel. It shall permit the door to be opened from the inside even if padlocked. A label plate or other device containing directions for operating the emergency lock release shall be permanently mounted on the door under or on the emergency lock release. Each door shall be provided with a hold-open, self-falling hook latch with a rubber bumper. Hardware shall be zinc-coated or chrome plated.

(2) In the way of hardware attachments, doors shall be reinforced with steel inserts in back of panels. Doors shall be rectangular and shall have a clear opening of at least 30 inches by 54 inches, up to 30 inches by 72 inches and a sill height of 2 inches above the interior deck height. Pallet conveyor doors shall have a clear opening of 60 inches by 54 inches, up to 60 inches by 72 inches, and a sill height of at least 2 inches above the interior deck height. Doors shall have the thermal equivalent of the insulated bulkhead in which they are located.

5.2.8.5 Chill and freeze storeroom doors. Chill and freeze storeroom doors shall be factory assembled and aligned complete with frames, hinges, hardware, gaskets, and thermal breaks, so that they can be installed aboard ship without distortion to the plane of the frames or disturbing the gasket seals. The doors shall be operable from both sides. A locking device with an inside emergency release shall be provided for each door. A label plate or other device containing directions for operating the emergency lock release shall be permanently mounted on the door under or on the emergency lock release. Each door shall be provided with a hold-open, self-falling hook latch with a rubber bumper. Hardware shall be zinc-coated or chrome plated. Doors shall be reinforced in way of hardware attachments with steel inserts in back of panels. Doors shall be rectangular and shall have a clear opening of 30 inches by 54 inches, except that pallet conveyor doors shall have a total clear opening of 60 inches by 54 inches. Clear openings other than 30 inches by 54 inches may be provided when replacing existing doors that have non-standard clear openings. Doors shall have the thermal equivalent of the insulated bulkhead in which they are located. Freeze storeroom doors shall be equipped with thermostat-controlled 115-volt heater cables at gasket contact surfaces at the sides, head, and sill for frost prevention.

5.3 Requirements for hot surface piping and piping components insulation. Requirements for hot surface piping and piping components insulation shall include the insulation and lagging materials in table IV.

TABLE IV. Insulation and lagging materials for piping, tubing, valves, fittings, flange joints, and machinery. [1/]

Service	Temperature Range (°F)	Piping and Tubing		Valves and Fittings		Flange Joints		Machinery	
		Insulation	Lagging	Insulation [2/]	Lagging [3/]	Insulation	Lagging [3/ 4/]	Insulation	Lagging
Gasses, steam, hot water, oil	125 to 1200	MIL-I-2781 (1200 °F max.) MIL-C-20079 [5/ 6/] and MIL-I-16411 (1200 °F max.) MIL-PRF-22344 [7/] (370 °F max.) MIL-PRF-32514, Types I and II, Class 1 (180 °F max.), Class 2 [8/] (300 °F max.) MIL-DTL-24688, Type I (400 °F max.), Type III (600 °F max.) ASTM C547, Annex A1, Type IV, Grade A (1000 °F max.)	MIL-C-20079 and MIL-A-3316	MIL-I-2781 (1200 °F max.) MIL-PRF-2819, Class 2 (1200 °F max.) MIL-C-2861 (1800 °F max.) MIL-C-20079 [6/] and MIL-I-16411 (1200 °F max.) MIL-PRF-22344 [7/] (370 °F max.) MIL-PRF-32514, Types I and II, Class 1 (180 °F max.), Class 2 [8/] (300 °F max.) MIL-DTL-24688 Type I (400 °F max.), Type III (600 °F max.) ASTM C547, Annex A1, Type IV, Grade A (1000 °F max.) MIL-I-22023 (400 °F max.)	MIL-C-20079 and MIL-A-3316	MIL-I-2781 (1200 °F max.) MIL-PRF-2819, Class 2 (1200 °F max.) MIL-C-2861 (1800 °F max.) MIL-C-20079 [6/] and MIL-I-16411 (1200 °F max.) MIL-PRF-22344 [7/] (370 °F max.) MIL-PRF-32514, Types I and II, Class 1 (180 °F max.), Class 2 [8/] (300 °F max.) MIL-DTL-24688, Type I (400 °F max.), Type III (600 °F max.) ASTM C547, Annex A1, Type IV, Grade A (1000 °F max.)	MIL-C-20079 and MIL-A-3316	MIL-PRF-2819, Class 2 (1200 °F max.) MIL-C-2861 (1800 °F max.) MIL-I-16411 (1200 °F max.) MIL-PRF-2818 (1000 °F max.) MIL-DTL-24688, Type I (400 °F max.) Type III (600 °F max.) MIL-I-22023 (400 °F max.)	MIL-C-20079 and MIL-A-3316

TABLE IV. Insulation and lagging materials for piping, tubing, valves, fittings, flanges, joints, and machinery - Continued. 1/

NOTES:

1/ Additional materials are covered in 4.12 (metal sheathing); 5.1 (anti-sweat and refrigerant insulation); 5.3 (hot surface piping and piping components insulation); 5.4 (thermal and acoustic insulation for machinery and equipment), and 5.3.4.6 (weather deck hot piping).

2/ Alternatively, pre-formed mineral wool insulation with a hard fibrous-glass cover, such as CADAFIT 1200 °F, or equal as approved by NAVSEA, may be used as applicable.

3/ Alternatively, silicone rubber, aluminized fibrous-glass cloth, such as Alpha 2337-3-AMA or 2025-2-AMA, or equal as approved by NAVSEA, may be used as applicable.

4/ Flammable liquid flanges shall not be lagged (in accordance with 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 pods 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 VIII and XII).

6/ To be used only on a temporary basis, such as replacement of permanent insulation damaged while a ship is at sea.

7/ Fibrous-glass pipe insulation conforming to MIL-PRF-22344 shall not be installed on hot piping above 1-inch IPS. Additionally, this insulation shall be installed only on piping with a vertical orientation or in a horizontal orientation in “low traffic” areas, 4 feet and higher above deck.

8/ Insulation material conforming to MIL-PRF-32514, Type II, Class 2 and NAVSEA approved for use at 300 °F may be used up to 300 °F for surface ship non-nuclear applications only.

5.3.1 Hot surface piping and piping components insulation installation requirements. Hot surface piping and piping components insulation installation requirements shall be in accordance with 804-5959214 for the following material types and temperatures:

5.3.1.1 Thermal cellular elastomeric insulation (tubular form) on piping less than 5-inch IPS (temperatures up to 300 °F). Thermal cellular elastomeric insulation conforming to MIL-PRF-32514, Type II shall be installed on hot piping, in the thicknesses specified in table V, as follows:

a. Use a sharp knife to slit the tubular form thermal cellular elastomeric insulation lengthwise on one side.

b. Snap the insulation over the clean, dry pipe.

c. Brush coat both slit surfaces completely with adhesive conforming to MIL-A-24179. Push the insulation down over the pipe to hold adhesive coated surfaces apart. Allow the adhesive to dry until dry to the touch but tacky under slight pressure before joining surfaces. Ensure that the surface nearest to the pipe is pressed together first and evenly before joining the entire surface.

d. If the insulation should become stuck to the pipe after applying adhesive, break the insulation loose by running a finger down the pipe, between the insulation and the pipe.

e. In non-high traffic areas, seal unlagged thermal cellular elastomeric insulation conforming to MIL-PRF-32514 with one coat of water-based paint conforming to MIL-PRF-24596, to ensure that the insulation seams remain tight. Paint the insulation with one coat of enamel conforming to MIL-DTL-24607.

f. If the thermal cellular elastomeric insulation conforming to MIL-PRF-32514 is in a high traffic area and is required to be lagged, or if required to qualify to and pass the fire test in MIL-PRF-32514, lag and paint the insulation as specified (see 4.10 and 4.11). It should be noted that lagging material cannot be replaced or repaired with paint applications.

5.3.1.2 Thermal cellular elastomeric insulation (sheet form) on piping greater than 5-inch IPS (temperatures up to 300 °F). Thermal cellular elastomeric insulation conforming to MIL-PRF-32514, Type II (sheet form insulation) shall be installed on piping greater than 5-inch IPS in the thicknesses specified in table V as follows:

a. Determine the circumference of the pipe.

b. Cut the sheet insulation to proper width, permitting it to fit loosely without stretching around the pipe.

c. Brush coat both surfaces of the lengthwise seam with adhesive conforming to MIL-A-24179.

d. Allow the adhesive to dry until dry to the touch, but tacky under slight pressure before joining surfaces.

e. Wrap the sheet around the pipe and seal the seam by pressing the surfaces firmly together. Press together at the ends and then in the middle. Close the entire seam starting from the middle.

f. Join butt joints between individual sections using adhesive conforming to MIL-A-24179. In all cases, ensure that the adhesive used to install the insulation is equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

g. In double layer work, apply the anti-sweat insulation with butt and longitudinal seams staggered where possible. Glue the first and second layers over the entire surface. Do not apply spots or strips of adhesive.

h. If the thermal cellular elastomeric insulation conforming to MIL-PRF-32514 is in a high traffic area and is required to be lagged, or if required to qualify to and pass the fire test inMIL-PRF-32514, lag the insulation as specified (see 4.10).

i. Paint the insulation in accordance with the requirements for thermal insulation (see 4.11).

5.3.1.3 Fibrous-glass pre-formed pipe insulation (temperatures up to 370 °F). Fibrous-glass pre-formed pipe insulation conforming to MIL-PRF-22344 shall be applied to pipe 1-inch IPS or less in low traffic areas only or in vertical orientations for temperatures between 100 and 370 °F in the thicknesses specified in table V as follows:

a. The fibrous-glass pre-formed sectional pipe insulation conforming to MIL-PRF-22344 shall be applied directly to the pipe. The butt joints of the two halves of the sectional insulation shall be staggered as close to 90 degrees as practicable.

b. Each section of fibrous-glass pre-formed insulation shall be secured with masking tape conforming to ASTM D6123/D6123M, or wire, such as 18-gauge hot-dipped galvanized iron wire conforming to ASTM A641/A641M or 18-gauge soft copper wire conforming to A-A-5955.

c. The insulation shall be lagged as specified (see 4.10).

d. The insulation shall be painted in accordance with the requirements for thermal insulation (see 4.11).

5.3.1.4 Polyimide-foam pre-formed pipe insulation (temperatures up to 600 °F). Polyimide-foam pre-formed pipe insulation conforming to MIL-DTL-24688, Type III shall be applied to hot piping systems for temperatures between 100 and 600 °F in the thicknesses specified in table V as follows:

a. Pre-formed polyimide foam pipe insulation conforming to MIL-DTL-24688, Type III shall be applied directly to the pipe.

b. Each section of polyimide pipe insulation shall be installed with all joints sealed, using adhesive conforming to MIL-A-24179, and if required, wire, such as 18-gauge hot-dipped galvanized iron wire conforming to ASTM A641/A641M or 18-gauge soft copper wire conforming to A-A-59551, to secure in place.

c. To ensure a complete seal and avoid loss of insulation efficiency, all seams and butt joints shall be fully covered with adhesive; the surface nearest the pipe shall be pressed together first and evenly before joining the entire surface.

d. Acrylic adhesive transfer tape, such as 3M's Y9485, or equal as approved by NAVSEA, may be used to secure the self-seal lap on pre-lagged insulation. This tape shall not be used for sealing butt and longitudinal joints. It is recommended by the manufacturer to not use this tape when ambient temperatures fall below 50 °F.

e. If the polyimide pipe insulation is not pre-lagged, the insulation shall be lagged as specified (see 4.10).

f. The insulation shall be painted in accordance with the requirements for thermal insulation (see 4.11).

5.3.1.5 Polyimide-foam thermal insulation (sheet form) on piping greater than 5-inch IPS (temperatures up to 400 °F). Polyimide-foam thermal insulation conforming to MIL-DTL-24688, Type I (sheet form insulation) shall be installed on piping greater than 5-inch IPS as follows:

a. Determine the circumference of the pipe.

b. Cut the sheet insulation to proper width, permitting it to fit loosely without stretching around the pipe.

c. Brush coat both surfaces of the lengthwise seam with adhesive conforming to MIL-A-24179.

d. Allow the adhesive to dry until dry to the touch, but tacky under slight pressure before joining surfaces.

e. Wrap the sheet around the pipe, and seal the seam by pressing the surfaces firmly together. Press together at the ends and then in the middle. Close the entire seam starting from the middle.

f. Join butt joints between individual sections using adhesive conforming to MIL-A-24179. In all cases, ensure that the adhesive used with the insulation is the same as that used to qualify the insulation to and pass the fire test in MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

g. In double layer work, apply the thermal polyimide sheet insulation with butt and longitudinal seams staggered where possible.

h. Lag the insulation as specified (see 4.10).

i. Paint the insulation in accordance with the requirements for thermal insulation (see 4.11).

TABLE V. Thickness of insulation for hot piping conforming to MIL-PRF-32514, type I and type II; MIL-PRF-22344; and MIL-DTL-24688, types I and III. [1/] [2/]

Maximum Operating Temperature Range (°F)	Specification	Nominal Thickness (inches)
100 to 180	MIL-PRF-32514, Type I and Type II	½
	MIL-PRF-22344	½
	MIL-DTL-24688, Type I and Type III, Classes 1 and 2	½
181 to 250	MIL-PRF-32514, Type II (Surface ship non-nuclear applications only)	1
	MIL-PRF-22344	½
	MIL-DTL-24688, Type I and Type III, Classes 1 and 2	¾
251 to 300	MIL-PRF-32514, Type II (Surface ship non-nuclear applications only)	1
	MIL-PRF-22344	¾
	MIL-DTL-24688, Type I and Type III, Classes 1 and 2	1
301 to 350	MIL-PRF-22344	1
	MIL-DTL-24688, Type I and Type III, Classes 1 and 2	1
351 to 370	MIL-PRF-22344	1
	MIL-DTL-24688, Type I and Type III, Classes 1 and 2	1½
371 to 400	MIL-DTL-24688, Type I and Type III, Classes 1 and 2	1½
401 to 600	MIL-DTL-24688, Type III, Classes 3, 4, 5 and 6	2

NOTES:

1/ Install MIL-PRF-22344 only on piping 1-inch IPS or less.

2/ MIL-PRF-22344 shall not be installed in designated “high traffic” areas unless in vertical orientation.

5.3.1.6 Mineral fiber pre-formed sectional pipe insulation (temperatures up to 1000 °F). Mineral fiber pre-formed sectional pipe insulation conforming to ASTM C547, Annex A1, Type IV, Grade A (1000 °F maximum) shall be applied to piping in low traffic areas, such as piping in a horizontal orientation greater than 4 feet above the deck, for temperatures between 100 to 1000 °F in the thicknesses specified in table VI as follows:

a. Mineral fiber pre-formed sectional pipe insulation conforming to ASTM C547, Annex A1, Type IV, Grade A shall be applied directly to the pipe. The butt joints of the two halves of the sectional insulation shall be staggered as close to 90 degrees as practicable.

b. Mineral fiber sectional pipe insulation shall be secured with wire, such as18-gauge hot-dipped galvanized iron wire conforming to ASTM A641/A641M or 18-gauge soft copper wire conforming to A-A-5955 or flat steel bands conforming to ASTM D3953.

c. In areas where extra protection from compression is needed, 0.016-inch minimum hemispherical (180-degree) rolled aluminum sheathing conforming to ASTM B209 alloy half hard aluminum sheathing with Polysurlyn moisture barrier, or equal as approved by NAVSEA, shall be applied on top of the mineral fiber pre-formed sectional pipe insulation prior to lagging with the fibrous-glass cloth conforming to MIL-C-20079.

d. The insulation shall be lagged as specified (see 4.10).

e. The insulation shall be painted in accordance with the requirements for thermal insulation (see 4.11).

TABLE VI. Thickness of mineral fiber insulation for hot piping conforming to ASTM C547, annex A1, type IV, grade A, 1000 °F maximum. 1/ 2/

Nominal Pipe Size (inches)	Maximum Temperature (°F) × Thickness (inches)									
	150	250	350	450	550	650	750	850	950	1000
1½and below	1	1	1	1½	2	2	2	2½	3	3½
2	1	1	1	1½	2	2½	2½	3	3½	4
2½, 3	1	1	1	1½	2	2½	2½	3½	4	4½
4	1	1	1	1½	3	2½	3	3½	4	4½
5,6	1	1	1½	2	2½	3	3	3½	4½	5½
8	1	1	1½	2	2½	3	3	4	4½	5½
10	1	1	1½	2	2½	3	3½	4	5	6
12	1	1	1½	2	2½	3½	3½	4	5	6
14	1	1	1½	2	2½	3½	3½	4½	5½	6½
16	1	1	1½	2	3	3½	3½	4½	5½	6½
18	1	1	1½	2	3	3½	4	4½	5½	6½

NOTES:

1/ Thickness of mineral fiber insulation in accordance with ASTM F683.

2/ Wherever possible, double layers shall be used where temperatures exceed 600 °F. Double layers may be used at temperatures below 600 °F.

5.3.1.7 Calcium silicate pre-formed sectional pipe insulation (temperatures up to 1200 °F). Calcium silicate pre-formed sectional pipe insulation conforming to MIL-I-2781 shall be applied to ½-inch nominal pipe sizes and larger, for temperatures between 100 and 1200 °F in the thicknesses specified in table VII, as follows:

a. Calcium silicate pre-formed sectional insulation conforming to MIL-O-2781 shall be applied directly to the pipe.

b. Sections shall be installed with joints sealed with adhesive in accordance with ASTM C474, such as CalBond Gold, or equal as approved by NAVSEA. When a single layer of insulation is installed, butt joints of the two halves of the sectional insulation shall be staggered as close to 90 degrees as practicable. Double layer construction shall be installed at temperatures above 600 °F. Where double layer construction is used, layers shall be placed in such a manner as to stagger as close to 90 degrees as practicable both butt and lateral joints.

c. Calcium silicate pre-formed sectional pipe insulation shall be secured with wire, such as18-gauge hot-dipped galvanized iron wire conforming to ASTM A641/A641M or 18-gauge soft copper wire conforming to A-A-5955, or flat steel bands conforming to ASTM D3953. Not less than three fastenings shall be used for securing each 3-foot section of calcium silicate insulation conforming to MIL-I-2781 on pipes up to 6 inches. Four fastenings shall be used to secure each 3-foot section of calcium silicate insulation conforming to MIL-I-2781 on larger pipes.

d. High temperature cement, MIL-C-2861, shall be used for filling voids and cracks in the calcium silicate pre-formed sectional pipe insulation conforming to MIL-I-2781 on both the inner and outer layers. The outer surface shall be smoothed using finishing cement conforming to ASTM C449 troweled to a uniform finish.

e. The insulation shall be lagged as specified (see 4.10).

f. The insulation shall be painted in accordance with the requirements for thermal insulation (see 4.11).

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

Nominal Pipe Size (inches)	Temperature Range (°F)	Nominal Thickness Total [1/] [2/] (inches)
½, 1½	125 to 388	1½
	389 to 750	2½
	751 to 950	3
	951 to 1050	4
2, 2½	125 to 338	1½
	339 to 388	2½
	389 to 900	3
	901 to 1050	4
3 through 4½	125 to 338	1½
	339 to 388	2½
	389 to 750	3½
	751 to 900	4
	901 to 950	4½
	951 to 1050	5
5, 6, 7	125 to 338	1½
	339 to 388	2½
	389 to 750	3½
	751 to 900	4
	901 to 950	4½
	951 to 1050	5½
8 and larger	125 to 338	1½
	339 to 388	2½
	389 to 500	3½
	501 to 750	4
	751 to 900	4½
	901 to 950	5
	951 to 1050	6

NOTES:

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.

5.3.2 Elbows and bends. Elbows and bends shall be insulated with tubular, sheet form, or pre-formed insulation. When available, templates shall be used for insulating elbows. Alternatively, pre-formed mineral wool insulation with a hard fibrous-glass cover, such as CADAFIT 1200 °F, or equal as approved by NAVSEA, may be used as applicable (see table IV).

5.3.2.1 45-degree elbow for 5-inch IPS piping and below for thermal cellular elastomeric insulation (tubular form) conforming to MIL-PRF-32514 (temperatures up to 300 °F). 45-degree elbows on 5-inch IPS piping and below with tubular form insulation shall be insulated as follows:

a. Cut across the diameter of the tubular form insulation at a 22.5-degree angle (see figure 1).

b. Cut the insulation lengthwise on one side on both cut sections. Snap one section of the insulation over the pipe so that the mitered cut corresponds to the center of the elbow.

c. Brush coat both slit surfaces and the ends of the tubular insulation completely with adhesive conforming to MIL-A-24179.

d. Snap the other mitered section over the pipe so that the sections together form a 45-degree angle.

e. Brush coat both slit surfaces and the ends of the second tubular insulation completely with adhesive conforming to MIL-A-24179. In all cases, ensure that the adhesive used to install the insulation is equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

f. Allow the adhesive to dry until dry to the touch, but tacky under slight pressure before joining surfaces.

g. Join the slit surfaces and the mitered butt ends together. Ensure all seams are sealed and there is a tight fit around the pipe.

h. If in a high traffic area or if required to qualify to and pass the fire test in MIL-PRF-32514, lag the insulation as specified (see 4.10).

i. Paint the insulation in accordance with the requirements for thermal insulation (see 4.11).

5.3.2.2 45-degree and 90-degree elbows on piping greater than 5-inch IPS for thermal cellular elastomeric insulation (sheet form) conforming to MIL-PRF-32514 (temperatures up to 300 °F) and polyimide-foam thermal insulation conforming to MIL-DTL-24688 (temperatures up to 400 °F). 45-degree and 90-degree elbows on piping greater than 5-inch IPS with sheet form insulation shall be insulated as follows:

a. Cut the sheet insulation into two symmetrical half-sections as shown on figure 4 for 45-degree elbows and figure 5 for 90-degree elbows (with the larger curve being the radius of the outer bend of the elbow and the smaller curve the radius of the inner bend of the elbow).

b. Ensure that the straight edge pieces are half the length of the circumference of the pipe.

c. Brush coat all curved surfaces completely with adhesive conforming to MIL-A-24179.

d. Allow the adhesive to dry until dry to the touch, but tacky under slight pressure before joining surfaces.

e. Wrap both sections around the pipe, and seal both seams together around the elbow as shown on figures 4 and 5, by pressing the surfaces firmly together. Press together at the ends and then in the middle. Close the entire seam starting from the middle.

f. Brush coat end surfaces completely with adhesive conforming to MIL-A-24179 and press together firmly to butt against the straight sections of pipe insulation. In all cases, ensure that the adhesive used with the insulation is the same as that used to qualify the insulation to and pass the fire test in MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, use the same lagging system.

g. If in a high traffic area or if required to qualify to and pass the fire test in MIL-PRF-32514, lag the insulation as specified (see 4.10).

h. Paint the insulation in accordance with the requirements for thermal insulation (see 4.11).

5.3.2.3 Pre-formed sectional insulation on elbows and bends. Pre-formed sectional insulation for thermal fibrous-glass conforming to MIL-PRF-22344 (temperatures up to 370 °F), polyimide-foam thermal conforming to MIL-DTL-24688 (temperatures up to 600 °F), mineral fiber thermal conforming to ASTM C547 (temperatures up to 1000 °F), and calcium silicate conforming to MIL-C-2781 (temperatures up to 1200 °F) shall be installed as follows:

a. Cut and miter sections of the pre-formed sectional insulation so as to provide a smooth fit around the contour of the elbow or bend.

b. Seal the section joints with adhesive or wire. Seal calcium silicate section joints conforming to MIL-I-2781 with adhesive conforming to ASTM C474. Seal polyimide section joints conforming to MIL-DTL-24688 with adhesive conforming to MIL-A-24179. Secure all pre-formed sections around the elbow or bend with wire, such as18-gauge (minimum) hot-dipped galvanized iron conforming to ASTM A641/A641M or 18-gauge (minimum) soft copper conforming to A-A-5955 or flat steel bands conforming to ASTM D3953, as required.

c. Lag the insulation as specified (see 4.10).

d. Paint the insulation in accordance with the requirements for thermal insulation (see 4.11).

5.3.3 Pipe hangers. Pipe hangers shall be in accordance with 804-1385781 or S4823-1385782 for surface ships and submarines, respectively. Hangers shall be insulated using one of the following procedures:

a. On pipes insulated with calcium silicate pre-formed pipe insulation conforming to MIL-I-2781, the pre-formed pipe covering shall be cut and fitted around the pipe clamp and hanger. High temperature cement conforming to MIL-C-2861 shall be used to fill voids or cracks in the insulation. The surface shall be smoothed using finishing cement conforming to ASTM C449 and lagged with fibrous-glass cloth conforming to MIL-C-20079 and adhesive conforming to MIL-A-3316 or rewettable fibrous-glass cloth conforming to MIL-C-20079.

b. Pre-formed sectional pipe covering shall be stopped where pipe hangers are clamped to the pipe. The remaining space shall be filled with layers of fibrous-glass felt conforming to MIL-I-16411 to the thickness of the adjoining pipe covering. High temperature cement conforming to MIL-C-2861shall be used to fill voids in the insulation. The surface shall be smoothed using finishing cement conforming to ASTM C449, and lagged with fibrous-glass cloth conforming to MIL-C-20079 and adhesive conforming to MIL-A-3316 or rewettable fibrous-glass cloth conforming to MIL-C-20079.

c. Alternatively, pre-formed sectional pipe covering shall be stopped approximately 1 inch from the pipe hanger. The remaining space shall be filled with layers of fibrous-glass felt conforming to MIL-I-16411 to the thickness of the adjoining pipe covering. A flexible cover shall be fabricated using fibrous-glass felt conforming to MIL-I-16411, covered with fibrous-glass cloth conforming to MIL-C-20079. Fit the cover around the hanger, overlap the adjacent pipe covering by a minimum of 2 inches, and secure with ring or hook fasteners to form a takedown seam.

5.3.4 Valves, fittings, and flanges covers. Valves, fittings, and flanges shall be insulated with permanently installed covers or reusable covers conforming to 804-5959214. Valves and fittings that are welded into the line shall be insulated permanently. Flanged valves and flanged fittings shall have reusable covers to permit servicing of takedown joints. The materials and thicknesses shall be as specified in table VIII. Where the pipe insulation is terminated at flanges, provisions shall be made for removal of flange bolts or bolt studs without removing sections of insulation on adjoining piping. In order to ensure that the pipe covering does 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 joint, however, shall be tight, without any gaps between the two sections, and shall incorporate means to prevent dislodging the insulation sections. The pipe insulation shall be stopped off squarely at a distance ¼-inch greater than the length of the flange bolts or bolt studs as shown on figure 11. On studded flanges, spaces shall be left on both sides of the flanged joint. Reusable covers shall be fabricated so that they overlap the adjoining pipe insulation a minimum of 2 inches.

5.3.4.1 Permanent valve and fitting covers. Permanent covers shall be applied to those valves and fittings that are welded into the system and that would not normally require servicing, or do not have takedown joints. Valves and fittings on hot piping systems that operate at temperatures of 125 °F and above shall be insulated by cutting fibrous-glass felt conforming to MIL-I-16411 into suitable widths and building up the thickness to within ½ inch of the adjacent pipe covering as shown on figure 12. Spaces that cannot be filled with layered felt shall be filled with loose felt. The felt shall be secured in position with 18-gauge wire conforming to ASTM A641/A641M and overlaid with 1-inch square wire mesh, 18- or 20-gauge conforming to ASTM A390. A ½-inch coating of finishing cement conforming to ASTM C449 shall be applied, troweled to a smooth finish, and then lagged with fibrous-glass cloth conforming to MIL-C-20079 or silicone coated aluminized fibrous-glass cloth or silicone rubber coated fibrous-glass cloth (see table IV). Flanges shall be insulated with removable covers (see 5.3.4.2.1 and 5.3.4.2.2).

TABLE VIII. Thickness of insulating materials for hot surfaces of valves, fittings, and flanges up to 1,200 °F. [1/]

Maximum Operating Temperature (°F)	MIL-C-20079, Plus Fibrous-Glass Felt, MIL-I-16411 [2/] [3/]	Insulation, Block, MIL-PRF-2819	Insulating Cement, MIL-C-2861	Polyimide Foam, MIL-DTL-24688	MIL-PRF-32514
100 to 180	1	1½	2	½	½
181 to 250	1	1½	2	¾	1 [4/]
251 to 300	1	1½	2	1	1 [4/]
301 to 338	1	1½	2	1	
339 to 350	1½	2	2½	1	
351 to 388	1½	2	2½	1½	
389 to 400	2	2½	3½	1½ (400 °F max)	
401 to 500	2	2½	3½		
501 to 750	3	4	5		
751 to 850	4	5	5½		
851 to 950	4½	5	Not to be used alone for temps. above 850 °F		
951 to 1050	5	5½			
1051 to 1200	6	6½			

NOTES:

[1/] Valves and fittings that are welded into the line shall be insulated permanently. Flanged valves and flanged fittings shall have reusable covers to permit servicing of takedown 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.

[2/] Alternatively, fibrous-glass cloth conforming to MIL-C-20079 plus mineral wool insulation (with a hard fibrous-glass cover) such as CADAFIT 1200 °F, or equal as approved by NAVSEA, may be used as applicable.

[3/] Reusable covers may also be fabricated using silicone rubber aluminized fibrous-glass cloth or silicone rubber coated fibrous-glass cloth as specified in table IV. Alternatively, flame-resistant meta-aramid material (such as Nomex®, or equal as approved by NAVSEA) hook-and-loop-fastened removable and reusable fiberglass insulation pads (such as SpeedWrap™, or equal as approved by NAVSEA), may be used for valve and fitting covers at the thicknesses specified herein for temperatures up to 1000 °F.

[4/] Insulation material conforming to MIL-PRF-32514, Type II, Class 2 and approved by NAVSEA for use at 300 °F, may be used at up to 300 °F for surface ship non-nuclear applications only.

5.3.4.2 Reusable covers for valve bonnets and valves. Reusable covers shall be used for 2-inch IPS and larger valve bonnets and valves having takedown joints at the ends. The reusable covers shall be fitted such that the bonnet joint shall be removed independently of the valve covering. Valves 2-inch IPS and under shall be fitted with separate covers, or covers of a one-piece design such that they shall be wrapped around the entire valve body and clipped or otherwise secured just below the packing gland or valve stem. The packing gland shall remain visible.

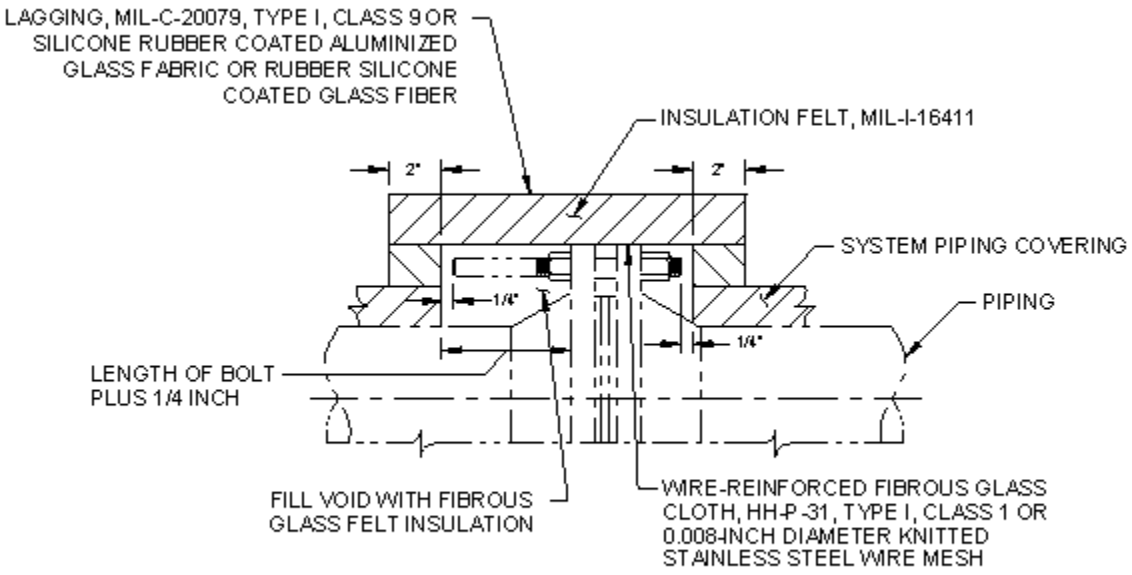

FIGURE 11. Typical removable flange cover for system operating at temperatures above 450 °F.

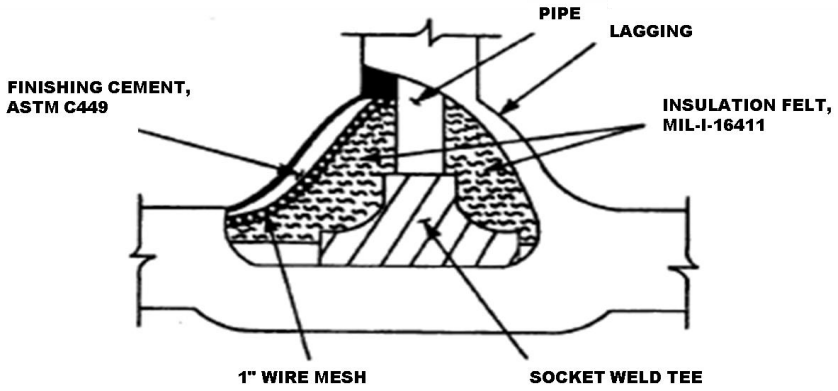

FIGURE 12. Permanent insulation of fitting on hot piping system using insulation felt.

5.3.4.2.1 Reusable covers construction for valves, fittings, and flanges. Reusable covers for valves, fittings, and flanges that are exposed to temperatures under 450 °F shall be constructed in two half-sections, using fibrous-glass felt conforming to MIL-I-16411 enclosed in fibrous-glass fabric conforming to MIL-C-20079, Type I, Class 9. Alternatively, silicone rubber-coated, aluminized glass fabric may be substituted for the plain fibrous-glass fabric conforming to MIL-C-20079 for the cover material (see table IV). Covers that are exposed to temperatures of 450 °F and higher shall have an 0.008-inch diameter knitted stainless steel wire mesh sewn onto the fibrous-glass cloth conforming to MIL-C-20079 on the inside (hot) surface and on the ends. Knitted wire mesh shall be made of Type 304 annealed stainless steel. The wire shall be 0.008 inch in diameter. The mesh shall consist of 7½+½ courses in accordance with inch equal spacing and 10+1 wires in accordance with inch equal spacing. The mesh shall be furnished in 30+½-inch flattened tubular form and shall be crimped 0.125- to 0.150-inch deep by 5/16-inch crimp to crimp. Alternatively, the inside surface and ends of pads may be fabricated of wire-reinforced fibrous cloth conforming to HH-P-31, Type I, Class 1. Each half cover shall be sewn and quilted with polytetrafluoroethylene (PTFE) coated fibrous-glass thread conforming to MIL-C-20079, Type III, Class 3, 4, or 6, for hand sewing, or PTFE-coated fibrous-glass sewing thread (fully sintered), Type III, Class 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. When the outside diameter of the fitting or flange is greater than that of the adjacent pipe covering, fibrous-glass felt conforming to MIL-I-16411 shall be used to build up the outer edges of the reusable cover to the required diameter. When the outside diameter of the fitting or flange is smaller than that of the adjacent pipe covering, the reusable cover shall be fabricated as shown on figure 13. The cover shall be secured by lacing wire through hook or ring fasteners.

5.3.4.2.2 Quick removable wrap. Alternatively, flame-resistant meta-aramid material (such as Nomex®, or equal as approved by NAVSEA) hook-and-loop-fastened removable and reusable fiberglass insulation pads (such as SpeedWrap™, or equal as approved by NAVSEA), may be used for valve and fitting covers at the thicknesses specified herein for temperatures up to 1000 °F. SpeedWrap™ pads are made of an inner pad of high temperature fibrous-glass felt conforming to MIL-I-16411 encased in fibrous-glass fabric conforming to MIL-C-20079, with a white, silicone-coated outer covering that does not require painting.

5.3.4.2.2.1 Quick removable wrap installation. Quick removable wrap shall be installed as follows:

a. When applying the quick removable wrap, ensure that the straight sections of pipe are insulated prior to securing the quick removable wrap on valves or fittings. Wrap the quick removable wrap around the pipe or fitting and secure the hook-and-loop edges together. Ensure that the edges of the quick removable wrap on the fitting or valve overlap the edges of the adjacent sections of insulation as much as possible.

b. Orient the hook-and-loop seam downward, when possible, to avoid inadvertent dripping from penetrating the pad.

c. Ensure that the ends of the pad are not left exposed in areas where intermittent wetting is possible.

d. Ensure that the quick removable wrap part most closely resembles the hardware type, such as an elbow, tee, or valve.

e. If used on standard valves, ensure that the quick removable wrap does not cover packing gland as this would prevent monitoring of packing gland leakage, which may lead to significant corrosion.

f. Do not paint the quick removable wrap following installation. Make sure the hook-and-loop fastener is securely fastened following installation so that if the pad is painted, the fastener shall still be operable.

WARNING

If the quick removable wrap is painted, this may result in severe peeling. It is noted that the water-based enamel conforming to MIL-PRF-24596 provides better results than most paints and will not peel unless disturbed. However, if the quick removable wrap is painted, two coats of water-based enamel conforming to MIL-PRF-24596 shall be applied to the silicone-coated outer covering. Coating the flame-resistant meta-aramid material hook-and-loop fastening tape with paint shall be avoided, as this will adversely affect their functionality.

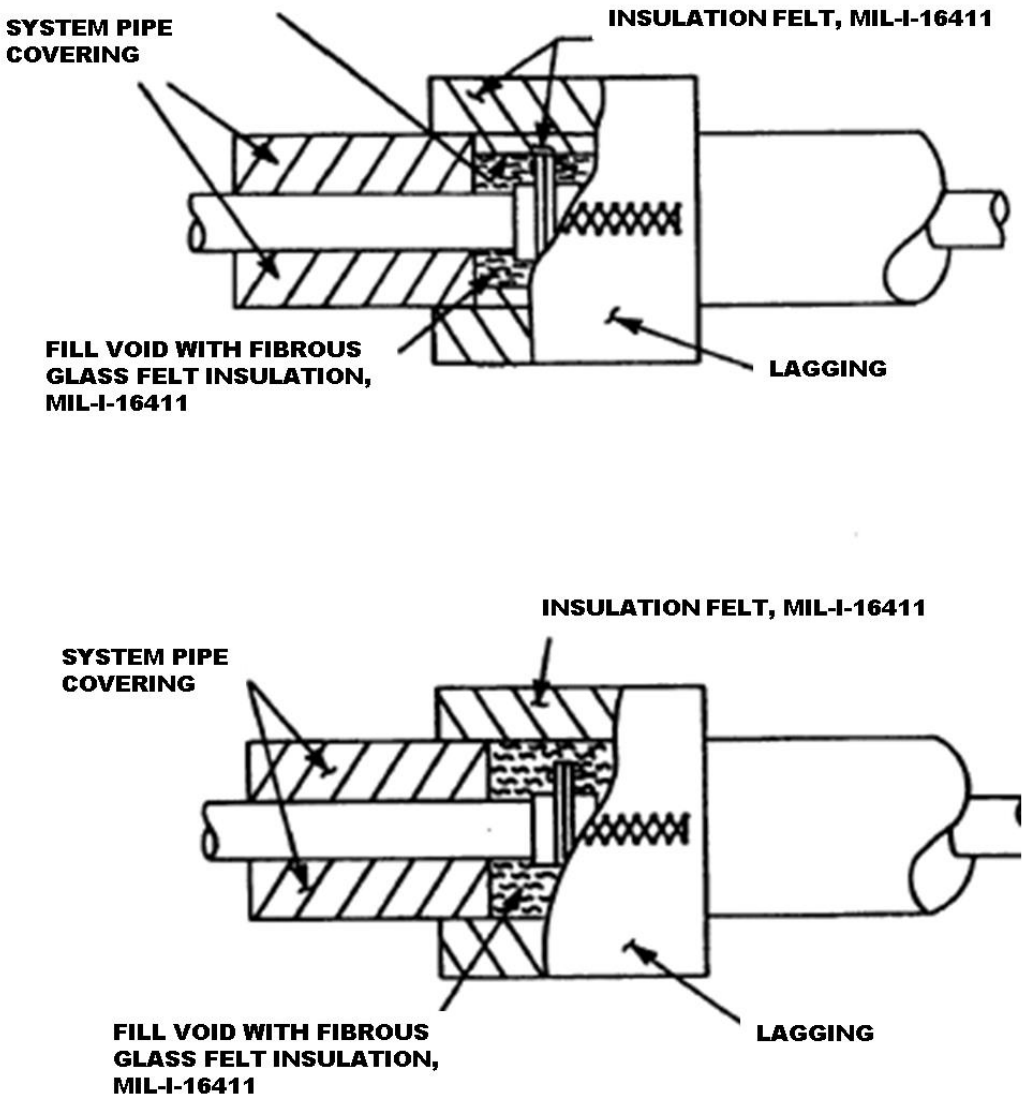

FIGURE 13. Removable covers where flange diameter is smaller than the outside diameter of the adjacent pipe covering.

5.3.4.3 Low temperature valve and fitting reusable covers. For low temperature valve and fitting reusable covers, pre-formed fibrous glass conforming to MIL-PRF-22344 may be used when temperatures are in the 100 to 370 °F range. Polyimide foam conforming to MIL-DTL-24688, Type I or Type III may be used as applicable for valve or fitting covers when temperatures are in the 100 to 600 °F range. Thermal cellular elastomeric insulation conforming to MIL-PRF-32514, Type II material and NAVSEA approved for use at temperatures up to 300 °F on surface ships for non-nuclear applications only may be used up to 300 °F, as applicable. 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 that will facilitate removal and replacement.

5.3.4.4 Rigid removable covers. Rigid removable covers shall be manufactured from segments of block insulation conforming to MIL-PRF-2819 or pre-formed pipe insulation conforming to MIL-I-2781, having the same thickness as that on the adjacent piping. Blocks shall be securely wired to frames of ½-inch square mesh, 18-gauge (0.049-inch diameter) (minimum), galvanized steel wire. Wire mesh frames on the outside and inside of the blocks shall have the ends bent over and joints secured with18-gauge (minimum), black annealed iron wire woven through the mesh. High temperature cement conforming to MIL-C-2861 shall be troweled smoothly over all surfaces of the wire mesh. Fibrous-glass felt conforming to 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 or silicone coated aluminized fibrous-glass cloth or silicone rubber coated fibrous-glass cloth (see table IV). Lagging may be 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 joints. 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. Rigid covers constructed of pre-formed pipe coverings are sufficiently rigid such that wire frames are not required. They shall be lagged and secured to the valve flange or fitting in the same manner as covers constructed of rigid block materials.

5.3.4.4.1 Pre-formed mineral wool insulation with hard glass cover. Alternatively, pre-formed mineral wool insulation with a hard fibrous-glass cover, such as CADAFIT 1200 °F, or equal as approved by NAVSEA, may be used as applicable. For thickness of pre-formed mineral wool insulation with a hard fibrous-glass cover, refer to the thicknesses shown in table VII at the appropriate temperature range.

5.3.4.5 Reusable covers for intermittent use boiler piping systems. Reusable covers may be used as an alternative to conventional pre-formed block pipe insulation conforming to MIL-PRF-2819 for systems that are subjected to periodic Planned Maintenance System (PMS) Ultrasonic Test (UT) measurement. Specific requirements for use of the alternate reusable covers shall be as follows for these systems:

a. Boiler soot blower piping shall be insulated in accordance with 804-841336. Reusable insulation, as specified (see 5.3.4.5.c), may be installed with TYCOM and NAVSEA 05P approval. The coverage shall be the same as with the conventional pre-formed insulation and not in the following locations: bilge area, on soot blower heads, or on soot blower head flanged joints. When used, the reusable covers pads shall be installed on all piping back to and including the root valves.

b. Blowdown piping and portions of the bottom blow system that are insulated on some ship classes, may be insulated with reusable covers as specified (see 5.3.4.5.c), with TYCOM and NSWCCD-SSES 922 approval.

c. Cover construction for intermittent use boiler piping shall be in accordance with the requirements for fabricating reusable covers for piping components (see 5.3.4.2.1). Silicone rubber coated fibrous-glass cloth shall be used for the outer and exposed end surfaces of the covers (see table IV). A 1½-inch thick thermal glass fiber insulating felt conforming to MIL-I-16411 shall be used. All hot side materials shall be suitable for steam piping service for temperatures up to 700 °F. The heavy weight liner cloth conforming to MIL-C-20079 shall have Type 304 stainless steel mesh on the hot side. Reusable covers shall be made flexible enough to follow piping contours and permit lacing in place. Piping covers shall be segmented as required to permit installation around interferences and to be easily handled. Reusable covers shall be sequentially numbered and marked (specific location and boiler number) for easy reinstallation.

5.3.4.6 Weather deck hot piping. Weather deck hot piping systems shall be insulated with calcium silicate pre-formed sectional pipe covering conforming to MIL-I-2781. Insulation thickness shall be as shown in table IX.

TABLE IX. Nominal thickness of insulation for weather deck hot piping.

Pipe Size (inches)	Calcium Silicate, MIL I-2781 (inches) (min)
¼ to 3	1½
3½ to 6	2
Over 6	2½

5.3.4.6.1 Preliminary surface preparation of weather deck piping. Preliminary surface preparation of piping shall include ensuring that all piping surfaces are clean, dry, and free of scale, corrosion products, and grease. Fittings, valves, flanges, pipe supporting clamps, and at least 3 inches of adjacent pipe shall be painted as follows: Apply one coat formula 150 conforming to MIL-DTL-24441 to a maximum DFT of 0.003 inch (3 mils). For temperatures above 300 °F, apply two coats of aluminum paint conforming to TT-P-28, Type I.

5.3.4.6.2 Weather deck pipe covering insulation. Pipe covering insulation shall be calcium silicate conforming to MIL-I-2781, applied to the piping with joints staggered and with longitudinal joints at the top and bottom on horizontal pipes. The insulation shall be secured tightly with ½-inch wide, 22-gauge, galvanized steel bands or 18-gauge galvanized iron wire on 9-inch centers that have been placed over a layer of fibrous-glass tape conforming to MIL-C-20079, Type II. Fill all joints and voids in the insulation with high temperature cement conforming to MIL-C-2861. Wrap tightly with one layer of fibrous-glass lagging cloth conforming to MIL-C-20079, Type I, using adhesive conforming to MIL-A-3316, Class 1. After the adhesive has dried, the lagging shall be coated with two brush coats of end-sealing compound conforming to MIL-C-22395. Where the insulation is cut off, the exposed insulation and 3 inches of exposed pipe shall be coated with high temperature cement conforming to MIL-C-2861, and two coats of end sealing compound conforming to MIL-C-22395. A layer of fibrous-glass cloth lagging conforming to MIL-C-20079, tailored to fit over the pipe insulation exposed surface and 3 inches of the pipe, shall be applied while the sealing compound is still tacky. The fibrous-glass cloth lagging shall be attached to the pre-formed pipe insulation with adhesive conforming to MIL-A-3316, and to the pipe with a ½-inch wide, 22-gauge galvanized steel band. The cut-off section shall then be covered with a 3⁄16-inch thick coating of end-sealing compound conforming to MIL-C-22395. Alternatively, the lagged insulation and ends may be clad with metal sheathing (see 4.12) in lieu of end-sealing compound.

5.3.4.6.3 Insulation for weather deck piping fittings, flanges, and valves. Insulation for weather deck piping fittings, flanges, and valves shall be fabricated from sections of molded calcium silicate pipe covering conforming to MIL-I-2781 or block insulation conforming to MIL-PRF-2819 cemented together with adhesive conforming to ASTM C474, such as CalBond Gold, or equal as approved by NAVSEA. 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.

5.3.4.6.4 Permanent covers for weather deck piping fittings, flanges, and valves. Permanent covers for weather deck piping fittings, flanges, and valves shall be fabricated from sections of pre-formed calcium silicate pipe insulation material conforming to MIL-I-2781. Permanent covers shall be fitted snugly to fittings and adjacent pipe covering and voids shall be filled with tightly packed fibrous-glass felt conforming to MIL-I-16411. Permanent covers shall be lagged and coated in the same manner as the adjacent piping insulation.

5.3.4.6.5 Removable covers for weather deck fittings, flanges, and valves. Removable covers for weather deck fittings, flanges, and valves shall be fabricated in two halves from rigid pre-formed calcium silicate insulation material conforming to MIL-I-2781. Where specified, these removable covers shall extend over the adjacent pipe covering 1½times the thickness of the insulation. Each half shall be separately lagged and coated with end-sealing compound conforming to MIL-C-22395. Once installed, the two halves shall be secured with ½-inch wide, 22-gauge galvanized steel bands and completely covered with two coats of end-sealing compound conforming to MIL-C-22395. Alternatively, the lagged insulation and ends may be clad with metal lagging in lieu of end-sealing compound.

5.3.4.6.6 Hanger clamps. Hanger clamps shall have pre-formed calcium silicate pipe insulation conforming to MIL-I-2781 trimmed to fit as closely as possible. Voids shall be filled to within ¼ inch of the surface with tightly packed fibrous-glass felt conforming to MIL-I-16411. The remaining ¼-inch space is finished by filling with end-sealing compound conforming to MIL-C-22395, generously overlapping both the support member and the adjacent insulation. Fibrous-glass cloth lagging conforming to MIL-C-20079 shall be applied and coated with an end-sealing compound conforming to MIL-C-22395, along with the adjacent piping insulation.

5.4 Requirements for thermal and acoustic insulation for machinery and equipment. Requirements for thermal and acoustic insulation for machinery and equipment shall conform to the lagging and adhesive materials as follows:

a. Insulation blanket, thermal, fibrous mineral conforming to MIL-PRF-2818.

b. Insulation, thermal cellular elastomeric foam conforming to MIL-PRF-32514.

c. Insulation felt, thermal, glass fiber conforming to MIL-I-16411.

d. Insulation felt, thermal and sound absorbing, fibrous glass conforming to MIL-I-22023.

e. Insulation, thermal and acoustic absorptive, cellular polyimide foam conforming to MIL-DTL-24688.

f. Insulation block, thermal, Classes II and III conforming to MIL-PRF-2819.

g. Cement, insulation, high temperature conforming to MIL-C-2861.

h. Blended hydraulic cement conforming to ASTM C595/C595M.

i. Cloth, glass; tape, textile glass; and thread, glass conforming to MIL-C-20079.

j. Fibrous-glass metallic cloth and tape lagging material, Type I conforming to HH-P-31.

k. Steel sheets, carbon, zinc coated, coating designation G115 conforming to ASTM A653/653M.

l. Aluminum, Type 6061-0 conforming to ASTM B209.

m. Corrosion-resistant steel (CRES), Type 304 conforming to ASTM A240/A240M.

n. Building paper, vegetable fiber (kraft, waterproofed, water repellent, and fire resistant) conforming to UU-B-790.

o. Silicone rubber, aluminized fibrous-glass cloth, such as Alpha lightweight 2337-2-TA or Alpha heavyweight 2025-2-AMA, or equal as approved by NAVSEA.

p. Barium sulfate-loaded vinyl sheet conforming to MIL-A-24699.

q. Adhesive, fire-resistant, thermal insulation conforming to MIL-A-3316 or as approved by NAVSEA.

r. Adhesive, flexible unicellular, plastic thermal insulation conforming to MIL-A-24179 or as approved by NAVSEA.

s. Finishing cement conforming to ASTM C449 is used as a surface finish over insulation material to provide a hard, smooth finish to which lagging is applied.

t. Coating compounds, thermal insulation, fire and water-resistant, vapor barrier conforming to MIL-PRF-19565, Type II, which is applied with a stiff brush or a trowel over lagging on all porous anti-sweat, refrigerant machinery, and equipment insulation materials.

u. Molded and expanded perlite block insulation with sodium silicate binder conforming to ASTM C610 for use on the inside of the outer casings of boilers.

5.4.1 Securement. Insulation materials shall be supported, secured, fastened, or bonded to be held in place. Approved securement materials for use on ship machinery and equipment are available in the following forms:

a. Wire, electrical, copper (uninsulated) conforming to A-A-59551.

b. Wire, 18-gauge minimum (0.049-inch diameter) hot-dipped galvanized iron, BWG 18, medium temper, Class 3 coating conforming to ASTM A641/A641M.

c. Strapping, flat steel, and seals conforming to ASTM D3953.

d. Reinforcement, 1-inch mesh, galvanized, wire netting, 18-gauge or 20-gauge conforming to ASTM A390 is used for both reinforcement and stiffening of insulation.

5.4.2 Surface preparation. Surfaces of all equipment and machinery to be insulated shall be prepared in accordance with Standard Item 009-32, as applicable (see 4.12).

5.4.3 Insulation installation requirements on machinery and equipment. Insulation shall be installed on machinery and equipment and lagged, where required, in accordance with 804-5959212 and the instructions herein. The extent and thickness of insulation to be applied to machinery and equipment shall be as shown in table X. Where methods of application require fibrous-glass cloth lagging conforming to MIL-C-20079 to be secured to the insulation with adhesive conforming to MIL-A-3316, the cloth shall be completely adhered to the entire outer surface of the insulation or finishing cement and the cloth surface shall be sealed with adhesive conforming to MIL-A-3316. All lagging shall be fitted securely, lapping all joints by at least 2 inches, and shall present a smooth appearance. Rewettable glass cloth lagging conforming to MIL-C-20079 may be used as an alternative to fibrous-glass cloth lagging adhered with adhesive conforming to MIL-A-3316; however, it shall only be used in areas not subject to live steam or dampness. Unless otherwise specified (see 6.2), fibrous-glass cloth and tape lagging shall be covered with one coat of fire-retardant paint conforming to MIL-DTL-24607, after installation. The inside surface of removable covers shall not be painted. Where fasteners are required, they shall be attached during manufacture (before heat treatment, stress relief, and testing) by a NAVSEA approved procedure. Welding of fasteners, clips, or hooks to machinery, pressure vessels, or other related equipment after their construction is prohibited, unless specifically authorized by NAVSEA.

5.4.4 Equipment supports. Units of equipment with design internal temperatures of 300 °F and higher shall be insulated from their supports, or the supports insulated from the structure to which they are attached, where the heat transmitted may be objectionable on the other side of the structure. Insulation shall be held in place with flat metal bands and seals, or wire secured to clips, hooks, machinery bolts, or other fastenings as specified (see 5.4.1).

5.4.5 Permanent insulation application to machinery and equipment. Permanent insulation shall be applied to all surfaces of machinery and equipment, such as turbines, that have an operating temperature of 125 °F or greater. Machinery and equipment surfaces that shall be permanently insulated shall be insulated with thermal block insulation conforming to MIL-PRF-2819, high temperature cement conforming to MIL-C-2861, fibrous-glass insulation felt conforming to MIL-I-16411, mineral fiber blanket conforming to MIL-PRF-2818, or polyimide-foam insulation conforming to MIL-DTL-24688. Thicknesses of insulation materials shall be as shown in table X. The insulation shall be applied by one of the following methods:

5.4.5.1 Block insulation application. Block insulation conforming to MIL-PRF-2819 shall be applied to machinery and equipment, such as turbines, as follows (see figure 14):

a. Fill all irregularities of the surface of the machinery or equipment, such as a turbine, with high temperature cement conforming to MIL-C-2861, or glass insulation felt conforming to MIL-I-16411, to form a smooth surface.

b. Carefully fit the block insulation conforming to MIL-PRF-2819 to the surface with all joints staggered and tightly butted. When two or more layers of block insulation conforming to MIL-PRF-2819 are used, ensure that the joints of the adjacent layer are staggered.

c. Use cement conforming to MIL-C-2861 or fibrous-glass felt insulation conforming to MIL-I-16411 to point up joints and crevices between the layers of block.

d. Ensure that block insulation conforming to MIL-PRF-2819 is held in place with 18-gauge, galvanized, hot-dipped iron wire conforming to ASTM A641/A641M, spaced on 3-inch maximum centers, or strapping conforming to ASTM D3953, spaced on 9-inch maximum centers. When restraining wire is used, it shall be attached to manufacturer-installed clips or hooks.

e. Spread 1-inch wire mesh netting conforming to ASTM A390 over the outer layer of block insulation conforming to MIL-PRF-2819 and secure with 18-gauge, galvanized, hot-dipped iron wire conforming to ASTM A641/A641M to the restraining wire or strapping conforming to ASTM D3953.

f. Apply a ½-inch layer of high temperature cement conforming to MIL-C-2861 tempered with hydraulic cement conforming to ASTM C595 (4 parts high temperature cement conforming to MIL-C-2861 to 1 part hydraulic cement conforming to ASTM C595/C595M), or finishing cement conforming to ASTM C449, over the mesh netting conforming to ASTM A390 to a smooth finish. Allow to dry for 1 hour.

g. Apply adhesive conforming to MIL-A-3316, Class 1 to the hard cement finish and lag with fibrous-glass cloth conforming to MIL-C-20079, Type I.

h. Attach brass or galvanized steel hooks, rings, or snap fasteners to the permanent insulation adjacent to the removable turbine casing flange joint covers (see 5.4.6).

5.4.5.2 High temperature insulation cement application. High temperature insulation cement conforming to MIL-C-2861 shall be applied to machinery and equipment, such as turbines, as an alternative to block insulation conforming to MIL-PRF-2819 as follows (see figure 15):

a. When high temperature insulation cement conforming to MIL-C-2861 is used, it shall be applied in layers ½- to 1-inch thick. Each layer shall be permitted to thoroughly dry at least 24 hours before a succeeding layer is applied.

b. One-inch wire mesh netting conforming to ASTM A390 shall be applied between layers of the high temperature insulation cement conforming to MIL-C-2861 and spread over the outermost layer.

c. A ½-inch layer of finishing cement conforming to ASTM C449 shall be applied over the mesh netting to a smooth finish.

d. Adhesive conforming to MIL-A-3316, Class 1 shall be applied to the hard cement finish. It shall then be lagged with fibrous-glass cloth conforming to MIL-C-20079, Type I.

e. Brass or galvanized steel hooks, rings, or snap fasteners shall be attached to the permanent insulation adjacent to removable turbine casing flange joint covers (see 5.4.6).

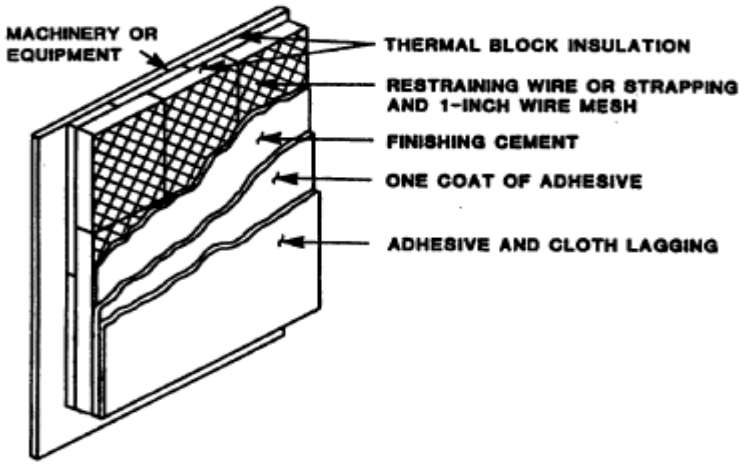

FIGURE 14. Application of thermal block insulation conforming to MIL-PRF-2819, class 2, to machinery and equipment (temperature range 125 to 1200 °F).

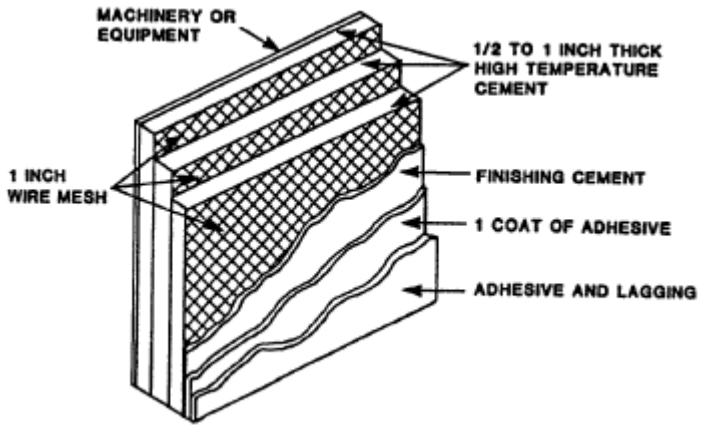

FIGURE 15. Application of high temperature insulation cement conforming to MIL-C-2861 to machinery and equipment (temperature range 125 to 850 °F.

TABLE X. Thickness of insulation materials for hot surfaces of machinery and equipment (does not include finishing cement). [1/]

Maximum Operating Temperature (°F)	MIL-C-20079 Plus Fibrous-Glass Felt MIL-I-16411 [2/ 3/] Nominal Thickness (inches)	MIL-PRF-2819 Nominal Thickness (inches)	MIL-PRF-2818 Nominal Thickness (inches)	MIL-C-2861 Nominal Thickness (inches)	MIL-DTL-24688, Type I Nominal Thickness (inches)	MIL-PRF-32514 Nominal Thickness (inches)
125 to 180	1	1½	1½	2	½	½ (180 °F max.)
181 to 250	1	1½	1½	2	¾	
251 to 300	1	1½	1½	2	1	
301 to 338	1	1½	1½	2	1	
339 to 350	1½	2	2	2½	1	
351 to 388	1½	2	2	2½	1½	
389 to 400	2	2½	2½	3½	1½ (400 °F max.)	
401 to 500	2	2½	2½	3½		
501 to 750	3	4	4	5		
751 to 850	4	5	5	5½		
851 to 950	4½	5	5	Not to be used alone for temps. above 850 °F		
951 to 1050	5	5½	5½ (1000 °F max.)			
1051 to 1200	6	6½				

TABLE X. Thickness of insulation materials for hot surfaces of machinery and equipment (does not include finishing cement) – Continued. [1/]

NOTES:

1/ Valves and fittings which are welded into the line shall be insulated permanently. Flanged valves and flanged fittings shall have reusable covers to permit servicing of takedown 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.

2/ Alternatively, fibrous-glass cloth conforming to MIL-C-20079 plus mineral wool insulation (with a hard fibrous-glass cover), such as CADAFIT 1200 °F, or equal as approved by NAVSEA, may be used as applicable.

3/ Reusable covers may also be fabricated using silicone rubber aluminized fibrous-glass cloth or silicone rubber coated fibrous-glass cloth as specified in table IV.

5.4.5.3 Fibrous-glass felt, mineral fiber blanket, and polyimide-foam application. Fibrous-glass felt conforming to MIL-I-16411 (for temperatures between 125 and 1200 °F) (see figure 16), mineral fiber blanket conforming to MIL-PRF-2818 (for temperatures between 125 and 1000 °F) (see figure 17), and polyimide foam conforming to MIL-DTL-24688 (for temperatures between 125 and 400 °F) shall be applied to machinery and equipment as follows:

a. Fibrous-glass felt conforming to MIL-I-16411, mineral fiber blanket conforming to MIL-PRF-2818, or polyimide-foam insulation conforming to MIL-DTL-24688 shall be applied in layers to make up the required thickness as specified in table X. Joints shall be staggered as close to 90 degrees as practicable and tightly butted. When two or more layers are used, joints of the adjacent layers shall be staggered. Adjacent layers may be held to one another with adhesive conforming to MIL-A-3316.

b. The insulation shall be secured firmly in place with 18-gauge, galvanized, hot-dipped iron wire conforming to ASTM A641/A641M spaced on approximately 3-inch centers, or strapping conforming to ASTM D3953 spaced on 9-inch maximum centers. Restraining wires shall be fastened to manufactured insulation clips or hooks where applicable.

c. One-inch (1-inch) wire mesh netting conforming to ASTM A390 shall be spread over the outer layer of fibrous-glass felt insulation conforming to MIL-I-16411, mineral fiber blanket conforming to MIL-PRF-2818, or polyimide foam conforming to MIL-DTL-24688, and secured with 18-gauge, galvanized, hot-dipped iron wire conforming to ASTM A641, to the restraining wire or strapping conforming to ASTM D3953.

d. A ½-inch layer of high temperature cement conforming to MIL-C-2861 tempered with hydraulic cement conforming to ASTM C595 (4 parts high temperature cement conforming to MIL-C-2861 to 1 part hydraulic cement conforming to ASTM C595), or finishing cement conforming to ASTM C449, shall be applied over the mesh netting conforming to ASTM A390 to a smooth finish. Allow to dry for 1 hour.

e. Adhesive conforming to MIL-A-3316, Class 1 shall be applied to the hard cement finish. It shall then be lagged with fibrous-glass cloth conforming to MIL-C-20079, Type I.

f. Brass or galvanized steel hooks, rings, or snap fasteners shall be attached to the permanent insulation adjacent to removable turbine casing flange joint covers (see 5.4.6).

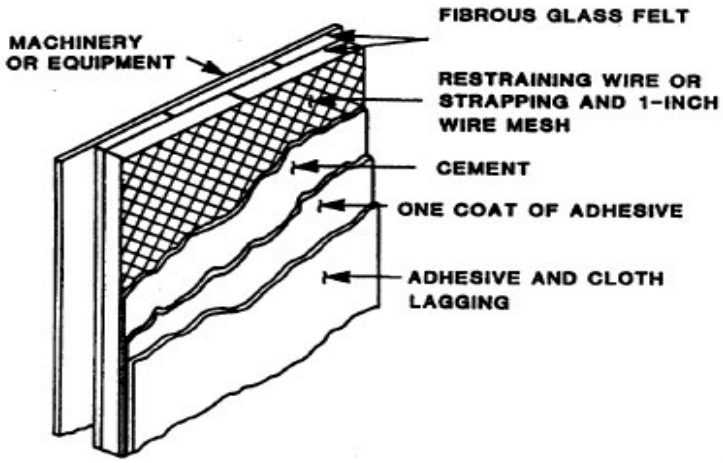

FIGURE 16. Application of fibrous-glass felt conforming to MIL-I-16411 to machinery and equipment (temperature range 125 to 1200 °F).

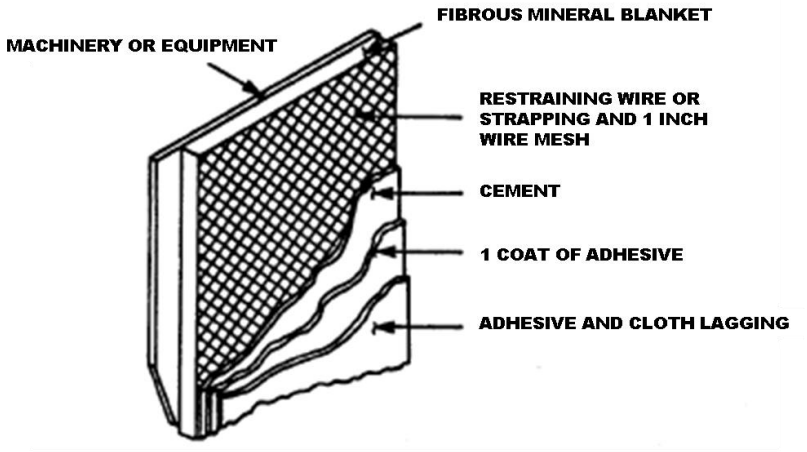

FIGURE 17. Application of mineral fiber blanket conforming to MIL-PRF-2818 to machinery and equipment (temperature range 125 to 1000 °F).

5.4.6 Removable flange joint cover for turbine casings. Removable covers shall be used for the flange joint between the upper and lower turbine casings. Covers are formed by quilting layers of fibrous-glass insulation felt conforming to MIL-I-16411 or mineral fiber blanket conforming to MIL-PRF-2818, together with PTFE-coated fibrous-glass thread for hand sewing conforming to MIL-C-20079, Type III, Class 4, or coated fibrous-glass sewing thread for machine sewing conforming to MIL-C-20079, Type III, Class 3. The turbine side and end surfaces of the flange cover, for service of 450 °F and above, shall be covered with wire-reinforced fibrous-glass cloth conforming to HH-P-31, Type I, Class 1 or knitted wire mesh. The outer surface shall be covered with fibrous-glass cloth conforming to MIL-C-20079, Type I, Class 9. Flange covers for temperatures under 450 °F shall be enclosed with fibrous-glass cloth conforming to MIL-C-20079, Type I, Class 9, on both the inside and outside (see figure 18). Alternatively, silicone rubber coated and aluminized glass fabric or silicone rubber coated glass fabric, may be substituted for plain fibrous-glass cloth as the cover material (see table IV).

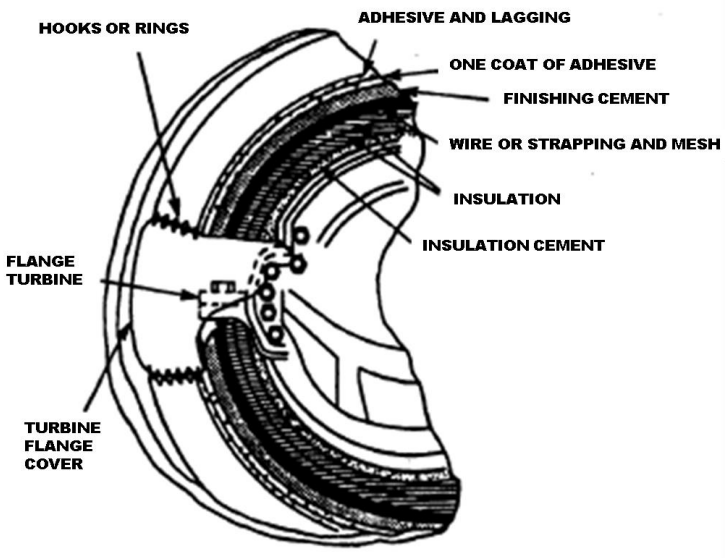

FIGURE 18. Turbine casing removable flange cover.

5.4.6.1 Semi-removable turbine casing flange cover. Semi-removable turbine casing flange covers may be installed as an alternative for removable covers (see 5.4.6). 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 conforming to MIL-C-20079, Type I; wire inserted fibrous-glass cloth conforming to 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 conforming to MIL-I-16411, mineral fiber blanket conforming to MIL-PRF-2818, or insulation block conforming to MIL-PRF-2819, Class 2, to the required thickness and shape. The insulation shall be lagged with fibrous-glass cloth, or silicone coated aluminized fibrous-glass cloth, or silicone rubber coated 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 conforming to MIL-A-3316, Class 1, and when the adhesive has completely dried, painted with one coat of paint conforming to MIL-PRF-24596 or MIL-DTL-24607.

NOTE: When installing any of the foregoing covers, spaces between the removable cover and the surfaces they insulate shall be filled with pieces of fibrous-glass insulation felt conforming to MIL-I-16411. The felt shall be packed loosely enough to preserve air cell structure and tightly enough to prevent air circulation.

5.4.7 Thermal insulation installation on boiler casings. Thermal insulation installation on boiler casings shall be as follows:

a. Prior to installation of insulation block conforming to MIL-PRF-2819, ¼-inch diameter round bars conforming to ASTM A108, Grades 1008-1025 shall be spaced approximately 18 inches apart and tack welded to the boiler outer-casing. Tack welds shall be located approximately 12 inches apart. Expanded metal conforming to ASTM F1267 shall then be tack welded to the round bar. Tack welds shall be approximately 6 inches apart.

b. Insulation block conforming to MIL-PRF-2819 shall be fitted to the expanded metal using adhesive conforming to MIL-A-3316, and secured with 18- or 20-gauge wire netting, laced to welded notched studs on the outer boiler casing. Voids and gaps in the insulation block shall be filled with cement conforming to MIL-C-2861, or fibrous-glass insulation felt conforming to MIL-I-16411. One-inch wire mesh netting conforming to ASTM A390 shall be applied over the insulation block and attached with wire conforming to ASTM A641/641M. Finishing cement conforming to ASTM C449 shall be used to smooth surfaces and completely cover the wire mesh netting to a thickness of ½ inch. After drying, the hard cement finish shall be lagged with fibrous-glass cloth conforming to MIL-C-20079, Type I and adhesive conforming to MIL-A-3316.

c. Upper casing insulation that is exposed to moisture, which causes the lagging cloth and cement to separate from the under layer of block, shall be reinforced. Longer studs shall be used at selected locations that protrude through the lagging cloth. The cloth shall be mechanically anchored in place at these locations by use of an oversize washer and nut.

d. Boiler bottom casing insulation shall be reinforced with expanded metal conforming to ASTM F1267 to prevent the insulation from sagging. Threaded studs ½ inch in diameter shall be welded to the casing on 24- by 30-inch centers prior to applying insulation and lagging. A 1-inch by #6 expanded metal shall be fastened against the insulation and lagging using nuts and washers.

e. Thermal insulation composed of a fine grade perlite and sodium silicate binder conforming to ASTM C610 shall be the replacement material for the asbestos mill board located on the inside of the outer casings of boilers. The standard size suitable for window areas is 1-inch thick by 12-inch by 36-inch sections. Sections of perlite shall be installed over existing fasteners. A light-gauge metal sheathing conforming to ASTM A653/653M shall be installed over the perlite block to retain it in position and protect it from erosion in accordance with S9086-GY-STM-010.

f. Access panels and doors shall be covered with removable covers constructed as specified (see 5.4.6). The removable covers shall be secured to the permanent insulation or ¼-inch diameter round bar conforming to ASTM A108, Grades 1008 through 1025, with 18-gauge wire conforming to ASTM A641/641M.

5.4.7.1 Thermal insulation installation on boiler steam and water drum shells. Thermal insulation installation on steam and water drum shells shall be with block insulation conforming to MIL-PRF-2819, fibrous-glass felt insulation conforming to MIL-I-16411, or mineral fiber blanket insulation conforming to MIL-PRF-2818. The block insulation conforming to MIL-PRF-2819, shown on figure 19, shall be installed in the upper drum areas. This is considered a "high traffic" area where workers normally stand on the insulation to gain access to safety valves or other components. On boiler drums, galvanized wire conforming to ASTM A641/641M shall be used in place of 360-degree straps shown on figure 19. The wire is run between washers that are tack welded to the casing attachment bars. When wire is used, the maximum spacing between bands shall be decreased.

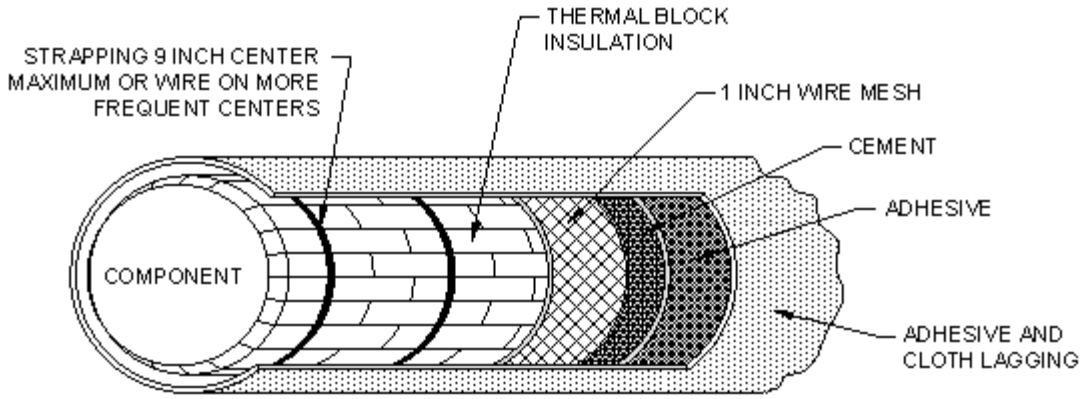

FIGURE 19. Typical drum shell insulation.

5.4.7.2 Thermal insulation installation on boiler drum ends. Boiler drum ends shall be insulated with block insulation conforming to MIL-PRF-2819, high temperature cement conforming to MIL-C-2861, or fibrous-glass felt conforming to MIL-I-16411. The insulation shall be applied by one of the following methods:

a. Insulation block conforming to MIL-PRF-2819 shall be installed and lagged (see 5.4.5.1).

b. High temperature cement conforming to MIL-C-2861 shall be applied in layers between ½- and 1-inch thick. Each layer shall be reinforced with 1-inch wire mesh netting conforming to ASTM A390 and allowed to set for 24 hours, or until dry. The finished installation shall be lagged with fibrous-glass cloth conforming to MIL-C-20079 and adhesive conforming to MIL-A-3316 (see 5.4.5.2).

c. Fibrous-glass felt conforming to MIL-I-16411 shall be installed and lagged (see 5.4.5.3).

5.4.7.3 Removable cover installation on boiler drum manhole plates. Boiler drum manhole plates shall be insulated with a removable cover (see figure 20). The removable cover shall be formed, cloth lagged, and attached to the permanent drum end insulation using the method specified (see 5.4.6) for removable turbine flange covers.

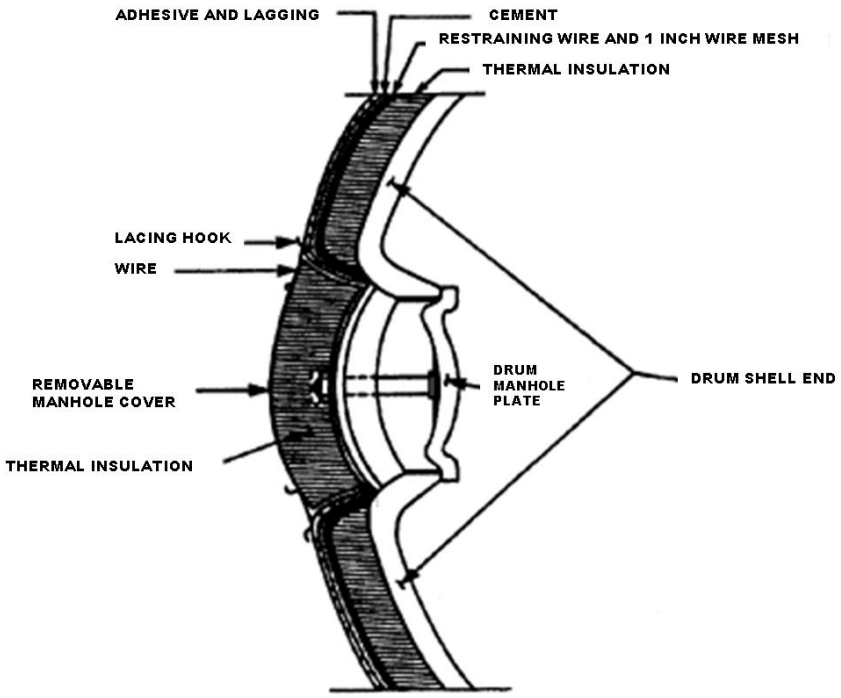

FIGURE 20. Drum shell manhole plate and removable cover.

5.4.7.4 Removable cover installation on superheater headers. Superheater headers shall be insulated with removable covers. The removable covers shall be constructed using the method specified (see 5.4.6). The covers shall be held in place with 18-gauge, galvanized iron wire conforming to ASTM A641/641M, which shall be laced through hooks or rings attached to the blanket and studs welded to the superheater support plate.

5.4.7.5 Insulation installation on boiler uptakes and breeching. Boiler uptakes and breechings shall be insulated with fibrous mineral insulation blanket conforming to MIL-PRF-2818 or fibrous-glass insulation felt conforming to MIL-I-16411 as follows:

a. Fibrous mineral insulation blanket conforming to MIL-PRF-2818 or fibrous-glass insulation felt conforming to MIL-I-16411 shall be installed in the thicknesses designated in table X. If acoustic absorptive treatment is required to decrease the noise level, the acoustic treatment shall be added to the thermal treatment.

b. The insulation shall be applied to the uptake or breeching with pieces butted closely together. It shall be secured with 18-gauge, galvanized iron wire conforming to ASTM A641/641M or by impaling it on the studs used to support the metal sheathing conforming to ASTM A653/653M Coating Designation G 115, not less than 1/32 inch thick. Galvanized steel washers may be placed on the studs to hold the insulation in place until the lagging is installed.

c. Metal sheathing for uptakes and breechings shall be galvanized sheet metal conforming to ASTM A653/653M, Coating Designation G 115, not less than 1/32 inch thick. Insulation and sheathing are not required on uptakes and breechings above the weather deck, except where the transfer of heat to spaces adjacent to the uptake area would be objectionable.

5.4.8 Thermal insulation installation to low pressure distilling plant. Thermal insulation shall be installed on low pressure distilling plant as follows:

a. The evaporator shells, feed heaters, and air ejector condensers shall be permanently insulated with fibrous-glass insulation felt conforming to MIL-I-16411 or block insulation conforming to MIL-PRF-2819. The evaporator shells, feed heaters, and air ejector condensers shall be held in place with 18-gauge galvanized iron wire conforming to ASTM A641/641M, spaced on approximately 3-inch centers, covered with a ½-inch layer of finishing cement conforming to ASTM C449, and allowed to dry.

b. Adhesive conforming to MIL-A-3316, Class 1 shall be applied to the hard cement finish. It shall then be lagged with fibrous-glass cloth conforming to MIL-C-20079, Type I.

5.4.8.1 Removable cover installation on air ejectors, feed heater hotwell drain regulator, and feed heater waterbox flanges. The air ejectors, feed heater hotwell drain regulator, and feed heater waterbox flanges shall be covered with removable covers as follows:

a. The removable covers shall be constructed using the method specified (see 5.4.6).

b. The removable covers shall be attached to galvanized sheet steel covers templated and sectioned to suit the installation. Sections shall be held together and to the evaporator with ¼-inch machine screws or self-tapping screws. The covers shall be secured to the metallic sheathing with 18-gauge. galvanized iron wire conforming to ASTM A641/641M, laced through rings or hooks attached to the covers constructed of fibrous-glass cloth conforming to MIL-C-20079, and hooks welded to the metallic sheathing.

5.4.8.2 Insulation installation on distillate cooler and stage condensers. The distillate cooler and stage condenser waterboxes shall be insulated by one of the following methods:

a. Anti-sweat insulation conforming to MIL-PRF-32514 shall be applied, lagged, and painted using the method specified (see 5.1.16.1).

b. When installing fibrous-glass insulation felt conforming to MIL-I-22023 or MIL-I-16411, the insulation shall be applied, lagged and painted using the method specified (see 5.1.16.2).

5.4.9 Thermal insulation installation to auxiliary machinery, pumps, and equipment. Thermal insulation shall be installed where practical to auxiliary machinery, pumps, and equipment as follows:

a. Auxiliary machinery, pumps, and equipment shall be permanently insulated where practical, with thermal block conforming to MIL-PRF-2819; fibrous-glass felt conforming to MIL-I-16411; polyimide foam conforming to MIL-DTL-24688 (for temperatures up to 400 °F); or mineral fiber blanket insulation conforming to MIL-PRF-2818, to the required thickness as specified in table X.

b. The insulation material shall be secured with 18-gauge, galvanized iron wire conforming to ASTM A641/641M and covered with 1-inch wire mesh netting conforming to ASTM A390. Cement conforming to MIL-C-2861 or fibrous-glass felt insulation conforming to MIL-I-16411 shall be used to fill crevices and completely cover the wire mesh netting to a ½-inch thickness.

c. The surface shall be smoothed using finishing cement conforming to ASTM C449. Fibrous-glass cloth lagging conforming to MIL-C-20079 shall be applied to the hard cement finish. A final coating of adhesive conforming to MIL-A-3316 shall be applied to the smooth lagged surface, soaking the lagging with adhesive completely over the entire surface. When the adhesive has completely dried, paint with one coat of fire-resistant coating conforming to MIL-PRF-24596 or MIL-DTL-24607.

5.4.9.1 Removable cover installation on auxiliary machinery, pumps, and equipment. For units of machinery or equipment, such as small pumps, where it would be impractical to install permanent insulation, the entire insulation may be made removable. The removable cover shall be constructed using the method specified (see 5.4.6).

5.4.10 Thermal insulation installation on unfired pressure vessels. Thermal insulation shall be installed on unfired pressure vessels as follows:

a. Unfired pressure vessels, including catapult wet accumulators, shall be insulated with thermal block insulation conforming to MIL-PRF-2819 or fibrous-glass felt conforming to MIL-I-16411 to the required thickness as specified in table X.

b. The insulation shall be held in place with 18-gauge, galvanized iron wire conforming to ASTM A641/641M, spaced on approximately 3-inch centers, or strapping conforming to ASTM D3953, spaced on 9-inch maximum centers.

c. The insulation shall be covered with a ½-inch layer of finishing cement conforming to ASTM C449 and lagged with fibrous-glass cloth conforming to MIL-C-20079 secured with adhesive conforming to MIL-A-3316. When the adhesive has completely dried, paint with one coat of fire-resistant coating conforming to MIL-PRF-24596 or MIL-DTL-24607.

5.4.10.1 Removable cover installation on unfired pressure vessels. Removable covers shall be installed over butt-welded shell inserts where periodic radiographic inspection of the joint is required. The covers shall extend at least 4 inches beyond the weld joint. The covers shall be constructed, lagged, and attached using the method specified (5.4.6).

5.4.11 Insulation installation on gas turbine exhaust and diesel exhaust ducts. The exhaust duct systems of certain class ships, such as FFG 7 and DDX, are externally insulated. Those of CG 47, DD 963, DDG 993, and DDG 51 class ships are internally insulated. All insulation shall be installed as specified (see 6.2). Requirements for externally insulated and internally insulated exhaust ducts are as follows:

a. Externally insulated exhaust ducts shall be insulated from their lower termination adjacent to the turbine exhaust flange coupling up to the 02 deck level with a 6-inch thickness of fibrous-glass insulation conforming to MIL-I-16411 or high temperature fire protection, thermal, and acoustic insulation conforming to MIL-PRF-32161. Four-inch thickness of insulation conforming to MIL-I-16411 or MIL-PRF-32161 shall be installed from the 02 deck line to the top of the stack. Insulation shall be secured with CRES Grade 316L pins of no less than 12 gauge, with a pin spacing not to exceed 12 inches on centers and secured with strapping conforming to ASTM D3953. All insulation shall be protected with a 1/16-inch thick steel system.

NOTE

For DDX and other ship classes where specified, wire mesh netting and insulating cement conforming to MIL-C-2861 shall not be required in unmanned uptake spaces. For DDX, supplemental vapor barrier material, such as VentureClad 1577CW, or equal as approved by NAVSEA, may be used to protect the exhaust ducting external insulation system material from degradation due to water exposure.

b. Internally insulated exhaust ducts shall be insulated with mineral wool conforming to MIL-PRF-2818. Prior to installation of insulation, all cavities including corners shall be completely filled with small pieces of MIL-PRF-2818 insulation to a firm consistency, with precautions taken to avoid the formation of voids. Mineral fiber blanket insulation with a minimum density not less than 8 pounds per cubit foot (lbs/ft^3) conforming to MIL-PRF-2818 shall be installed in a 4-inch thickness between stiffeners and encased in a glass cloth liner in a CRES wire mesh screen. The entire insulated area and stiffeners are wrapped with additional layers of mineral fiber blanket insulation conforming to MIL-PRF-2818 to meet the ship's specific thermal and acoustic requirements, and the insulation is protected on the gas flow side by a perforated metal plate. This insulation treatment is designed to meet Grade A shock requirements.

c. Diesel exhaust systems on submarines may require a transmission loss treatment (see 5.10) in addition to thermal insulation, in order to meet compartment airborne noise criteria.

5.4.11.1 Removable cover installation over the bolting area of access covers for exhaust ducts. Removable covers shall be installed over the bolting area of access covers on exhaust ducts. The inside surface of the removable cover shall be lagged with a NAVSEA approved mesh such as Inconel mesh, or equal as approved by NAVSEA, and the outside surface with fibrous-glass cloth conforming to MIL-C-20079. Insulation thickness requirements according to temperature table X. See 5.4.6 for details concerning the construction of removable covers.

5.5 Requirements for thermal insulation for ducts. Requirements for thermal insulation, adhesive, lagging, and fastener materials for ducts are as follows:

a. Insulation, thermal and acoustic absorptive, cellular polyimide foam conforming to MIL-DTL-24688, Type I and Type II, Classes 1, 3, and 4.

b. Insulation felt, thermal and sound absorbing, fibrous glass conforming to MIL-I-22023, Type I, Class 4, and Type III.

c. Insulation board, fibrous glass conforming to MIL-I-742, Type I and Type II.

d. Insulation, anti-sweat and refrigerant, thermal foam conforming to MIL-PRF-32514, Type III.

e. Cloth, glass; tape, textile glass; and thread, glass conforming to MIL-C-20079.

f. Adhesive, fire resistant conforming to MIL-A-3316, Class 1, Grade A.

g. Scrim reinforced foil tape such as Compac #110 FSK, or equal as approved by NAVSEA.

h. Coating compounds, thermal insulation, fire and water-resistant, vapor barrier conforming to MIL-PRF-19565, Type II.

i. Studs, welding and arc shields (ferrules), aluminum alloy conforming to MIL-S-24149/2, Type III, Class 3.

j. Studs, welding, carbon steel, for stored energy capacitor discharge arc welding conforming to MIL-S-24149/4, Type VI, Class 3.

k. Steel, corrosion resisting, #22, USSGA Cl 430, 2B finish conforming to ASTM A240/A240M.

5.5.1 Thermal insulation installation requirements for ducts. Requirements for installing thermal insulation on ducts shall be in accordance with 804-5773932 and as follows:

a. Round or flat oval ducts are generally insulated with 1-inch thick fibrous-glass insulation felt conforming to MIL-I-22023, Type I, Class 4 or polyimide foam conforming to MIL-DTL-24688, Type I or Type II, Classes 1, 3, and 4. However, the thickness of the insulation shall be as specified (see 6.2). It is to be noted that the fibrous-glass felt and polyimide foam have different acoustic and transmission loss properties and cannot be used interchangeably.

b. Square or rectangular ducts are generally insulated with 1-inch thick fibrous-glass insulation board conforming to MIL-I-742, Type I or II, or fibrous-glass felt conforming to MIL-I-22023, Type III, or 1-inch thick polyimide-foam panels conforming to MIL-DTL-24688, Type I or Type II, Classes 1, 3, and 4. However, the thickness of the insulation shall be as specified (see 6.2).

c. Ducts may be insulated with thermal cellular elastomeric insulation conforming to MIL-PRF-32514, Type III. The thickness of the insulation shall be as specified. In all cases, the adhesive used to install the insulation shall be equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, the same lagging system shall be used.

d. For wide ducts, self-adhesive-backed insulation pins, carbon steel conforming to MIL-S-24149, Type VI, Class 3 or aluminum alloy conforming to MIL-S-24149, Type III, Class 3 as applicable, and steel or aluminum caps (commercial), as applicable, may be used to hold insulation in place while the adhesive sets.

e. When un-faced fibrous-glass insulation felt conforming to MIL-I-22023, Type I, or un-faced polyimide-foam insulation conforming to MIL-DTL-24688, Type I is used, the insulation shall be covered with fibrous-glass cloth conforming to MIL-C-20079. The fibrous-glass cloth shall be secured and coated with adhesive conforming to MIL-A-3316, Class 1, Grade A. Alternatively, rewettable fibrous-glass cloth conforming to MIL-C-20079 may be used. The adhesive or rewettable fibrous-glass cloth shall be allowed to dry thoroughly before painting or adding a vapor barrier, if required.

f. Vapor barriers conforming to MIL-PRF-19565 shall be applied on all finished fiberglass cloth lagging surfaces, including flanges, seams, joints of insulated air-conditioning ducts, and trunks, except where insulation conforming to MIL-I-22023, Type III, and MIL-DTL-24688, Type II, Classes 3 and 4 are used.

g. After installation, the faced insulation shall be painted as specified (see 4.11) to match the other surfaces in the compartment.

h. Insulation, where required on watertight ducts, shall not be installed until specified compartment pressure tests have been completed.

i. Corrosion resisting steel sheathing conforming to ASTM A240/A240M, #22, USSGA Class 430, 2B finish shall be installed wherever necessary to protect the insulation from damage.

5.5.2 Installation procedures for thermal insulation on ducts. Installation procedures for thermal insulation on ducts shall be as follows for the following materials:

5.5.2.1 Polyimide insulation conforming to MIL-DTL-24688, type I and type II, classes 1, 3, and 4. Polyimide insulation conforming to MIL-DTL-24688, Type I un-faced panel; Type II, Class 1, panel faced with fiberglass cloth; Type II, Class 3 panel faced with aluminized polyester/aluminum foil; and Type II, Class 4 panel faced with aluminized polyester/aluminum foil with factory applied fibrous-glass cloth facing shall be applied as follows:

a. Adhesive conforming to MIL-A-3316, Class 2 or Class 3, Pelican 301 adhesive, or equal as approved by NAVSEA, shall be applied to the duct outer surface. The application of Pelican 301 adhesive shall be made around the perimeter of the duct and in a crisscross pattern across the middle of the duct. For wide ducts, self-adhesive backed insulation pins, such as carbon steel conforming to MIL-S-24149, Type VI, Class 3 and steel or aluminum caps (commercial), as applicable, may be used to hold insulation in place while the adhesive sets (see 5.5.1.d).

b. The polyimide panels conforming to MIL-DTL-24688 shall be applied to the adhesive coated duct.

c. If a polyimide panel conforming to MIL-DTL-24688, Type I un-faced or Type II, Class 3 faced with aluminized polyester/aluminum foil is used, a coat of adhesive conforming to MIL-A-3316, Class 1, Grade A shall be applied over the outer surface of the insulation and lagged with fibrous-glass cloth lagging conforming to MIL-C-20079, Type I. Another coat of adhesive conforming to MIL-A-3316, Class 1, Grade A shall be applied over the fibrous-glass cloth lagging conforming to MIL-C-20079, Type I and allowed to dry thoroughly before painting or applying a vapor barrier, if required. When required, a vapor barrier coating conforming to MIL-PRF-19565 shall be applied to the surface.

d. If polyimide insulation conforming to MIL-DTL-24688, Type II, Classes 1 and 4 is used, no additional fibrous-glass cloth lagging is required. However, all seams shall be covered with adhesive conforming to MIL-A-3316, Class 1, Grade A and 2-inch wide fibrous-glass cloth tape conforming to MIL-C-20079, Type II, Class 1. The adhesive shall be allowed to dry thoroughly before painting.

e. The insulation shall be painted in accordance with the requirements for ventilation ducting (see 4.11).

5.5.2.2 Fibrous-glass felt conforming to MIL-I-22023, type I and type III. Fibrous-glass felt conforming to MIL-I-22023, Type I un-faced, and Type III, with fiberglass scrim reinforced polyester facing shall be installed on ducts as follows:

a. Adhesive conforming to MIL-A-3316 shall be applied to the duct outer surface. For wide ducts, self-adhesive backed insulation pins such as carbon steel conforming to MIL-S-24149, Type VI, Class 3 and steel or aluminum caps (commercial), as applicable, may be used to hold insulation in place while the adhesive sets (see 5.5.1.d).

b. Fibrous-glass felt conforming to MIL-I-22023 shall be wrapped around the adhesive coated duct.

c. A coat of adhesive conforming to MIL-A-3316, Class 1, Grade A shall be applied over the outer surface of the fibrous-glass felt conforming to MIL-I-22023, Type I and lagged with fibrous-glass cloth lagging conforming to MIL-C-20079. Another coat of adhesive conforming to MIL-A-3316, Class 1, Grade A shall be applied over the fibrous-glass cloth lagging conforming to MIL-C-20079, Type I and allowed to dry thoroughly before painting or applying a vapor barrier, if required. When required, a vapor barrier coating conforming to MIL-PRF-19565 shall be applied to the surface.

d. When fibrous-glass felt conforming to MIL-I-22023, Type III is used, no additional fibrous-glass cloth lagging is required. However, all seams shall be covered with adhesive conforming to MIL-A-3316, Class 1, Grade A and 2-inch wide fibrous-glass cloth tape conforming to MIL-C-20079, Type II, Class 1. The adhesive shall be allowed to dry thoroughly before painting.

e. The insulation shall be painted in accordance with the requirements for ventilation ducting (see 4.11).

5.5.2.3 Fibrous-glass board conforming to MIL-I-742, type I and type II. Fibrous-glass board conforming to MIL-I-742, Type I faced with fibrous-glass cloth and Type II, un-faced fibrous-glass board shall be installed on ducts as follows:

a. Adhesive conforming to MIL-A-3316 shall be applied to the duct outer surface. For wide ducts, self-adhesive backed insulation pins such as carbon steel conforming to MIL-S-24149, Type VI, Class 3 and steel or aluminum caps (commercial), as applicable, may be used to hold insulation in place while the adhesive sets (see 5.5.1.d).

b. The fibrous-glass board conforming to MIL-I-742 shall be fit in place and applied to the adhesive coated duct.

c. When fibrous-glass board conforming to MIL-I-742, Type I is used, no additional fibrous-glass cloth lagging is required. However, all seams shall be covered with adhesive conforming to MIL-A-3316, Class 1, Grade A and 2-inch wide fibrous-glass cloth tape conforming to MIL-C-20079, Type II, Class 1. The adhesive shall be allowed to dry thoroughly before painting or applying a vapor barrier, if required. When required, a vapor barrier coating conforming to MIL-PRF-19565 shall be applied to the surface.

d. When fibrous-glass board conforming to MIL-I-742, Type II is used, a coat of adhesive conforming to MIL-A-3316, Class 1, Grade A shall be applied over the outer surface of the insulation and lagged with fibrous-glass cloth conforming to MIL-C-20079, Type I. Another coat of adhesive conforming to MIL-A-3316, Class 1, Grade A shall be applied over the fibrous-glass cloth lagging conforming to MIL-C-20079, Type I and allowed to dry thoroughly before painting or applying a vapor barrier, if required. When required, vapor barrier coating conforming to MIL-PRF-19565 shall be applied to the surface.

e. The insulation shall be painted in accordance with the requirements for ventilation ducting (see 4.11).

5.5.2.4 Thermal cellular elastomeric insulation conforming to MIL-PRF-32514, type III. Thermal cellular elastomeric insulation conforming to MIL-PRF-32514, Type III shall be installed on ducts as follows:

a. Adhesive conforming to MIL-A-24179 shall be applied to the duct outer surface.

b. Insulation conforming to MIL-PRF-32514, Type III shall be wrapped around the adhesive coated duct.

c. Adhesive conforming to MIL-A-24179 shall be applied to all butt force joints and seams.

d. A coat of adhesive conforming to MIL-A-3316, Class 1, Grade A shall be applied over the outer surface of the insulation and lagged with fibrous-glass cloth conforming to MIL-C-20079, Type I. Another coat of adhesive conforming to MIL-A-3316, Class 1, Grade A shall be applied over the fibrous-glass cloth lagging conforming to MIL-C-20079, Type I and allowed to dry thoroughly before painting. In all cases, the adhesive used to install the insulation shall be equivalent to that used to qualify the insulation in accordance with MIL-PRF-32514. If the material also required the use of a lagging system to qualify to this test, the same lagging system shall be used.

e. The insulation shall be painted in accordance with the requirements for ventilation ducting (see 4.11).

5.5.2.5 Insulation installation on ventilation heaters. Insulation shall be installed on ventilation heaters as follows:

a. Fibrous-glass board conforming to MIL-I-742, Type I shall be cut in panels to fit all surfaces except the standing flanges, beveling the edges of the panels at 45 degrees to permit access to the bolts in the flanges.

b. The surfaces to be insulated shall be coated with adhesive conforming to MIL-A-3316 and the panels fit to the coated surfaces, applying sufficient pressure to ensure adherence of the panel to the surface.

c. The fibrous-glass board panels shall be taped with 2-inch wide fibrous-glass tape conforming to MIL-C-20079, Type II, Class 1, applied with adhesive conforming to MIL-A-3316. To assist in holding the panels in place and to cover the exposed fibrous-glass, the beveled boundaries of the panels shall be covered with 4-inch wide fibrous-glass tape conforming to MIL-C-20079, Type II, Class 1, leaving a ¾-inch lap on the standing flange. Fibrous-glass-faced fibrous-glass board conforming to MIL-I-742, Type I faced does not require additional lagging.

d. Casings of cooling coils may be insulated at the factory. Where the insulation has not been installed before delivery, the casings shall be insulated as specified above for heaters.

5.5.2.6 Insulation installation on duct flanges. Duct flanges shall be insulated using one of the following methods:

5.5.2.6.1 Flange covers constructed of fibrous-glass felt insulation conforming to MIL-I-16411. An insulation flange cover of fibrous-glass felt conforming to MIL-I-16411 shall be constructed as follows:

a. The flange area shall be wiped to ensure that the flange is clean and dry.

b. 1-inch thick fibrous-glass felt conforming to MIL-I-16411shall be measured and cut so that it shall fit snuggly around entire flange area.

c. Fibrous-glass felt conforming to MIL-I-16411 shall be covered with fibrous-glass cloth conforming to MIL-C-20079.

d. The cover components shall be secured on the inside with stainless steel or galvanized C-ring staples or fasteners.

e. Lacing hooks or rings shall be punched and washers shall be placed through the ends of the cover. An 18-gauge lacing wire shall be pulled through and secured at the ends of the cover to fit it around the flange. The lacing wire shall be run through the length of the cover on both sides before securing around the flange.

f. The cover shall be wrapped around the flange and secured in place. The lacing wire shall be crossed across the top of the cover through the lacing hooks or rings and washers and tightened so the cover fits snuggly.

g. The entire exterior of the cover constructed of fibrous-glass cloth conforming to MIL-C-20079 shall be coated with adhesive conforming to MIL-A-3316 and allowed to dry thoroughly.

h. At least one coat of vapor barrier conforming to MIL-C-19565 shall be applied over the fibrous-glass cloth cover and allowed to dry thoroughly.

i. One coat of paint conforming to MIL-PRF-24596 or MIL-DTL-24607 shall be applied over the fibrous-glass cloth cover.

5.5.2.6.2 Flange covers constructed of fibrous-glass board conforming to MIL-I-742, type I or type II. An insulation flange cover of fibrous-glass board conforming to MIL-I-742, Type I or Type II shall be constructed as follows:

a. The flange area shall be wiped to ensure the flange is clean and dry.

b. A 1-inch thick fibrous-glass board conforming to MIL-I-742, Type I or Type II shall be measured and cut with a straight edge knife so that the insulation is cut beyond the width of the side of the flange and the length of the circumference of the flange to cover the flange completely.

c. One strip of 1-inch thick fibrous-glass insulation board conforming to MIL-I-742 shall be placed on either side of the flange and then a larger piece of fibrous-glass insulation board conforming to MIL-I-742 shall be placed over these strips and the flange. The entire flange area shall be covered with the fibrous-glass insulation board conforming to MIL-I-742. If using the fibrous-glass-faced fibrous-glass insulation board conforming to MIL-I-742, Type I, the faced side shall be facing out.

d. The edges of the board shall be taped down using 3-inch wide scrim reinforced foil tape, such as Compac #110 FSK, or equal as approved by NAVSEA, so that the flange area is secure and a tight seal is ensured.

e. The entire exterior of the fibrous-glass board conforming to MIL-I-742 shall be coated with adhesive conforming to MIL-A-3316 and covered with fibrous-glass cloth conforming to MIL-C-20079.

f. The entire exterior of the cover constructed of fibrous-glass cloth conforming to MIL-C-20079 shall be coated with adhesive conforming to MIL-A-3316 and allowed to dry thoroughly.

g. At least one coat of vapor barrier conforming to MIL-C-19565 shall be applied over the fibrous-glass cloth cover and allowed to dry thoroughly.

h. One coat of paint conforming to MIL-PRF-24596 or MIL-DTL-24607 shall be applied over the fibrous-glass cloth cover.

5.5.2.6.3 Flange covers constructed of polyimide insulation conforming to MIL-DTL-24688, type II, classes 1, 3, and 4. An insulation flange cover of polyimide insulation conforming to MIL-DTL-24688, Type II, Class 1, faced with fibrous-glass cloth; Type II, Class 3 faced with aluminized polyester/aluminum foil; and Type II, Class 4 faced with aluminized polyester/aluminum foil with factory applied fibrous-glass cloth shall be constructed as follows:

a. The flange area shall be wiped to ensure the flange is clean and dry.

b. A 1-inch thick polyimide insulation conforming to MIL-DTL-24688, Type II, Classes 1, 3, or 4 shall be measured and cut with a straight edge knife so that the insulation is cut beyond the width of the side of the flange and the length of the circumference of the flange to cover the flange completely.

c. One strip of 1-inch thick insulation conforming to MIL-DTL-24688, Type II, Classes 1, 3, or 4 shall be placed on either side of the flange and a larger piece of insulation conforming to MIL-DTL-24688 shall be placed over these strips and the flange. The entire flange area shall be covered with the polyimide board conforming to MIL-DTL-24688. The faced side of insulation conforming to MIL-DTL-24688 shall be facing out (see figure 21).

d. The edges of the board shall be taped down using 3-inch wide scrim reinforced foil tape, such as Compac #110 FSK, or equal as approved by NAVSEA, so that the flange area is secure and a tight seal is ensured (see figure 21).

e. The entire exterior of the polyimide board conforming to MIL-DTL-24688 shall be coated with adhesive conforming to MIL-A-3316 and shall be covered with fibrous-glass cloth conforming to MIL-C-20079.

f. When polyimide panel conforming to MIL-DTL-24688, Type II, Class 1 faced with fibrous-glass cloth is used, at least one coat of vapor barrier conforming to MIL-C-19565 shall be applied over the fibrous-glass cloth facing and allowed to dry thoroughly.

g. When polyimide panel conforming to MIL-DTL-24688, Type II, Class 3 faced with aluminized polyester/aluminum foil or Type II, Class 4 faced with aluminized polyester/aluminum foil with factory applied fibrous-glass cloth are used, a vapor barrier coating shall not be required.

h. The entire exterior of the fibrous-glass cloth cover shall be coated with adhesive conforming to MIL-A-3316 and allowed to dry thoroughly.

i. One coat of paint conforming to MIL-PRF-24596 or MIL-DTL-24607 shall be applied over the fibrous-glass cloth cover.

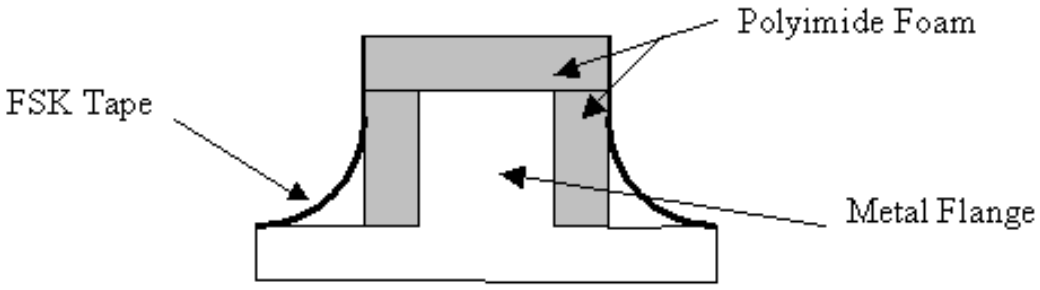

FIGURE 21. Polyimide flange cover.

5.5.3 Maintenance of duct insulation. If the fibrous-glass or polyimide-foam insulation is damaged, it shall be cut out and the damaged area shall be removed and replaced with new insulation following the specified installation procedures (see 5.5.2).

5.6 Requirements for acoustic lining insulation for ducts. Requirements for acoustic insulation, adhesive, lagging, sheathing, and fastener materials for acoustic lining of ducts shall be as follows:

a. Insulation felt, thermal and sound absorbing, fibrous glass conforming to MIL-I-22023, Type II, Class 3 or Type III.

b. Insulation, acoustic absorptive, cellular polyimide foam conforming to MIL-DTL-24688, Type II, Class 2.

c. Acoustic absorptive board, fibrous-glass perforated fibrous-glass cloth faced, conforming to MIL-A-23054.

d. Adhesive, fire resistant, conforming to MIL-A-3316, Class 1, Grade A or Class 2, Grade A.

e. 0.04-inch thick aluminum, perforated with 3⁄16-inch-diameter holes on 3⁄8-inch centers, conforming to ASTM B209, Alloy 5052, or SAE-AMS-QQ-A-250/8.

f. Cloth, glass and tape, textile glass conforming to MIL-C-20079.

g. Fibrous-glass scrim reinforced polyester vapor film conforming to MIL-Y-1140, Form 4, Class C, fibrous-glass scrim laminated to 0.5 mil polyester film.

h. Duct tape, NSN 5640-00-103-2254.

5.6.1 Acoustic insulation lining requirements for ducts. Requirements for lining ducts with acoustic insulation shall be as follows:

a. The standard acoustic duct lining consists of sound-absorbing blanket protected by a perforated metal liner or a sound-absorbing board with a factory bonded perforated facing.

b. For round or flat oval ducts, the acoustic lining shall consist of a fibrous-glass blanket conforming to MIL-I-22023 Type II, Class 3 or Type III; or a polyimide-foam panel conforming to MIL-DTL-24688, Type II, Class 2.

c. For rectangular ducts, the acoustic lining shall consist of a fibrous-glass blanket conforming to MIL-I-22023, Type II, Class 3 or Type III; a perforated hard surface fibrous-glass acoustical absorption board conforming to MIL-A-23054; or a polyimide-foam panel conforming to MIL-DTL-24688, Type II, Class 2.

d. For most applications, acoustic insulation lining shall be installed by first bending and riveting a sheet of perforated aluminum conforming to ASTM B209, to form a liner sheathing of the desired size and shape. Next, a 0.5 mil polyester vapor barrier film reinforced with fibrous-glass scrim shall be wrapped around the perforated metal liner, if required. An acoustic insulation blanket conforming to MIL-I-22023, shall be wrapped around the perforated metal liner and secured temporarily with tape. This assembly shall be inserted into the end of the duct section.

e. The perforated metal liner shall be 0.04-inch thick aluminum, perforated with 3⁄16-inch-diameter holes on 3⁄8-inch centers, conforming to ASTM B209, Alloy 5052, or SAE-AMS-QQ-A-250/8.

f. Adhesive conforming to MIL-A-3316, Class 1, Grade A shall be used for bonding fibrous-glass cloth to un-faced fibrous-glass insulation or un-faced polyimide-foam insulation. It shall also be used for sealing the edges of, and bonding fibrous-glass tape to, the joints of fibrous-glass board and polyimide-foam panels.

g. Adhesive conforming to MIL-A-3316, Class 2, Grade A shall be used to attach fibrous-glass and polyimide-foam insulation to metal surfaces.

h. Fibrous-glass cloth conforming to MIL-C-20079, Type I, Class 3 shall be used as lagging cloth and facing cloth for the fibrous-glass and polyimide-foam insulation.

i. Fibrous-glass tape conforming to MIL-C-20079, Type II, Class 1 shall be used to seal joints between faced fibrous-glass boards and un-faced fibrous-glass blankets as well as faced polyimide-foam panels conforming to MIL-DTL-24688.

5.6.2 Installation of acoustic insulation lining in ducts. Acoustic insulation lining shall be installed in ducts, where required, in accordance with the details shown on 804-5773932 and as follows:

a. Acoustic insulation lining shall be installed homogeneously throughout an entire duct section. When specified (see 6.2), only a portion of the duct run shall be lined.

b. Acoustic insulation lining shall be installed in one of the three basic duct shapes (round, rectangular, or flat oval) in a similar manner.

c. The fibrous-glass conforming to MIL-I-22023 or polyimide foam conforming to MIL-DTL-24688 shall be secured between the perforated metal liner conforming to ASTM B209 and the duct wall by a rivet connection between the perforated metal liner and the duct, at the ends of the duct. The treatment for rectangular duct sections shall be as specified on figure 22. The treatment for round or oval duct sections shall be as specified on figure 23.

d. An internal vapor barrier shall be installed where the ducting draws air that might become contaminated with oil, grease, or dirt in aerosol form, or very high levels of humidity. Where an internal vapor barrier is required, the perforated metal liner conforming to ASTM B209 shall be wrapped with thermal and acoustical insulation conforming to MIL-I-22023, Type III. Alternatively, the ASTM B209 perforated metal liner shall be wrapped with a layer of 0.5-mil polyester vapor barrier film reinforced with a fibrous-glass scrim and a layer of fibrous-glass blanket type insulation conforming to MIL-I-22023, Type II, Class 3.

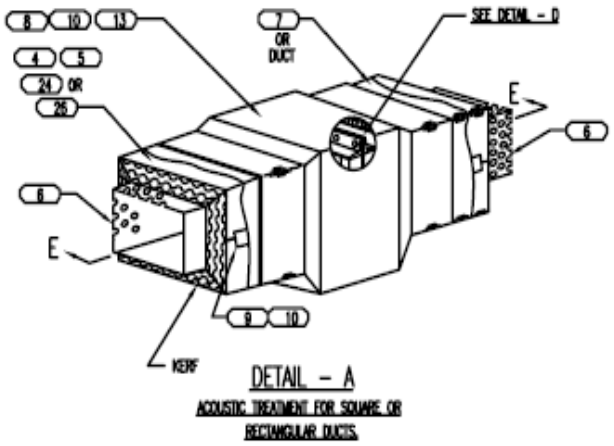

FIGURE 22. Typical acoustic insulation for rectangular ducts.

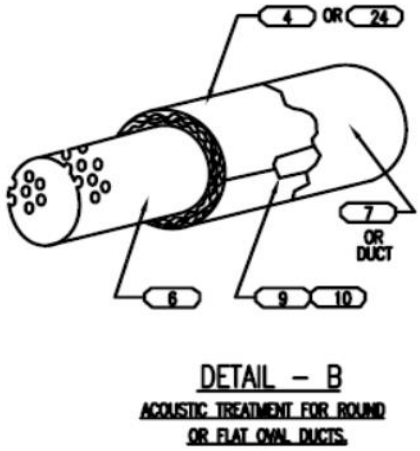

FIGURE 23. Typical acoustic insulation for round or oval ducts.

e. The acoustic insulation lining shall be faired into a flange that is used to connect the individual duct sections (see figure 24).

f. Any overlapping of perforated metal liner conforming to ASTM B209 shall be lapped in the direction of airflow to eliminate sharp edges that may produce non-laminar flow, resulting in aerodynamic noise.

g. The individual duct sections shall be flanged and bolted together. A gasket shall be inserted between the flanges and arranged so that the gasket does not protrude into the air-stream.

h. The interface of two duct sections shall be an interface between acoustic-to-acoustic insulated sections or acoustic-to-thermal insulated sections, as shown on figure 25.

i. Fibrous-glass blanket thermal insulation conforming to MIL-I-22023 or polyimide insulation conforming to MIL-DTL-24688, covered with fibrous-glass lagging cloth conforming to MIL-C-20079, and adhesive conforming to MIL-A-3316, shall be used to construct the cover at the flange (see figure 25).

j. In certain circumstances, a partial treatment may be required within a duct section. If a partial treatment is required, the insulation material shall be faired to the duct as shown on figure 26.

k. Installations of materials around bolted access covers shall be as shown on figure 27.

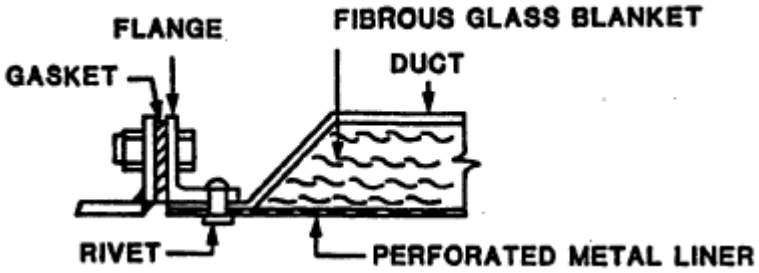

FIGURE 24. Typical flange connection.

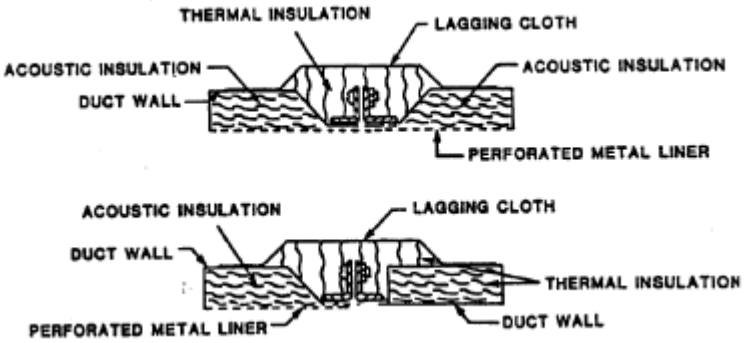

FIGURE 25. Treatment between insulated flanges, acoustic-to-thermal insulation (bottom), acoustic-to-acoustic insulation (top).

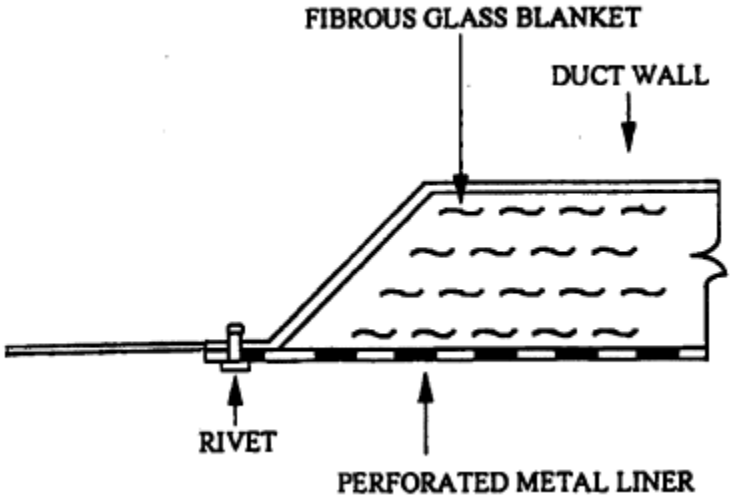

FIGURE 26. Insulation fairing detail for partial treatment of duct.

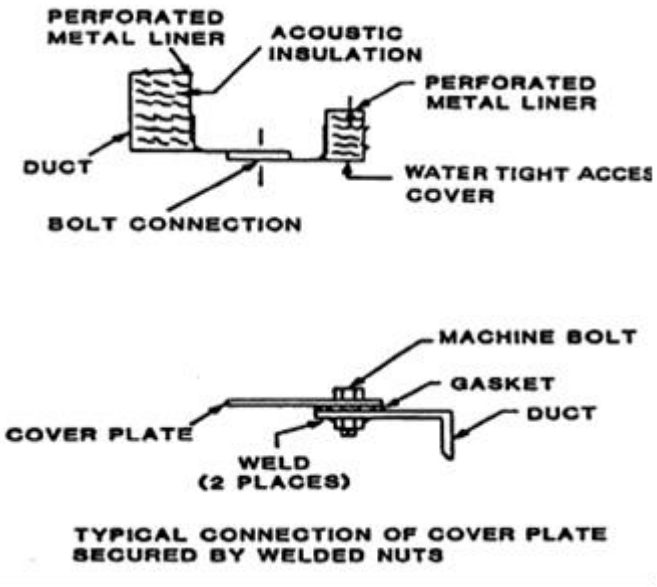

FIGURE 27. Typical installation around bolted access cover.

5.6.3 Installation of acoustic insulation lining in rectangular ducts with low air velocities (less than 2000 feet per minute). Acoustic insulation lining shall be installed in rectangular air ducts with low velocities as follows:

a. The inner surfaces of the duct shall be coated with adhesive conforming to MIL-A-3316, Class 2, Grade A.

b. Pre-cut pieces of perforated acoustic board conforming to MIL-A-23054 shall be attached to the adhesive conforming to MIL-A-3316 coated inner surface of the duct. The acoustic board shall be arranged so that the perforated fibrous-glass cloth facing is exposed to the airflow.

5.7 Requirements for acoustic transmission loss treatment for ducts. Requirements for acoustic transmission loss treatment materials for ducts shall consist of the following:

a. The acoustic materials (see 5.6) shall be used in acoustic transmission loss treatment components, in addition to the components listed below. Lead-loaded vinyl materials are prohibited and shall not be used.

b. Barium sulfate-loaded vinyl conforming to MIL-PRF-24699, or barium sulfate-loaded silicone of equal area density, such as Marine Coustifab, or equal as approved by NAVSEA.

c. Sheathing, USSG No. 22 (minimum) conforming to ASTM A240/A240M, Type 304, No. 2B finish or other, such as galvanized sheet steel, USSG No. 22 (minimum), and galvanized sheet steel conforming to ASTM A653/653M, coating designation G 115.

d. Sheathing, 0.04-inch thick aluminum, perforated with 3⁄16-inch-diameter holes on 3⁄8-inch centers, Alloy 5052, conforming to ASTM B209 or SAE-AMS-QQ-A-250/8. For submarine applications, use 0.05-inch thick aluminum, perforated with 3⁄16-inch-diameter holes on 3⁄8-inch centers, Alloy 5052, or conforming to SAE-AMS-QQ-A-250/8.

e. Vapor barrier coating conforming to MIL-C-19565, for use on fibrous-glass cloth facing or lagging cloth of fibrous-glass insulation.

f. Silicone rubber room temperature vulcanizing (RTV) low outgassing materials conforming to ASTM D6411/D6411M.

5.7.1 Acoustic transmission loss requirements for ducts. Requirements for the use of transmission loss treatments on ducts shall be as follows:

a. Acoustic insulation transmission loss treatments shall attenuate the transmission of sound through duct walls.

b. Acoustic insulation transmission loss treatments shall be applied to ducts with high internal noise levels when they penetrate noise critical spaces.

c. When specified (see 6.2), acoustic insulation transmission loss treatments shall be applied to ducts that pass through extremely noisy spaces. This is required to prevent high-level noise from being propagated to other compartments via the duct system.

d. Two standard treatments, double wall and barium sulfate-loaded vinyl or silicone septum lagged, shall be used.

5.7.2 Acoustic transmission loss treatment installation for ducts. Acoustic transmission loss insulation treatment shall be installed on ducts, where required, in accordance with details shown on 804-5773932. Acoustic transmission loss insulation installation consists of two standard treatments: double wall and barium sulfate-loaded vinyl or barium sulfate-loaded silicone. The effectiveness of both acoustic insulation treatments is dependent upon complete sealing of all sound transmission paths. All seams in the transmission loss treatment shall be sealed with tape. Any penetration, such as studs, shall be sealed with sealing compound conforming to ASTM D6411/D6411M. The installation procedures for the two treatments shall be as follows:

5.7.2.1 Double wall treatment. Double wall treatment shall consist of the following:

a. Adhesive conforming to MIL-A-3316 shall be applied to the duct outer surface. For wide ducts, self-adhesive backed insulation pins, carbon steel conforming to MIL-S-24149, Type VI, Class 3, and steel or aluminum caps (commercial), as applicable, shall be used to hold insulation in place while the adhesive sets (see 5.5.1.d).

b. A fibrous-glass board conforming to MIL-I-742, Type I; scrim reinforced polyester-faced fibrous glass conforming to MIL-I-22023, Type III; or polyimide insulation conforming to MIL-DTL-24688, Type II, Class 1 shall be applied and fit into place to the adhesive coated duct as shown on figure 28.

c. All seams shall be covered with adhesive conforming to MIL-A-3316, Class 1, Grade A and 2-inch wide fibrous-glass cloth tape conforming to MIL-C-20079, Type II, Class 1.

d. When a fibrous-glass board conforming to MIL-I-742, Type I or polyimide board conforming to MIL-DTL-24688, Type II, Class 1 is used, at least one coat of vapor barrier coating conforming to MIL-C-19565 shall be applied.

e. An outer duct wall shall be fabricated from either corrosion resistant steel conforming to ASTM A240/A240M, CRES, #22, USSGA Cl 430, 2B finish, or an aluminum sheet conforming to ASTM B209, and formed around the insulated duct. All seams shall be caulked or gasketed at the joints.

f. Inner and outer duct wall structural flanking paths shall be avoided by isolating inner and outer duct sections and hangers.

5.7.2.2 Barium sulfate-loaded vinyl conforming to MIL-PRF-24699 or barium sulfate-loaded silicone of equal area density. Barium sulfate-loaded vinyl conforming to MIL-PRF-24699 or barium sulfate-loaded silicone of equal area density shall be installed as follows:

a. A perforated metal liner conforming to ASTM B209, 0.04-inch thick aluminum, perforated with 3/16-inch-diameter holes on 3/8-inch centers, Alloy 5052, or SAE-AMS-QQ-A-250/8, shall be formed to the desired shape and size and secured with rivets to preserve its shape. For submarine applications, a 0.05-inch thick aluminum conforming to ASTM B209, perforated with 3/16-inch-diameter holes on 3/8-inch centers, Alloy 5052, or SAE-AMS-QQ-A-250/8 shall be used.

b. Where internal vapor barrier protection is required, the perforated metal liner shall be wrapped with a layer of 0.5-mil polyester vapor barrier film reinforced with a fibrous-glass scrim prior to installing the insulation.

c. The perforated metal liner shall be wrapped with a fibrous-glass blanket conforming to MIL-I-22023, Type II, Class 3 or polyimide board conforming to MIL-DTL-24688, Type II, Class 1.

d. The acoustic insulation shall be butt-jointed and taped. All seams shall be covered with adhesive conforming to MIL-A-3316, Class 1, Grade A and 2-inch wide fibrous-glass cloth tape conforming to MIL-C-20079, Type II, Class 1.

e. The insulation wrapped perforated metal liner shall be inserted into the duct.

f. The barium sulfate-loaded vinyl conforming to MIL-PRF-24699 or barium sulfate-loaded silicone treatment shall be applied to the outside of the duct, as shown on figure 29. The loaded vinyl or silicone layer shall be wrapped with overlapping seams to prevent flanking path degradation. A 2- to 4-inch overlap is commonly used.

g. The entire exterior of the barium sulfate-loaded vinyl conforming to MIL-PRF-24699 or barium sulfate-loaded silicone treatment shall be coated with adhesive conforming to MIL-A-3316 and covered with fibrous-glass cloth conforming to MIL-C-20079.

h. At least one coat of vapor barrier conforming to MIL-C-19565 shall be applied over the fibrous-glass cloth cover conforming to MIL-C-20079 and allowed to dry thoroughly.

i. Paint shall be applied in accordance with the requirements for ventilation ducting (see 4.11).

WARNING

Acoustic insulation treatments are severely compromised by structural flanking paths and void areas between material layers. Therefore, new treatment sections shall be inspected for flanking paths at the joint sections and between double duct walls. The acoustic materials shall also be inspected for damage and contamination by dust, water, or oily grime.

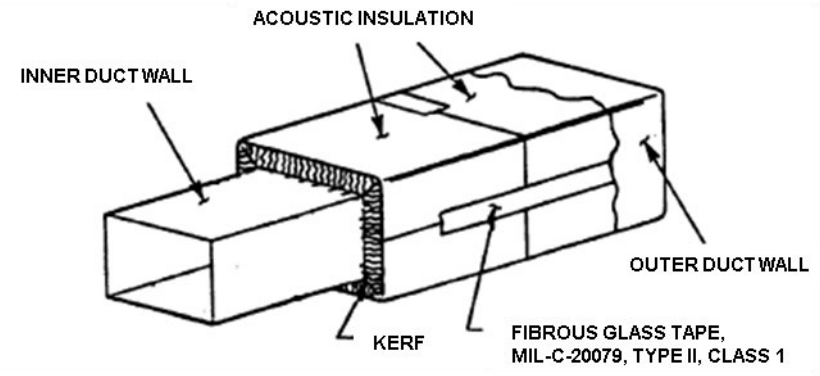

FIGURE 28. Double-wall transmission loss treatment.

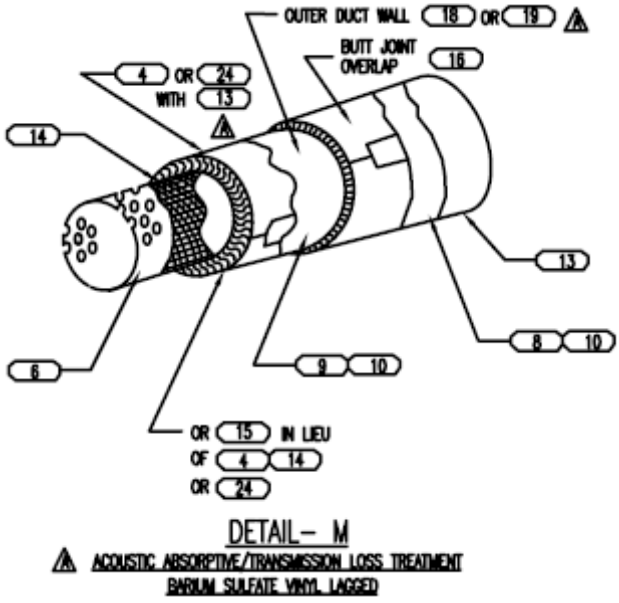

FIGURE 29. Barium sulfate-loaded vinyl or silicone transmission loss treatment.

5.8 Requirements for anti-sweat hull insulation materials for submarines. Anti-sweat hull insulation for submarines shall consist of the following materials:

a. There are two types of fire resistant, anti-sweat submarine hull insulation materials, as follows:

(1) Polyimide foam, such as Type CC306-KCF, or equal as approved by NAVSEA.

(2) Fibrous glass, such as Type HIMS, or equal as approved by NAVSEA.

b. Adhesive, flexible unicellular plastic thermal insulation, conforming to MIL-A-24179 and as specified (see 5.1.d), shall be used for securing fire-resistant, anti-sweat submarine hull insulation material to itself and to metals (see 5.8.a(1) and 5.8.a(2)).

c. Double sided acrylic adhesive pressure sensitive tape, such as 3M's Y9485, or equal as approved by NAVSEA.

d. Adhesive, seam tape, fire-resistant, Class 1, Grade A, conforming to MIL-A-3316.

e. Seam tape, cloth, glass and tape, textile glass conforming to MIL-C-20079.

5.8.1 Requirements for anti-sweat hull insulation for submarines. Beginning with the SSN 21 Class, the authorized materials for submarine hull insulation shall be fire-resistant, anti-sweat submarine hull insulation materials (see 5.8.a(1) and 5.8.a(2)). However, prior to SSN 21 Class PVC/nitrile foam rubber conforming to MIL-P-15280 was used for anit-sweat hull insulation.

NOTE

On older ships prior to SSN 21 Class, PVC/nitrile foam rubber conforming to MIL-P-15280 was used for anti-sweat hull insulation. However, foam conforming to MIL-P-15280 is no longer specified or used as repair or replacement material. When the foam conforming to MIL-P-15280 is to be replaced or repaired, fire-resistant, anti-sweat submarine hull insulation materials shall be used for the replacement and repair (see 5.8.a(1) and 5.8.a(2)). Thickness shall be the same as that specified for MIL-P-15280. One-inch thick material shall be applied to the pressure hull and webs of internal frames. One-half-inch thick material shall be applied to flanges of the internal frames.

5.8.2 Preparation of hull for installation of anti-sweat hull insulation on submarines. The hull and structural surfaces shall be prepared and painted in accordance with Standard Item 009-32, as applicable.

5.8.2.1 Installation of anti-sweat hull insulation materials on submarines. Installation of fire-resistant, anti-sweat submarine hull insulation materials (see 5.8.a(1) and 5.8.a(2)) shall be as follows:

a. The fire-resistant, anti-sweat submarine hull insulation (see 5.8.a(1) and 5.8.a(2)) shall be cut to the desired sizes and shapes. Each insulation piece shall be cut to fit around penetrations and framing members. The insulation shall be cut to the desired sizes and the cut edges shall be coated with adhesive conforming to MIL-A-24179 (see 5.1.d).

b. The insulation and the surfaces to be insulated, including cut edges, shall be coated with adhesive conforming to MIL-A-24179 (see 5.1.d), and allowed to air dry to become tacky, in accordance with manufacturer's directions. When tacky, the insulation shall be pressed into place.

c. Tape adhesive 3M Y9485, or equal as approved by NAVSEA, may be used as an alternative to adhesive conforming to MIL-A-24179. The tape adhesive shall be applied to the insulation panels around the entire perimeter, and with a minimum of 50 percent coverage overall, at least 3 days prior to installation of panels on the hull. This provides time for the tape to achieve optimum tack. Care shall be exercised to avoid crushing the insulation during application of the tape adhesive. The ambient temperature shall be maintained within manufacturer-recommended limits throughout application and the set-up period. Adhesive tape shall be applied to both pieces of polyimide insulation in way of faying surfaces to itself at butts and corners.

d. The pre-cut insulation panels shall be applied in flat-frame bay areas first, then wrapped around the T-frame ends. Insulation pieces shall then be inserted on frame webs.

e. Panels shall be allowed to air dry for at least 6 hours.

f. All joints (seams) and penetration edges shall be covered with fibrous-glass tape conforming to MIL-C-20079, Type II, Class 1, applied with adhesive conforming to MIL-A-3316, and allowed to dry thoroughly. The tape conforming to MIL-C-20079 shall be applied as follows:

(1) Apply a brush coat of adhesive conforming to MIL-A-3316 to the area to be taped.

(2) While the adhesive conforming to MIL-A-3316 is still wet, imbed the fibrous-glass tape into the adhesive.

(3) Apply a second brush coat of adhesive conforming to MIL-A-3316 over the fibrous-glass tape and allow the adhesive to dry.

g. After the adhesive conforming to MIL-A-3316 has dried, vapor barrier coating in accordance with MIL-PRF-19565 shall be applied over all taped areas.

h. After the vapor barrier coating has dried, two coats of water-based paint conforming to MIL-PRF-24596, Type I shall be applied over all tape and insulation surfaces, taking special care with the taped areas. Paint may be tinted to match surroundings.

5.8.3 Insulation of submarine tank tops to prevent condensation. When authorized, submarine tank tops that form part of a deck or walking flat in air-conditioned spaces shall have special treatment to prevent condensation. A 1-inch thick fibrous-glass blanket conforming to MIL-I-22023 shall be installed and compressed with a ¼-inch steel plate supported from the tank top by thermally isolated connections. The area between shall be airtight. The overall thickness shall be approximately 1 inch.

NOTE

On older ships prior to SSN 21 Class, PVC/nitrile foam rubber conforming to MIL-P-15280 and polyphosphazene were used on tank tops in non-walking areas. All repairs and replacement of this material in non-walking areas only shall be made using fire-resistant, anti-sweat submarine hull insulation material (see 5.8.a(1) and 5.8.a(2)).

5.8.4 Maintenance of anti-sweat hull insulation. Anti-sweat hull insulation shall be maintained as follows:

a. Anti-sweat hull insulation shall be inspected at least at semiannual intervals together with other portions of the hull structure. Areas behind insulation on weather and sea boundaries of ships operating in cold waters (below 40 °F) in ammunition spaces, where condensation is likely to occur, shall be inspected during overhauls to ensure that corrosion has not occurred on the ship structure. All damage, including that considered minor, shall be repaired with the materials specified (see 5.8).

b. In case of water damage, hull insulation shall be replaced with the materials specified (see 5.8), using the specified procedure(see 5.8.2.1), and as follows:

(1) Damaged insulation shall be cut out and removed.

(2) Adhered fragments of insulation shall be removed by scraping. The structure does not need to be cleaned to bare metal, except in way of newly welded attachments, where loose slag or other surface contaminants may be present.

(3) The replacement insulation shall be cut to ensure a neat fit with abutting insulation.

(4) The installation and painting of replacement fire-resistant, anti-sweat submarine hull insulation materials (see 5.8.a(1) and 5.8.a(2)) shall be as specified (see 5.8.2.1).

5.9 Requirements for thermal insulation for compartments. Thermal insulation for compartments shall consist of the following insulation, adhesive, tape, and attachment materials:

a. Fibrous-glass faced thermal insulation board conforming to MIL-I-742, Type 1.

b. Fibrous-glass un-faced thermal felt conforming to MIL-I-22023, Type I, Class 6.

c. Polyimide-foam faced thermal insulation panel conforming to MIL-DTL-24688, Type II, Class 1.

d. Insulation, anti-sweat and refrigerant, thermal foam, conforming to MIL-PRF-32514.

e. Plastic laminates, fibrous-glass reinforced, marine structural, conforming to MIL-P-17549.

f. Resins, polyester, low pressure laminating, fire retardant, conforming to MIL-R-21607.

g. Sheathing conforming to ASTM B209, Alloy 5052, or SAE-AMS-QQ-A-250/8.

h. Cloth, glass; tape, textile glass; and thread, glass conforming to MIL-C-20079.

i. Latex adhesive conforming to MIL-A-3316, Class I, Grade A.

j. Epoxy adhesive conforming to MIL-A-24456.

k. Aluminum alloy stud with compatible aluminum press fit cap as shown on 804-5773931 conforming to MIL-S-24149/2, Type III, Class 3 or MIL-S-24149/5, Type VII, Class 3 (DC/stored energy shot studs).

l. Carbon steel stud, with compatible carbon steel press-fit cap conforming to MIL-S-24149/1, Type VI, Class 3 or MIL-S-24149/5, Type VII, Class 3 (DC/stored energy shot studs).

m. Aluminum alloy or steel spacers.

n. Adhesive-attached studs, in accordance with MIL-S-24149, except that the studs are welded to a perforated metal pad, at least 2 13/16 inches square, of the same metal as the stud. In areas that are inaccessible for a stud welding gun, studs welded to a perforated pad, 22-gauge steel, or same metal as stud, 2 13/16 inches square, shall be bonded to ship's structure using epoxy adhesive conforming to MIL-A-24456. A maximum of 25 percent of the total number of studs required to secure insulation on each plane area bounded by stiffeners or bulkheads shall be attached in this manner.

o. Adhesive, for securing polyimide-foam thermal insulation panels conforming to MIL-A-24179 (see 5.1.d).

p. Double sided acrylic afadhesive tape, such as 3M's Y9485, or equal as approved by NAVSEA.

5.9.1 Thickness of insulation. The coverage and thickness of insulation to be installed shall be as specified (see 6.2). In the absence of specific guidance, the following thicknesses shall be acceptable.

a. Two-inch thickness of insulation in the following areas:

(1) Compartment overheads exposed to the weather where the ambient temperature of the compartment is under 105 °F, and for vertical boundaries of these compartments, where exposed to the weather, if the compartment is heated.

(2) Boundaries of main machinery spaces in the way of other compartments.

b. One-inch thickness of insulation in the following areas:

(1) Compartment overheads exposed to the weather where the ambient temperature of the compartment is 105 °F or over.

(2) Vertical boundaries of compartments exposed to the weather or sea where the ambient temperature of the compartment is under 120 °F.

(3) Between air-conditioned compartments and compartments where the ambient temperature of the adjacent compartment is between 95 and 119 °F.

(4) All ammunition space boundaries.

c. Other thicknesses as installed to meet special conditions.

5.9.2 Insulation installation requirements for compartments. Requirements for installing thermal insulation in compartments shall be as specified in 804-5773931 and as follows:

a. Surface preparation on both surface ships and submarines shall be in accordance with Standard Item 009-32 as applicable (see 4.12).

b. Where both thermal and acoustic absorptive treatments are specified, only the acoustic absorptive treatment shall be applied to plane surfaces, and thermal insulation shall be applied to beams and stiffeners (see 5.10).

c. Insulation on vertical surfaces shall extend from 6 inches above the deck to the overhead, except for the warm side of refrigerated stores spaces, uptake enclosures, magazines, and ammunition handling and ready service spaces, where it shall extend from the deck to the overhead.

d. When insulation extends to the deck, a 4-inch by ⅛-inch steel or aluminum alloy coaming shall be attached, as appropriate, to the deck with a continuous weld and the insulation shall be installed behind the coaming.

e. Vapor barrier conforming to MIL-C-19565 shall be applied to all insulation within laundries, sculleries, galleys, drying rooms, and to the insulation on the warm side of refrigerated stores spaces as specified (see 4.11). There shall be no breaks in the vapor barrier coating.

5.9.3 Attachment of studs to compartment bulkheads. Studs used for attachment of insulation to compartment bulkheads on surface ships and submarines shall be as follows:

a. Studs for surface ship and non-HY-80 submarine applications shall be welded as specified in MIL-STD-1689.

b. Studs for HY-80, HY-100, and HY-130 submarine applications shall be welded as specified in T9074-AD-GIB-010/1688.

c. Studs shall be welded to ship's structure, except in areas that are not accessible for the use of a stud welding gun.

d. In areas that are inaccessible for a stud welding gun, studs welded to a perforated pad, 22-gauge steel or same metal as stud, 2 13/16 inches square, shall be bonded to ship's structure using epoxy adhesive conforming to MIL-A-24456. A maximum of 25 percent of the total number of studs required to secure insulation on each plane area bounded by stiffeners or bulkheads shall be attached in this manner.

e. Studs for fibrous-glass insulation shall be spaced on approximately 12-inch centers, but in no case more than 15-inch centers. Studs shall be spaced no more than 6 inches from the edge of thermal insulation.

f. Stud spacing for polyimide-foam thermal insulation conforming to MIL-DTL-24688 shall not exceed 18 inches, except that studs shall be spaced no more than 12 inches from the edge of the insulation.

g. When thermal or acoustic insulation is applied over constrained damping treatment (see 5.10.3.b), the studs shall be welded to the constraining layer. Aluminum and steel studs are welded to aluminum and steel constraining layers, respectively. This is provided that an installation of identical design has been subjected to and successfully passed the Grade B, Type A high-impact shock test of MIL-S-901 for Class 1 lightweight equipment. If the installation has not been shock qualified, studs shall be welded to ship's structure in the same manner as installing thermal or acoustic insulation over unconstrained damping (see 5.10.3.a).

h. When thermal or acoustic insulation is applied over unconstrained damping treatment (see 5.10.3.a), a maximum of 25 percent of the total number of studs required to secure insulation on each plane area bounded by stiffeners or bulkheads shall be attached directly to the damping treatment using MIL-A-24456 epoxy adhesive.

5.9.4 Fibrous-glass insulation conforming to MIL-I-742 or MIL-I-22023 installation. Fibrous-glass insulation shall be installed in accordance with 804-5773931 and as follows:

a. Fibrous-glass insulation panels shall be secured on studs that shall be spaced on approximately 12-inch centers, but in no case more than 15-inch centers. Studs shall be spaced no more than 6 inches from the edge of thermal insulation.

b. Press-fit caps of aluminum alloy for use with aluminum alloy studs or zinc-plated carbon steel for use with steel studs shall be used to restrain the insulation on the studs.

c. Fibrous-glass insulation shall be installed on beams and stiffeners as shown on figure 30. Filler pieces, consisting of fibrous-glass insulation felt conforming to MIL-I-22023 shall be installed on the webs to form a boxed-in configuration when the web has a depth of 6 inches or less.

d. All seams shall be covered with adhesive conforming to MIL-A-3316, Class 1, Grade A and 2-inch wide fibrous-glass cloth tape conforming to MIL-C-20079, Type II, Class 1.

e. When vapor barrier conforming to MIL-C-19565 is required, it shall be applied as specified (see 4.11) to all insulation within the specified spaces. There shall be no breaks in the vapor barrier coating.

f. At least one coat of paint conforming to MIL-PRF-24596 or MIL-DTL-24607 shall be applied as specified (see 4.11) over the fibrous-glass cloth faced insulation. The fire retardant paint shall be tinted to match the other surfaces in the compartment.

g. Fibrous-glass-faced thermal and sound absorbing felt conforming to MIL-I-22023, Type III, shall not be painted if the fire retardant paint has been pre-applied at the factory. Otherwise, painting acoustic absorptive insulation shall be as specified (see 4.11).

5.9.5 Polyimide foam conforming to MIL-DTL-24688 insulation installation. Polyimide foam conforming to MIL-DTL-24688 shall be installed in accordance with 804-5773931 and as follows:

a. Polyimide-foam insulation panels conforming to MIL-DTL-24688 shall be secured on studs spaced on centers not to exceed 18 inches. Studs shall be spaced no more than 12 inches from the edge of the insulation.

b. Polyimide-foam insulation shall be installed on plane surfaces and on the flanges of beams and stiffeners prior to installing polyimide foam on the webs, such that the polyimide foam on the webs will tend to hold insulation on plane surfaces and polyimide foam on the flanges in place.

c. Press-fit caps of aluminum alloy for use with aluminum alloy studs or zinc-plated carbon steel for use with steel studs shall be used to restrain the insulation on the studs.

d. Polyimide-foam insulation conforming to MIL-DTL-24688 shall be installed on the webs and flanges of beams and stiffeners using adhesive conforming to MIL-A-24179 (see 5.1.d) or acrylic tape, such as 3M's Y9485, or equal as approved by NAVSEA. Studs are not required on flanges or webs when polyimide foam is installed.

e. All seams shall be covered with adhesive conforming to MIL-A-3316, Class 1, Grade A and 2-inch wide fibrous-glass cloth tape conforming to MIL-C-20079, Type II, Class 1.

f. When vapor barrier conforming to MIL-C-19565 is required, it shall be applied as specified (see 4.11) to all insulation within the specified spaces. There shall be no breaks in the vapor barrier coating.

g. At least one coat of paint conforming to MIL-PRF-24596 or MIL-DTL-24607 shall be applied as specified (see 4.11) over the fibrous-glass cloth faced insulation. The fire retardant paint shall be tinted to match the other surfaces in the compartment.

5.9.6 Underside of overhang areas exposed to weather insulation installation. The underside of overhang areas shall be insulated as follows:

a. Thermal foam insulation conforming to MIL-PRF-32514 shall be adhered to the underside of overhang areas exposed to the weather with epoxy adhesive conforming to MIL-A-24456.

b. A fiberglass-reinforced cover plate, 3/16-inch thick, conforming to MIL-P-17549, Grade 3, constructed of resin conforming to MIL-R-21607, Grade 2 with 5 parts by weight antimony trioxide added shall be bonded, as well as mechanically fastened, to the underside of the thermal foam insulation conforming to MIL-PRF-32514.

c. The resin conforming to MIL-R-21607, Grade 2 shall be opaque or pigmented to match surrounding structures.

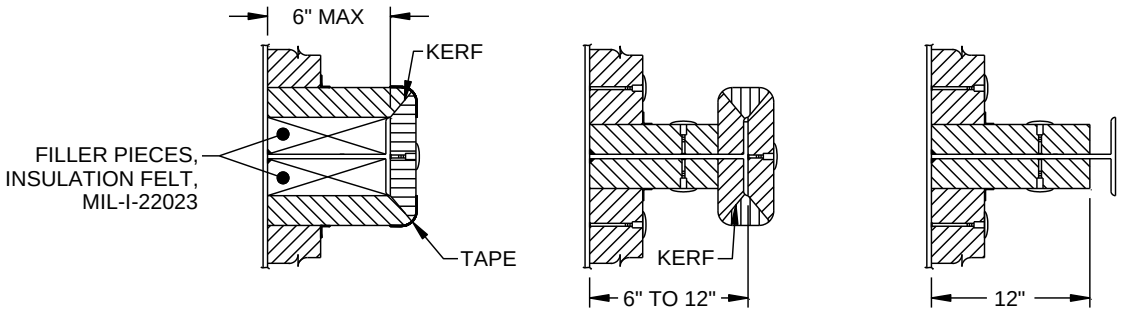

FIGURE 30. Installation of fibrous-glass thermal insulation on beams and stiffeners.

5.9.7 Maintenance of compartment insulation. Maintenance of compartment insulation shall be as follows:

a. If the fibrous-glass or polyimide-foam insulation is damaged beyond repair, cut out and remove the damaged area and replace with new insulation as specified (see 5.9.4 and 5.9.5).

b. For shipboard repair of small tears, dents, gouges, and similar damage to the fibrous-glass-facing of the insulation, apply fibrous-glass cloth tape conforming to MIL-C-20079, Type II over the damaged area with adhesive conforming to MIL-A-3316. The application of the fibrous-glass cloth tape will, in most instances, prevent further damage and ensure the continued serviceability of the insulation until the next overhaul of the ship when, if warranted, more extensive repairs can be made.

c. Where it has been determined that the insulation, instead of being replaced, can be repaired economically with a resultant condition at least equal to that of a newly installed insulation board, the following procedures shall be employed:

(1) The method to be used where damage is primarily to the cloth surface, and the body of the insulation board is relatively intact shall be as follows:

(a) Before the cloth covering is applied, prepare the damaged insulation as follows:

1 Replace missing studs.

2 Repair minor cuts, tears, and dents.

3 Cover studs and fasteners with small patches of cloth in order to provide a uniform foundation for the overall cloth.

(b) After the damaged insulation has been prepared, cut the fibrous-glass cloth conforming to MIL-C-20079, Type I, Class 2 to fit the area to be covered. A typical application would take a single piece of cloth from deck to overhead between structural members. Apply a coat of adhesive conforming to MIL-A-3316, Class 1 with either a brush or trowel over the insulation, and the set the cloth in place and press smooth. Apply a topcoat of adhesive conforming to MIL-A-3316, Class 1 onto the cloth as heavily as necessary to fill all the spaces of the cloth and ensure the adherence of the cloth.

5.10 Requirements for acoustic absorptive and transmission loss treatments for compartments. Requirements for acoustic absorptive and transmission loss treatments for compartments shall consist of the acoustic, transmission loss, hardware, and lagging and tape materials as follows:

a. Two-inch (2-inch) thick perforated hard surfaced fibrous-glass acoustical board conforming to MIL-A-23054.

b. Fibrous-glass thermal and acoustical felt (faced with reinforced polyester film to protect the board from contaminants such as oil, grease, and dirt) conforming to MIL-I-22023, Type III.

c. Polyimide foam, thermal and acoustic insulation conforming to MIL-DTL-24688, Type II.

d. Barium sulfate-loaded vinyl sheet conforming to MIL-A-24699 or barium sulfate-loaded silicone of equal area density, such as Coustifab, or equal as approved by NAVSEA.

e. Sheathing 0.04 inches thick, perforated with 3/16-inch diameter holes on 3/8-inch centers, staggered conforming to SAE-AMS-QQ-A-250/3.

f. Plastic isolating tape conforming to MIL-I-24391.

g. Fibrous-glass tape conforming to MIL-C-20079, Type II, Class 1.

h. Latex adhesive conforming to MIL-A-3316, Class I, Grade A.

i. Epoxy adhesive conforming to MIL-A-24456.

j. Sealing compound, silicone rubber base conforming to ASTM D6411/D6411M.

k. Duct tape, NSN 5640-00-103-2254.

l. Aluminum alloy stud, plus a compatible carbon steel press-fit cap conforming to MIL-S-24149/2, Type III, Class 3.

m. Carbon steel stud, plus a compatible carbon steel press-fit cap conforming to MIL-S-24149/1, Type IV, Class 3.

n. Rubber cap conforming to MIL-PRF-6855, Class 2, Type A, Grade 60.

o. Acrylic tape, such as 3M's Y9485, or equal as approved by NAVSEA.

5.10.1 Acoustic absorptive treatments installation requirements for compartments. Requirements for installing acoustic absorptive treatments in compartments shall be in accordance with in 804-5773931 and as follows:

a. Surface preparation on both surface ships and submarines shall be in accordance with Standard Item 009-32, as applicable (see 4.13).

b. Treatments intended for acoustic absorptive purposes shall be applied to plane surfaces only.

c. Where acoustic absorptive treatment is required on vertical surfaces, the treatment shall be eliminated behind status boards, control or switching panels, or equipment mounted on or against the bulkhead. Treatments installed for acoustic absorptive purposes only shall not be installed in the way of shower stalls, or built-in furniture, except behind berths.

d. Where both acoustic absorptive treatment and thermal insulation are specified, only the acoustic absorptive treatment shall be applied to plane surfaces, and thermal insulation shall be applied to beams and stiffeners.

e. When treatment for acoustic absorptive purposes is indicated for compartment bulkheads, doors in those bulkheads shall not be covered, except in fan rooms.

f. Painting of acoustic treatments shall be minimized to the maximum extent possible, since paint buildup on the facing or plugging the holes in the perforated sheathing or facing can change the acoustic performance properties of the treatment. Where painting is required, the paint shall be brushed or sprayed on in thin coats, exercising care to avoid plugging or bridging the holes in the sheathing or facing. Acoustic absorptive insulation shall be painted as specified (see 4.11).

5.10.2 Perforated hard-surfaced fibrous-glass board conforming to MIL-A-23054, fibrous-glass felt conforming to MIL-I-22023, and polyimide-foam acoustic absorptive insulation conforming to MIL-DTL-24688, type II, class 2 installation. Acoustic absorptive insulation conforming to MIL-A-23054, MIL-I-22023, and MIL-DTL-24688 shall be installed in accordance with 804-5773931 and as follows:

a. Studs shall be welded to the ship structure using a stud gun where possible and spaced as specified (see 5.9.3). On composite surfaces, self-drilling and self-tapping studs shall be used.

(1) Perforated hard-surfaced fibrous-glass board conforming to MIL-A-23054 and fibrous-glass felt conforming to MIL-I-22023 shall be attached to the ship structure using studs conforming to MIL-S-24149, and press-fit caps.

(2) Polyimide-foam insulation conforming to MIL-DTL-24688 shall be attached to plane surfaces using carbon steel or aluminum studs and press-fit caps, as applicable. Studs are not required on flanges or webs where polyimide foam is installed. For installation of acoustic polyimide-foam insulation conforming to MIL-DTL-24688, Type II, Class 2 on bulkheads and underside of deck areas that are inaccessible for a stud welding gun, studs welded to a perforated pad, 22-gauge steel or same metal as stud, $2\frac{3}{16}$ inches square, shall be bonded to the ship's structure using epoxy adhesive conforming to MIL-A-24456 or 3M VHB 4941 tape, or equal as approved by NAVSEA. A maximum of 25 percent of the total number of studs required to secure acoustic polyimide-foam insulation conforming to MIL-DTL-24688, Type II, Class 2 on each plane area bounded by stiffeners or bulkheads shall be attached in this manner for surface ships and submarines.

b. A perforated hard-surfaced fibrous-glass board conforming to MIL-A-23054 or polyimide-foam acoustic absorptive insulation conforming to MIL-DTL-24688, Type II, Class 2 shall be installed on ship structures in dry environments, outside of machinery spaces as shown on figure 31. When fibrous-glass insulation is installed on plane surfaces, polyimide foam with fibrous-glass cloth facing conforming to MIL-DTL-24688 may be installed on webs and flanges of stiffeners.

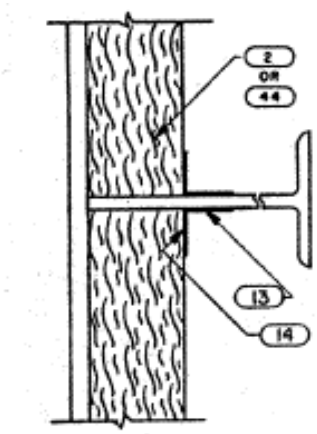

FIGURE 31. Acoustic absorptive treatment.

c. Fibrous-glass sound absorbing acoustic treatment conforming to MIL-I-22023, Type III shall be installed on the plane surfaces of machinery spaces, shops, or other spaces where the insulation may be exposed to oil, water, grease, dirt, or high levels of humidity. When acoustic absorptive treatment is applied to plane surfaces in these spaces, faced fibrous-glass board insulation conforming to MIL-I-742, Type I shall be applied to the beams and stiffeners. All penetrations of the treatment conforming to MIL-I-22023, Type III treatment facing, including studs, shall be sealed with an elastomeric sealant conforming to ASTM D6411/D6411M.

d. Treatments installed for acoustic absorptive purposes on vertical surfaces shall extend from 6 inches above the deck to the overhead, except for the warm side of refrigerated stores spaces, uptake enclosures, magazines, and ammunition handling and ready service spaces, where it shall extend from deck to overhead.

e. Acoustic treatments that extend down to the deck shall be protected by a 4-inch by ⅛-inch steel or aluminum coaming, as appropriate, which shall be welded to the deck with a continuous weld, with the treatment installed behind the coaming. On GRP structures, a GRP coaming shall be used.

f. All seams and edges of faced insulation shall be sealed with fibrous-glass tape conforming to MIL-C-20079, Type II, Class 1, using adhesive conforming to MIL-A-3316, Class 1, Grade A. In high traffic and work areas, the facing shall be protected by perforated aluminum sheathing conforming to SAE-AMS-QQ-A-250/3, extending from the deck to a height of 4 feet. Two layers of plastic isolating tape conforming to MIL-I-24391 shall be installed between the mounting brackets and the aluminum sheathing whenever the materials are dissimilar.

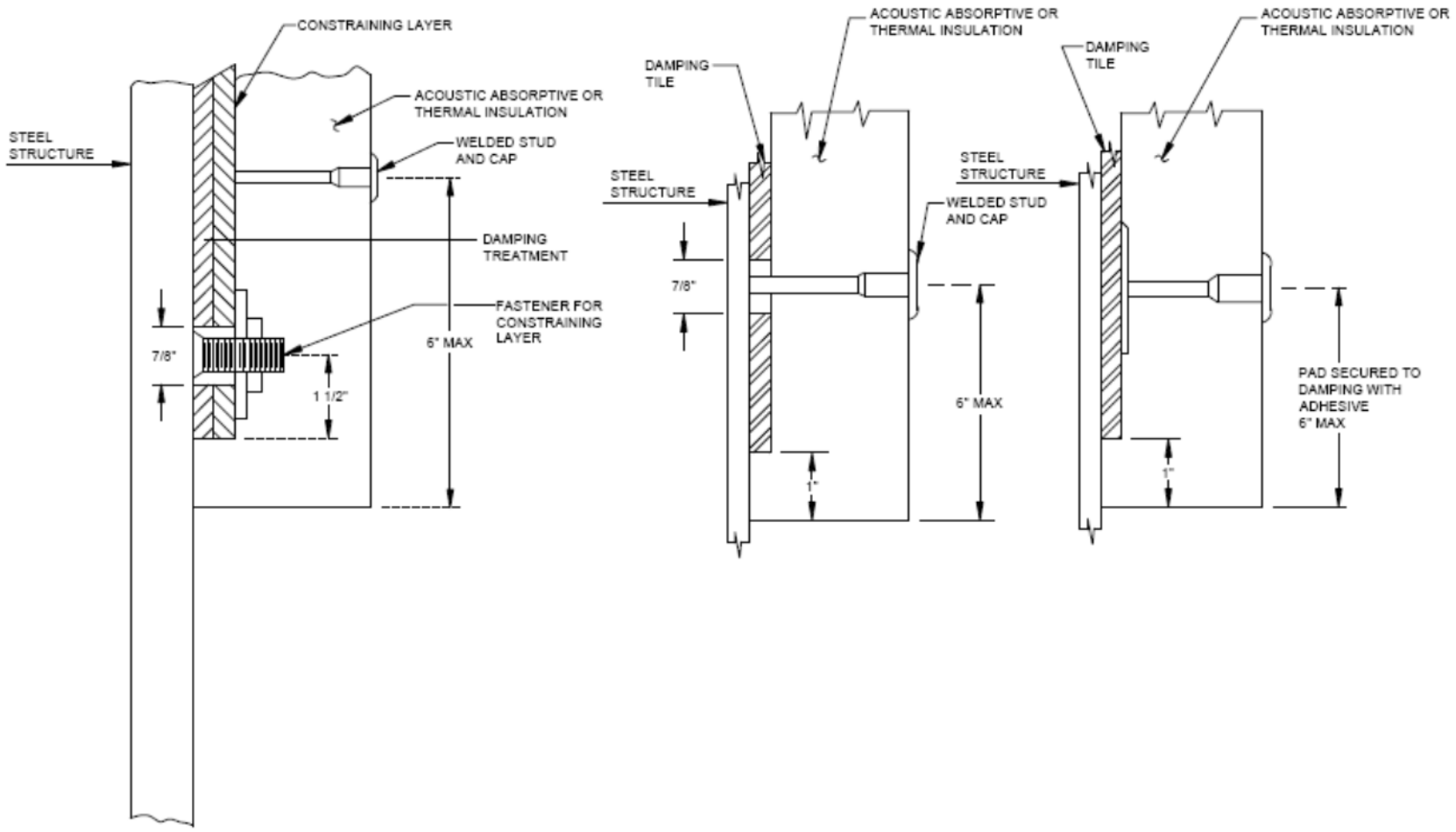

FIGURE 32. Acoustic absorptive or thermal insulation over free layer (unconstrained) or constrained damping tiles.

5.10.3 Acoustic treatments installed over free layer (unconstrained) and constrained damping tiles. Acoustic treatments, fibrous-glass or polyimide-foam, installed over free layer (unconstrained) and constrained damping tiles shall be installed as shown on figure 32 and as follows:

a. When acoustic treatments are installed over free layer (unconstrained) damping tiles, at least 75 percent of the studs required to secure each section of insulation shall be welded to the structure being damped using the automatic-timed arc technique. Welded studs shall be installed prior to cleaning and painting operations. Holes, ⅞ inch in diameter, shall be cut, drilled, or punched in the damping tiles to provide passage for the welded studs. A maximum of 25 percent of the total number of studs required to secure each section of insulation shall be attached directly to the damping tiles. The studs in this case shall be welded to a pad or baseplate, at least 2 13/16 inches square, of the same type metal as the stud, and the pad in turn shall be bonded to the damping tiles using adhesive conforming to MIL-A-24456.

b. When acoustic treatments are installed over constrained damping tiles, the studs shall be welded directly to the constraining layer, provided that an installation of identical design has been subjected to and successfully passed the Grade B, Class I high-impact shock test of MIL-S-901 for Type A lightweight equipment. If the installation has not been shock qualified, studs shall be welded to the ship's structure in the same manner as when installing acoustic insulation over free layer (unconstrained) damping. Holes, ⅞ inch in diameter, shall be cut in the damping tiles and the constraining layer to provide passage for the studs.

5.10.4 Transmission loss treatment installation requirements for compartments. Requirements for installing transmission loss treatments in compartments shall be in accordance with 804-5773931 and as follows:

a. Surface preparation on both surface ships and submarines shall be in accordance with Standard Item 009-32 as applicable (see 4.13).

b. Treatments installed for transmission loss purposes shall cover all stiffeners as well as plane surfaces to obtain full coverage of the surfaces, with no exceptions made for interferences.

c. Treatments installed for transmission loss purposes on vertical surfaces shall extend fully from the deck to the overhead to obtain full coverage of the surfaces, with no exceptions made for interferences.

d. The coverage of high transmission loss treatments should generally extend beyond the surfaces that are indicated to be treated.

e. The layers of transmission loss treatments in the way of penetrations shall be completely sealed through the treatments. Examples of this include fully sealing around pipes, foundations, and structures that pass through the treatment.

f. Where both transmission loss treatment and thermal insulation are specified, only transmission loss treatment shall be applied.

g. When treatment for transmission loss purposes is indicated for compartment bulkheads, doors in those bulkheads shall also be treated.

h. Where treatments for transmission loss purposes are required on vertical surfaces, the transmission loss treatment shall be extended behind all status boards, control and switching panels, bulkhead and overhead mounted equipment, piping, cabling, and built-in furniture and stalls.

i. Care shall be taken not to tear loose the fibrous-glass cloth facing or rip or damage the transmission loss treatment before, during, or after installation.

j. Care shall be taken to assure the transmission loss treatment remains dry and does not come in contact with fluids.

5.10.4.1 Transmission loss treatment installation. Transmission loss treatment shall be installed in accordance with 804-5773931 and as follows:

a. Studs for transmission loss treatments shall be spaced on no more than 12-inch centers. Studs at edges shall not be placed more than 6 inches from the edge of the transmission loss treatment.

b. Two-inch (2-inch) thick fibrous-glass conforming to MIL-I-22023, Type II, Class 6 shall be installed against the ship's structure as the inner layer. For improved transmission loss performance, the inner layer shall consist of insulation conforming to MIL-A-23054, 2 inches thick. Typical transmission loss treatments on plane bulkheads are shown on figure 33.

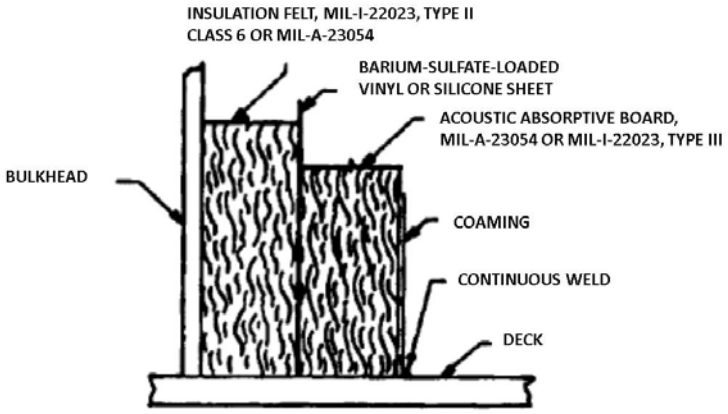

FIGURE 33. Transmission loss treatment on bulkhead.

c. Barium sulfate-loaded vinyl conforming to MIL-A-24699 or barium sulfate-loaded silicone, such as Coustifab (¾, 1, or 1½ pounds per square foot), or equal as approved by NAVSEA, shall be installed over the inner layer of fibrous glass.

d. Seams between adjacent sections of loaded vinyl or silicone shall overlap a minimum of 6 inches. All seams in each loaded vinyl or silicone layer of the transmission loss treatment shall be sealed with duct tape.

e. The outer layer to be installed over the loaded vinyl or silicone in dry environments, outside of machinery spaces, shall consist of 2-inch thick fibrous glass conforming to MIL-A-23054.

f. In spaces where there is exposure to oil, grease, dirt, water, or high levels of humidity, the outer layer to be installed over the loaded vinyl or silicone shall consist of 2-inch thick fibrous glass conforming to MIL-I-22023, Type III.

g. Where no other insulation is specified at the boundary of a transmission loss treatment, the transmission loss treatment shall be extended for 12 inches beyond the indicated boundary on bulkheads and overheads. In those instances where other insulation is specified at the boundary of transmission loss treatments, the loaded vinyl or silicone sheet shall be extended a minimum of 12 inches beyond the indicated boundary on bulkheads and overheads, as shown on figure 34.

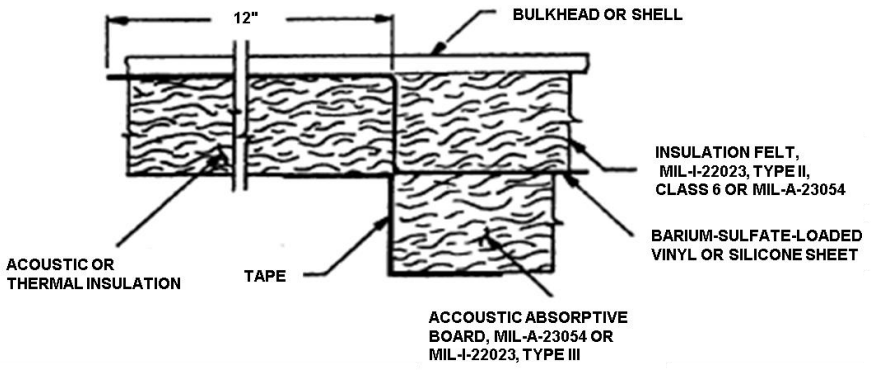

FIGURE 34. Transmission loss treatment butted to thermal or acoustic absorption treatment.

h. If gaps exist after installation, all penetrations, such as studs, shall be carefully sealed with sealing compound conforming to ASTM D6411/D6411M (see figure 35).

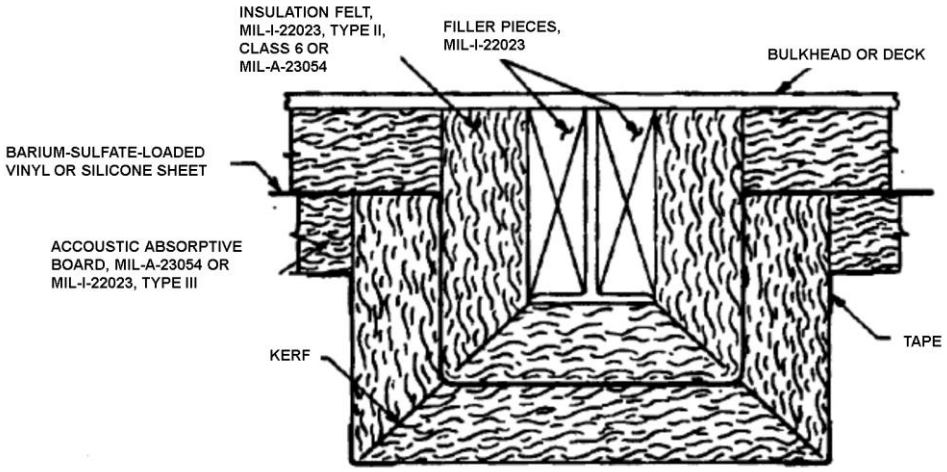

FIGURE 35. Transmission loss treatment around beams and stiffeners.

i. Carefully seal all seams and exposed edges of the transmission loss treatment using fibrous-glass tape conforming to MIL-C-20079, secured with adhesive conforming to MIL-A-3316. Carefully seal all penetrations, including studs, with sealing compound conforming to ASTM D6411/D6411M (see figure 36).

5.10.4.2 Transmission loss treatments for compartments on submarines. Transmission loss treatments for compartments on submarines consist of the following components in accordance with 804-5773931 and the details on figure 36.

a. For submarines, high transmission loss treatment shall consist of the following:

(1) A composite of ½-inch layers of polyimide foam conforming to MIL-DTL-24688 with a barium sulfate-loaded vinyl or barium sulfate-loaded silicone septa and a fibrous-glass cloth facing, such as RB LLC TA 301 (TLP-3) Coustifab, or equal as approved by NAVSEA.

(2) A composite of ½-inch layers of fibrous glass with a barium sulfate-loaded vinyl or barium sulfate-loaded silicone septa and a fibrous-glass cloth facing conforming to NUC Specification No. 120569 MA-R2.

b. Where layers of material conforming to NUC Specification No. 120569 MA-R2 are installed individually, each successive layer shall be installed to overlap or butt the joint. Where pre-molded multilayered composite sections of transmission loss material are installed, they shall be firmly butted together to avoid gaps to the maximum extent possible.

c. Penetrations shall be treated with a two-layer configuration of polyimide foam with septa or fibrous glass with septa. The two-layer configuration shall be installed with a staggered joint (minimum offset of 0.5 inch) between the first and second layers. There shall be no line-of-sight joints. Variations from this treatment shall be as approved by NAVSEA. The joint outer/inboard surface shall be covered with a 2-inch wide fibrous-glass cloth tape conforming to MIL-C-20079, Type II, secured with adhesive conforming to MIL-A-3316. When one or more layers of material conforming to NUC Specification No. 120569 MA-R2 are installed around penetrations, firmly packed fibrous-glass insulation conforming to NUC Specification No. 120569 MA-R2, excluding vapor barrier and fibrous-glass cloth, shall be used to fill voids and gaps.

d. When two or more layers of the composite of ½-inch layers of polyimide foam conforming to MIL-DTL-24688 with barium sulfate-loaded vinyl septa and a fibrous-glass cloth facing, such as RB LLC TA 301 (TLP-3), Coustifab, or equal as approved by NAVSEA, are installed, the polyimide foam conforming to MIL-DTL-24688 shall be used as an acoustic caulking compound and shall be firmly packed to fill all voids and gaps and around penetrations.

e. Set-back joints are required on submarine hull barrier treatments. The top layer transmission loss treatment shall have a set-back of 1 inch on each section to be joined, with a ½-inch by 2-inch snug fit of polyimide foam or fibrous glass, as applicable. Insert block centered over the butt joint and cover with 4-inch wide fibrous-glass cloth tape conforming to MIL-C-20079, Type II adhered with adhesive conforming to MIL-A-3316.

f. All exposed edges of barrier treatments shall be covered with a 4-inch wide fibrous-glass tape conforming to MIL-C-20079, Type II adhered with adhesive conforming to MIL-A-3316.

g. To the greatest extent practicable, transmission loss treatments shall be installed as one composite layer as follows:

(1) Cyanoacrylate adhesive, such as Loctite adhesive #404, or equal as approved by NAVSEA, shall be installed to the stud.

(2) A rubber cap conforming to MIL-PRF-6855, Class 2, Type A, Grade 60 shall be installed over the stud.

(3) The stud shall be cut off flush with the top of the rubber cap.

(4) A cap cover shall be made of a ½-inch layer of polyimide foam conforming to MIL-DTL-24688 with a barium sulfate-loaded vinyl or barium sulfate-loaded silicone septa and a fibrous-glass cloth facing such as RB LLC TA 301 (TLP-3), Coustifab, or equal as approved by NAVSEA. An alternative method to construct a cap cover shall use a ½-inch layer of fibrous glass with a barium sulfate-loaded vinyl or barium sulfate-loaded silicone septa and a fibrous-glass cloth facing conforming to NUC Specification No. 120569 MA-R2.

(5) The cap cover shall be secured in place by bonding to the rubber cap and transmission loss treatment with cyanoacrylate adhesive, such as Loctite adhesive #404, or equal as approved by NAVSEA.

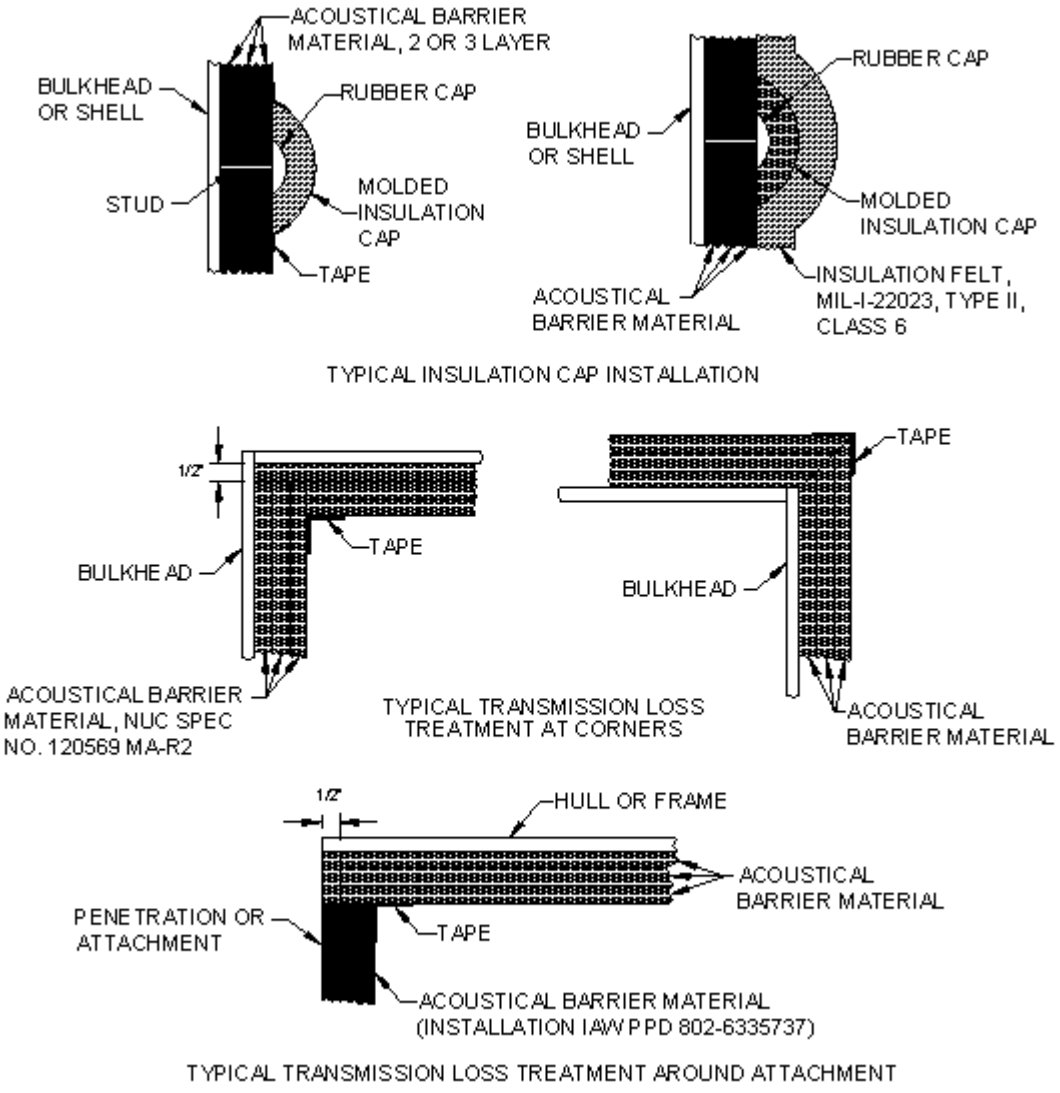

FIGURE 36. Typical submarine transmission loss treatments.

5.10.5 Maintenance of acoustic absorptive and transmission loss treatments. All acoustic absorptive and transmission loss treatments shall be inspected annually (or during post-overhaul periods of SSN/SSBN submarines) for damage. Immediate action shall be taken to repair all damage, including that considered minor, since the effectiveness of many acoustical treatments depends on the maintenance of their integrity to ensure continued acoustic performance.

5.11 Requirements for high temperature fire insulation for ship's structures. Requirements for high temperature fire insulation for use on Navy ships shall include compliance with the list of approved N-class fire-resistant divisions in table XI, the requirements specified in MIL-STD-3020, and the high temperature fire insulation materials as follows:

a. Insulation, high temperature fire protection, thermal and acoustic conforming to MIL-PRF-32161.

b. Fibrous-glass insulation felt conforming to MIL-I-22023, Type II, Class 2.

c. Sheathing conforming to ASTM B209, Alloy 5052, 0.04-inch thick, perforated with 3⁄16-inch diameter holes on 3⁄8-inch centers, staggered.

d. Plastic isolating tape conforming to MIL-I-24391.

e. Fibrous-glass tape conforming to MIL-C-20079, Type II, Class 1.

f. Latex adhesive conforming to MIL-A-3316, Class 1, Grade A.

g. Fiberglass scrim reinforced polyester film facing, such as Tuffskin #1613, IMO RMW, or equal as approved by NAVSEA.

h. Epoxy adhesive conforming to MIL-A-24456.

i. CRES or carbon steel studs and caps, for use on steel structures.

j. Bi-metallic studs and CRES caps for use on aluminum structures. Studs and caps conforming to 803-5184182.

k. CRES or ceramic spacers conforming to 803-5184182.

5.11.1 N-class divisions. N-class divisions are fire-resistant divisions formed by bulkheads and decks (overheads) that are designed to protect against structural failure and prevent the passage of flame or hot gases when exposed to a rapid rise hydrocarbon fire exposure (Class B), described in “Method of Fire Tests for Fire Resistance of Bulkheads and Decks (Overheads)”of MIL-STD-3020, after shock testing in accordance with MIL-S-901. The minimum fire test duration shall be 30 minutes. In addition, N-class divisions shall be designed to prevent excessive temperature rise as follows:

a. Class N-60: When exposed to fire for 60 minutes after the shock test:

(1) There shall be no passage of flame or hot gases on the unexposed face for 60 minutes.

(2) The average unexposed face temperature rise shall be not more than 250 °F for 60 minutes.

(3) The temperature rise by any of the individual unexposed face thermocouples shall be not more than 325 °F for 60 minutes.

b. Class N-30: When exposed to fire for 30 minutes after the shock test:

(1) There shall be no passage of flame or hot gases on the unexposed face for 30 minutes.

(2) The average unexposed face temperature rise shall be not more than 250 °F for 30 minutes.

(3) The temperature rise by any of the individual unexposed face thermocouples shall be not more than 325 °F for 30 minutes.

c. Class N-0: When exposed to fire for 30 minutes after the shock test, there shall be no passage of flame or hot gases or ignition of cotton pad on the unexposed face for 30 minutes. There is no temperature rise requirement.

5.11.1.1 N-class divisions, restricted or unrestricted. N-class bulkhead divisions may be either restricted or unrestricted. N-class decks shall only be insulated from below. N-class divisions shall be insulated as follows:

a. Restricted: When a division is protected against a fire threat from one side only, the division shall be designated as fire resistant with restricted application.

b. Unrestricted: When a division is protected against a fire threat from both sides, the division shall be designated as fire resistant with unrestricted application. A fire zone bulkhead shall always be designed for fire resistance with unrestricted application. When the unrestricted steel division is fire tested, the fire exposure shall be on the bare steel side and the insulation shall be on the unexposed side. This does not apply to aluminum or composite divisions.

5.11.2 High temperature fire insulation installation requirements on ship’s structures. Requirements for installing high temperature fire insulation on ship’s structures shall be as specified in 803-5184182 and as follows:

a. Surface preparation on both surface ships and submarines shall be in accordance with Standard Item 009-32, as applicable (see 4.13).

b. The extent of protective high temperature fire insulation to be installed on ship’s structures shall be as specified (see 6.2).

c. The N-class utilized shall be as specified (see 6.2), installed to protect ship's structure against flame impingement. The thickness of high temperature fire insulation for N-class divisions shall be in accordance with the list of approved N-class fire-resistant divisions in table XI.

d. High temperature fire insulation may be substituted for thermal insulation in accordance with MIL-PRF-32161.

e. High temperature fire insulation may be substituted for acoustic insulation in accordance with MIL-PRF-32161.

(1) When acoustic high temperature fire insulation is installed, it shall extend from deck to overhead.

(2) Acoustic high temperature fire insulation shall be attached using studs and caps specified in 803-5184182.

(3) Studs at the edges of acoustic fire insulation shall be placed no more than 3 inches from the edge of the insulation.

f. Each insulation system used on a stanchion shall be fire tested in accordance with MIL-STD-3020. The core temperature thermocouples shall be installed on the stanchion in accordance with UL 1709. As specified (see 6.2), test procedures shall be approved by NAVSEA prior to testing. The average temperature at any of the four levels of the steel stanchion shall not exceed 1000 °F and no thermocouple shall indicate a temperature greater than 1200 °F during the period of fire exposure for which classification is desired. For aluminum stanchions, the average temperature rise of thermocouples at any of the four levels shall not exceed 360 °F during the period of fire exposure for which classification is desired.

g. N-class divisions shall be installed on the ship as tested. The fire-resistant assembly shall be considered approved when it is constructed and insulated in accordance with the fire test reports referenced in table XI and in accordance with 803-5184182. This approval does not currently apply to submarines. Additional testing would be required under the submarine material control program.

5.11.3 Studs and fasteners. Studs and fasteners and their attachment mechanisms for high temperature fire insulation on fire-resistant divisions and their penetrations, which have been subjected to the shock test of MIL-S-901 in accordance with MIL-STD-3020, shall be as follows:

a. Studs installed on metal divisions shall be arc welded with a capacitor discharge stud welder.

b. Each insulated N-class approved system for steel, aluminum, and composite divisions shall be installed with the same attachment system used to install the high temperature fire insulation in the MIL-S-901 shock test and fire test required in the approval process. The attachment hardware required for each specific system shall be in accordance with 803-5184182 and the fire test reports of table XI.

c. For composite structures requiring high temperature fire insulation, self-drilling or self-tapping studs shall be used in accordance with 803-5184182.

5.11.4 High temperature fire insulation installation. High temperature fire insulation shall be installed in accordance with 803-5184182 and as follows:

a. High temperature fire insulation conforming to MIL-PRF-32161 shall be secured on welded studs that shall be spaced so as not to exceed 12-inch centers on plane surfaces, except that studs shall be located within 3 inches of any seam in the high temperature fire insulation. The high temperature fire insulation shall be installed with the fibrous-glass cloth faced side facing inboard.

b. Stud spacing along the length of beams and stiffeners shall be 12 inches maximum, except where sections of insulation butt together, studs shall be positioned within 3 inches of the seam.

c. Deep beams may require additional studs on the lower part of the web to ensure that the high temperature fire insulation is held securely against the beam and filler pieces. Additional studs shall be installed if the web is 12 inches or greater in depth. Studs shall be positioned equidistant from the web limits where possible; however, a stud shall be within 3 inches of the end of the wrap-around high temperature fire insulation.

d. In those areas that are inaccessible for use of a stud gun, studs shall be manually welded, if possible. In the event that manual welding of studs cannot be accomplished, studs shall be attached to a perforated metal pad, 22-gauge steel, 2 13/16 inches square with epoxy adhesive conforming to MIL-A-24456. No more than two adhesive attached studs adjacent to each other in any direction shall be allowed. The total number of adhesive attached studs shall be kept to a minimum, but shall not exceed 10 percent of the total number of studs required to secure the high temperature fire insulation on each plane area of bulkheads and decks.

e. High temperature fire insulation shall be restrained on the stud or weld pin by either a press-fit cap or a speed clip and dome cap in accordance with 803-5184182.

f. High temperature fire insulation normally shall be applied to continuous plane surfaces first, followed by wrapping of beams or stiffeners. When insulating around beams or stiffeners which have a shallow web, there may not be sufficient clearance for the stud gun when welding studs to the web. It may be necessary to install the insulation in a continuous wrap around the shallow beam as shown in Detail D of 803-5184182.

g. High temperature fire insulation on all vertical structures shall extend from the deck to the overhead. A protective coaming of 4-inch by ⅛-inch steel or aluminum alloy shall be welded to the deck using a continuous weld. The high temperature fire insulation shall be installed behind the coaming.

h. When high temperature fire insulation conforming to MIL-PRF-32161 is installed, all butt joints shall be made to form a ½-inch compression seam by compressing adjacent sheets of high temperature fire insulation by ¼-inch. High temperature fire insulation systems of more than one layer of insulation shall have the seams between each layer offset in accordance with the fire test report in table XI.

i. A 2-inch wide fibrous-glass tape conforming to MIL-C-20079, Type II, Class 1 shall be secured with adhesive conforming to MIL-A-3316 over the coaming and the fibrous-glass cloth facing of the high temperature fire insulation.

j. Where some compartments, such as machinery spaces, may not have decks, the bottom edge of the fire insulation shall be protected by a boundary angle in areas where the insulation is subject to damage. Where the insulation is not subject to damage, the edge may be covered with fibrous-glass tape. The bottom edge of the high temperature fire insulation shall be treated as shown on figure 37.

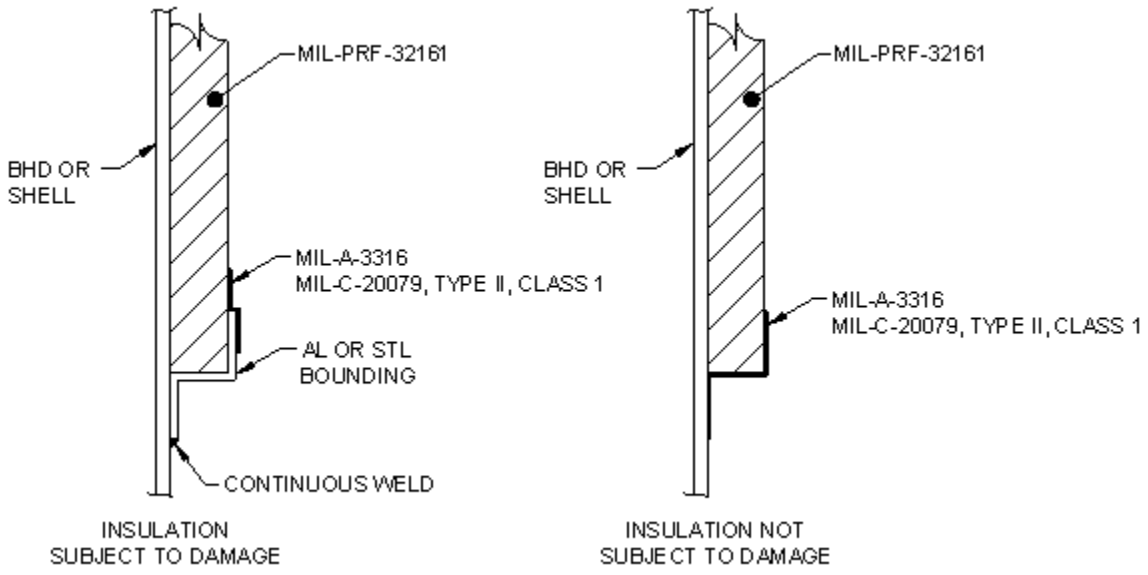

FIGURE 37. High temperature fire insulation end treatments.

k. All butt joints and seams shall be sealed with 2-inch wide fibrous-glass tape conforming to MIL-C-20079, Type II, Class 1, secured with adhesive conforming to MIL-A-3316, Class 1.

l. High temperature fire insulation required on beams and stiffeners shall be installed in one continuous wrap-around of the web and flange to form a boxed-in configuration. For fire insulation configurations thicker than 1 inch that contain fibrous-glass or polyimide-foam base layers, kerfing of the base layer shall be allowed only when necessary. Fibrous-glass filler pieces conforming to MIL-I-22023, Type I, Class 2 shall be installed on each side of the beam and stiffener webs under the high temperature fire insulation. Stud spacing along the length of the beam or stiffener shall be 12 inches maximum, except that where sections of insulation butt together, studs shall be positioned within 3 inches of the seam. Studs normally are positioned on the center of the beam and stiffener webs; however, studs shall be positioned within 3 inches of the end of the insulation wrap-around, as shown in Details B and D of 803-5184182. For beams, stiffeners, webs, and girders having a flange width greater than 4 inches, installation of the high temperature fire insulation shall be as specified on figure 38.

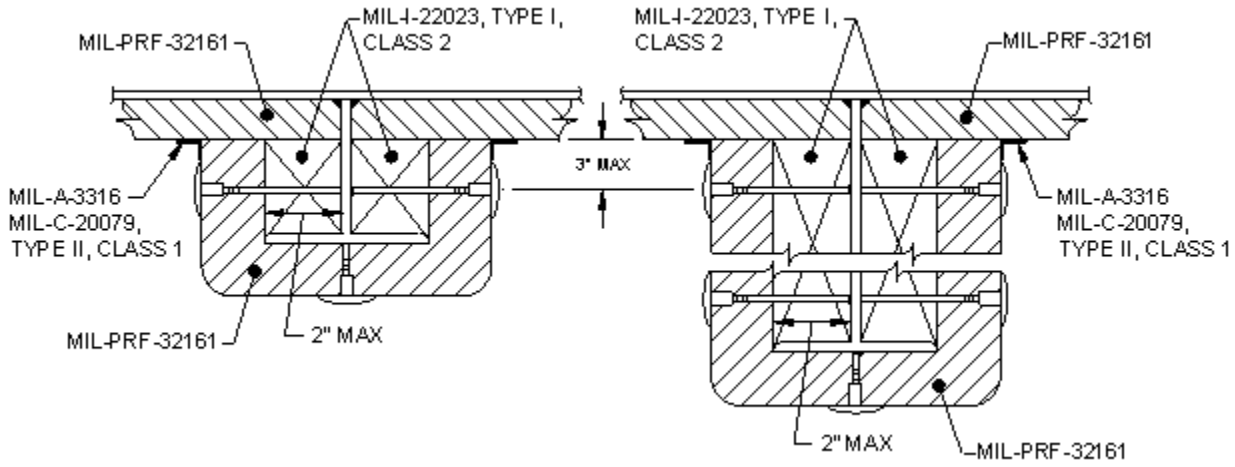

FIGURE 38. High temperature fire insulation installation on wide and deep beams.

m. Where there is a penetration sleeve installed in the web, high temperature fire insulation shall be used as filler pieces around the penetration sleeve, extending for at least 2 inches on either end of the sleeve (see figure 39).

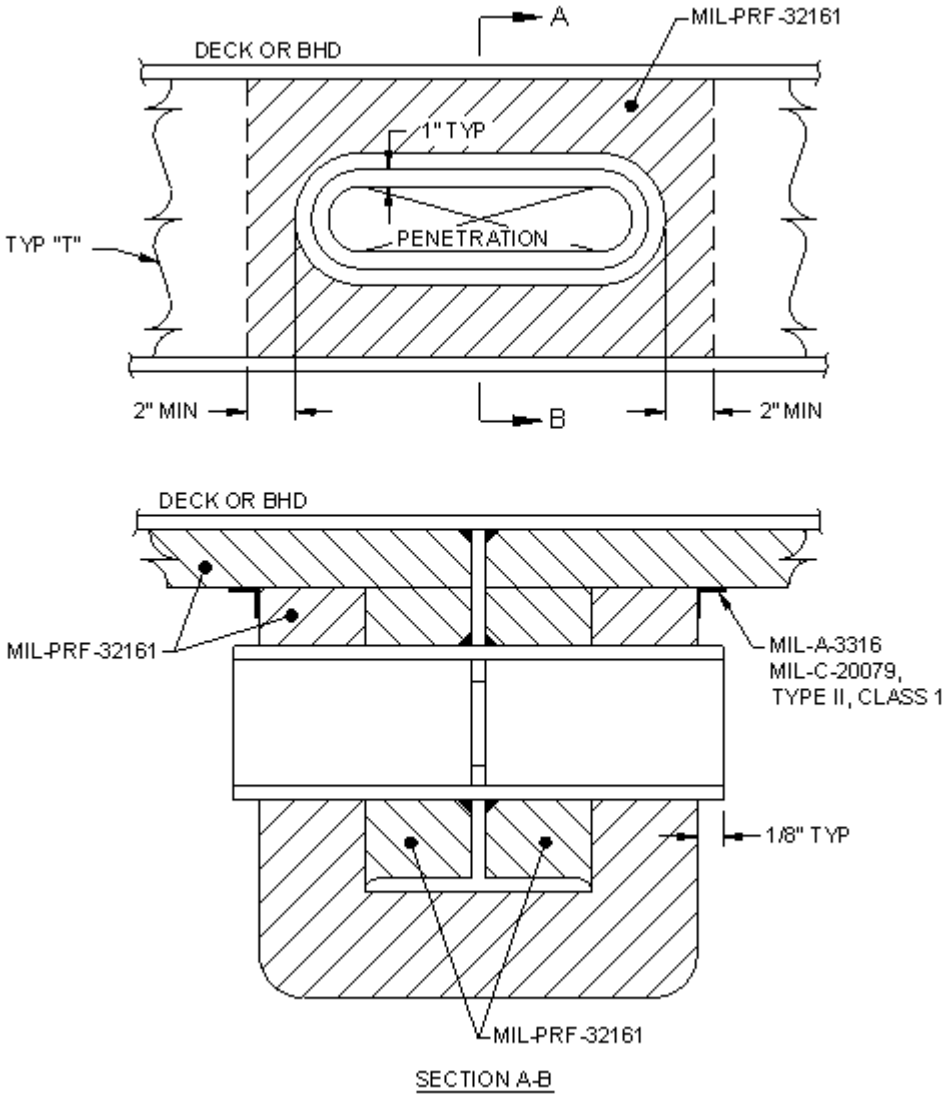

FIGURE 39. High temperature fire insulation installations around penetration sleeves in accordance with 803-5184182.

n. When stiffeners act as stanchions under transverse web frames, the stiffeners and both sides of the bulkhead plate, for a distance of 12 inches on either side of the stiffeners, shall be insulated for the full deck height (see figure 40). In addition, the upper 12 inches of the bulkhead shall be insulated on both sides (see figure 41).

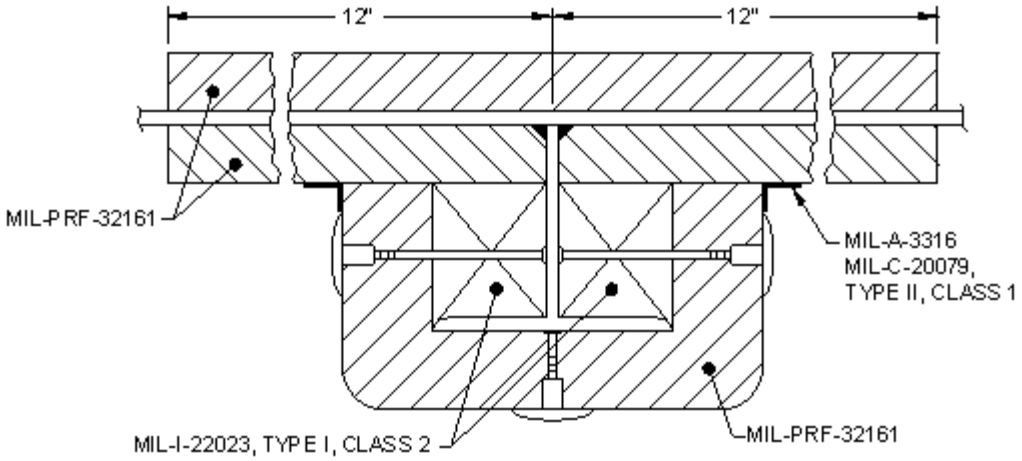

FIGURE 40. High temperature fire insulation installation on stiffeners under transverse frames.

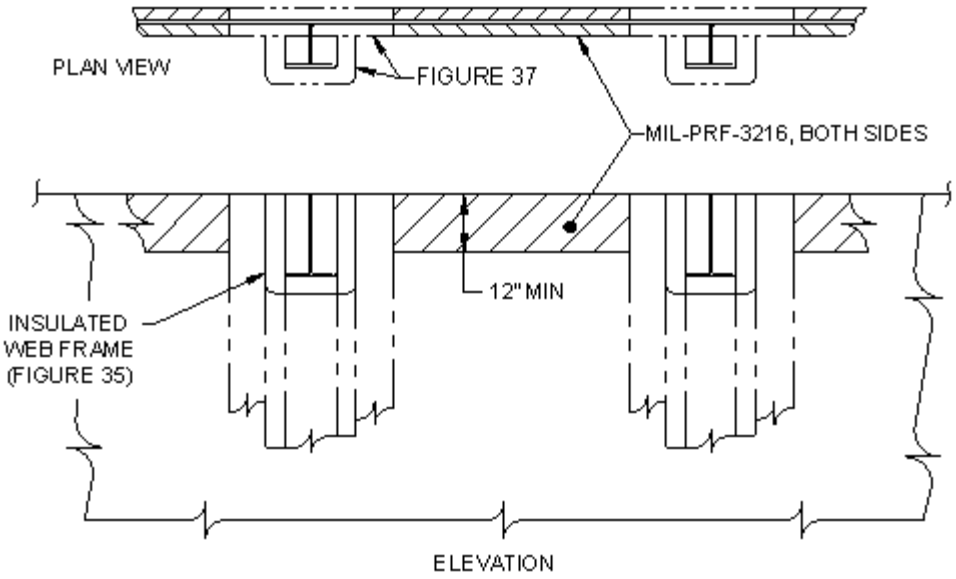

FIGURE 41. High temperature fire insulation installation on transverse bulkhead in accordance with 803-5184182.

o. On non-structural bulkheads where pipe stanchions act as supports, high temperature fire insulation system thickness in accordance with the list of N-class fire-resistant deck divisions in table XI shall be installed to cover the stanchion and a minimum of 12 inches on each side of the stanchion on both sides of the bulkhead as shown in Detail H of 803-5184182.

5.11.5 Oil, water, vapor protection, and sheathing of high temperature fire insulation. High temperature fire insulation, fire thermal, and fire acoustic insulation which may be exposed to oil, water, or vapors shall be treated as follows:

a. High temperature fire insulation conforming to MIL-PRF-32161 shall be brush coated with three coats of vapor barrier compound conforming to MIL-C-19565. The vapor barrier compound shall be pigmented orange and white and the three coats applied as white/orange/white. The final coat shall be pigmented to match the surrounding structure. Where acoustic insulation is required to be installed, it shall be painted with one coat of water based paint conforming to MIL-PRF-24596, pigmented to match the surrounding structure. The paint shall be applied in one thin coat and care shall be taken to prevent the paint from bridging or sealing the perforations in the acoustic treatment.

b. Where the high temperature fire acoustic insulation system is being installed, the outer surface of the insulation system shall consist of high temperature fire insulation conforming to MIL-PRF-32161, covered with a fiberglass scrim reinforced polyester film facing, such as Tuffskin #1613, IMO RMW, or equal as approved by NAVSEA. The fiberglass scrim reinforced polyester film facing shall be factory bonded to the high temperature fire insulation with adhesive conforming to MIL-A-3316, Class 1, Grade A. All seams and edges of the faced insulation shall be sealed with fibrous-glass tape conforming to MIL-C-20079, Type II, Class 1, secured with adhesive conforming to MIL-A-3316, Class 1, Grade A. All penetrations of the facing, including studs, shall be sealed with elastomeric sealant conforming to ASTM D6411/D6411M as shown in Detail P of 803-5184182. The order of installation of acoustic and fire insulation may be reversed subject to prior NAVSEA approval.

c. In high traffic and work areas, the inboard facing of fibrous-glass cloth or fiberglass scrim reinforced polyester film facing of the acoustic treatment shall be protected by aluminum sheathing conforming to ASTM B209, Alloy 5052, 0.04-inch thick, perforated with 3/16-inch diameter holes on 3/8-inch centers, staggered. The aluminum sheathing shall extend up from the deck for a height of 4 feet and shall be installed with a factory edge at the top. A 2-inch wide strip of fibrous-glass tape conforming to MIL-C-20079, Type II, Class 1 shall be secured with adhesive conforming to MIL-A-3316 and applied to the facing where the aluminum sheathing would rest against the facing, positioned such that 1 inch of fibrous-glass tape extends above the top of the aluminum sheathing. The aluminum sheathing shall be secured to the deck coaming with CRES rivets. Where dissimilar metals would be in contact, they shall be separated by two layers of isolating tape conforming to MIL-I-24391. Where high temperature fire insulation conforming to MIL-PRF-32161 is installed in high traffic and work areas, solid aluminum sheathing conforming to ASTM B209, Alloy 5052, 0.04 inch thick, shall be installed.

d. Fiberglass scrim reinforced polyester film facing, such as Tuffskin #1613, IMO RMW, or equal as approved by NAVSEA, and perforated aluminum sheathing conforming to ASTM B209, Alloy 5052, 0.04-inch thick, perforated with 3/16-inch diameter holes on 3/8-inch centers, staggered, shall be installed around beams as shown on figure 42. CRES, ceramic spacers, or speed clips may be used when aluminum sheathing is installed over the exterior surface of the insulation. Spacers are used to prevent the sheathing from being pushed in and compressing the insulation around the studs, such that the aluminum sheathing rests against the flared end of the spacer. In the event that spacers or speed clips compatible with the studs are not commercially available, acceptable substitutes may be fabricated from CRES 304 tubing cut to the proper length. The diameter of the tubing shall be the minimum necessary to fit over the stud.

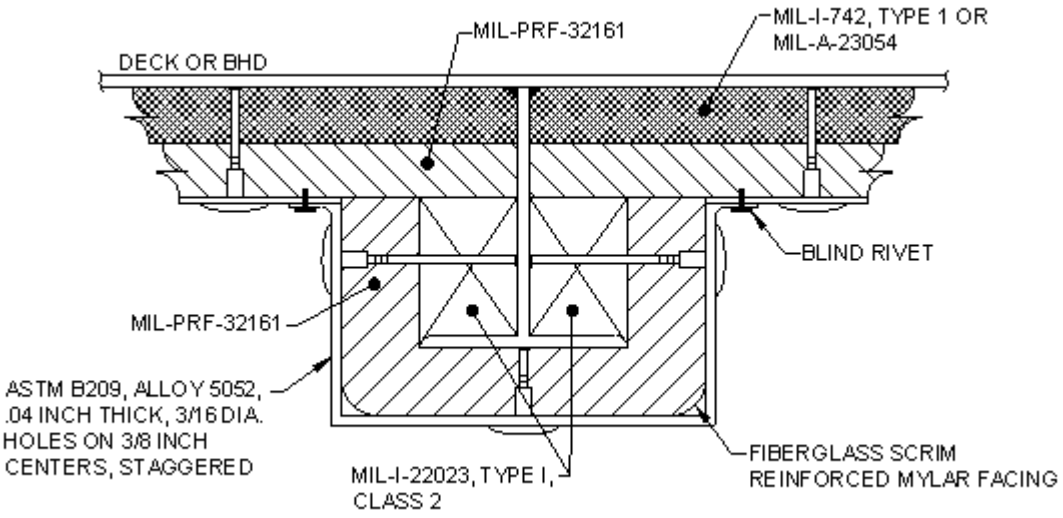

FIGURE 42. High temperature fire insulation with sheathing around beam.

5.11.6 High temperature fire insulation of doors and hatches. Aluminum bulkheads normally have steel doors where fire protection is required. The door and hatch frames are bolted to the aluminum bulkheads and overlap the bulkheads more than the standard installations on steel bulkheads. High temperature fire insulation shall be installed to completely cover the joint between the bulkhead and the door or hatch frame, and shall cover as much of the frame itself as is possible without interfering with operation of the doors and hinges, as shown on figure 43. The bounding angle bar shall be attached by a continuous weld to the bulkhead. Care shall be taken to ensure that there are no openings which could provide a heat path behind the high temperature fire insulation.

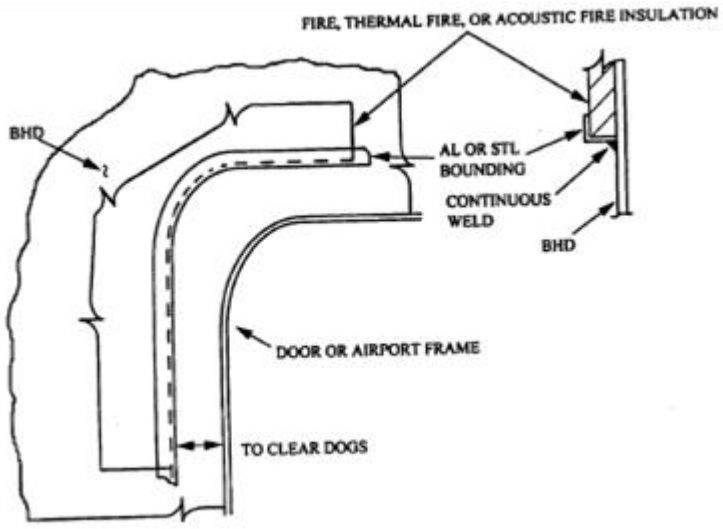

FIGURE 43. High temperature fire insulation treatment around doors and hatches.

5.11.7 Penetrations through bulkheads and decks. Penetrations in fire-resistant divisions shall be classified consistent with the rating of the boundary which they penetrate, except where otherwise specified, penetrations shall be tested in accordance with MIL-STD-3020.

a. High temperature fire insulation conforming to MIL-PRF-32161 shall be carefully fitted around all bulkhead penetrations. Where multiple penetrations are located in spaces requiring fire insulation, void spaces shall be packed with high temperature fire insulation and secured with adhesive conforming to MIL-A-3316, Class 1, Grade A.

b. Penetrations shall be wrapped a minimum of 12 inches and shall be secured with 0.5-inch wide by 0.020-inch thick steel bands as shown in Details S, T, and U of 803-5184182. Treatments around a pipe or vent penetration shall be as shown on figure 44. Treatments around bulkhead penetrations shall be as shown on figure 45.

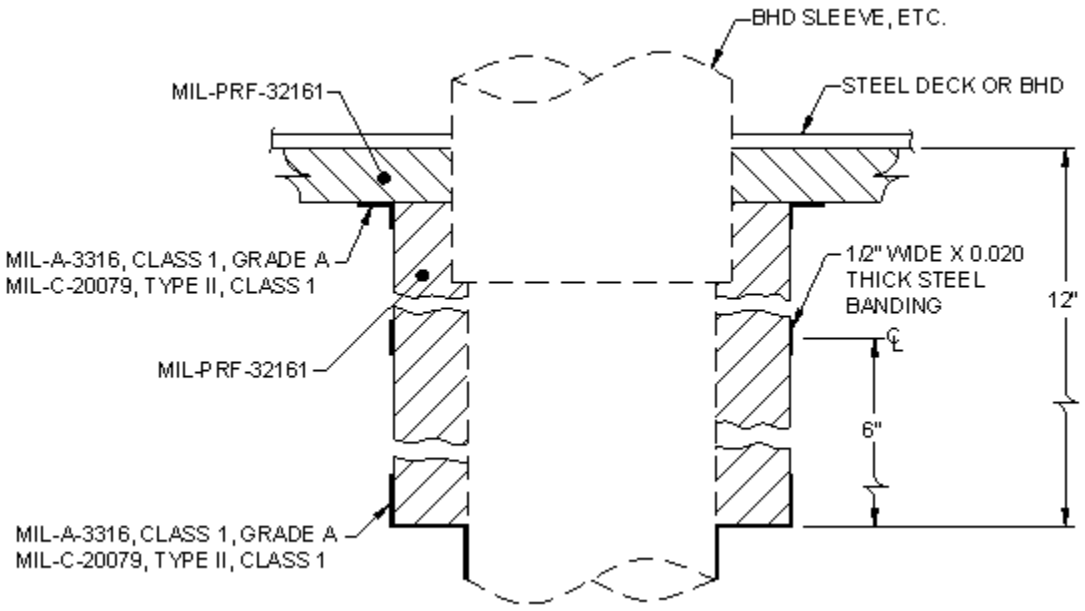

FIGURE 44. High temperature fire insulation treatment around pipe or vent penetrations.

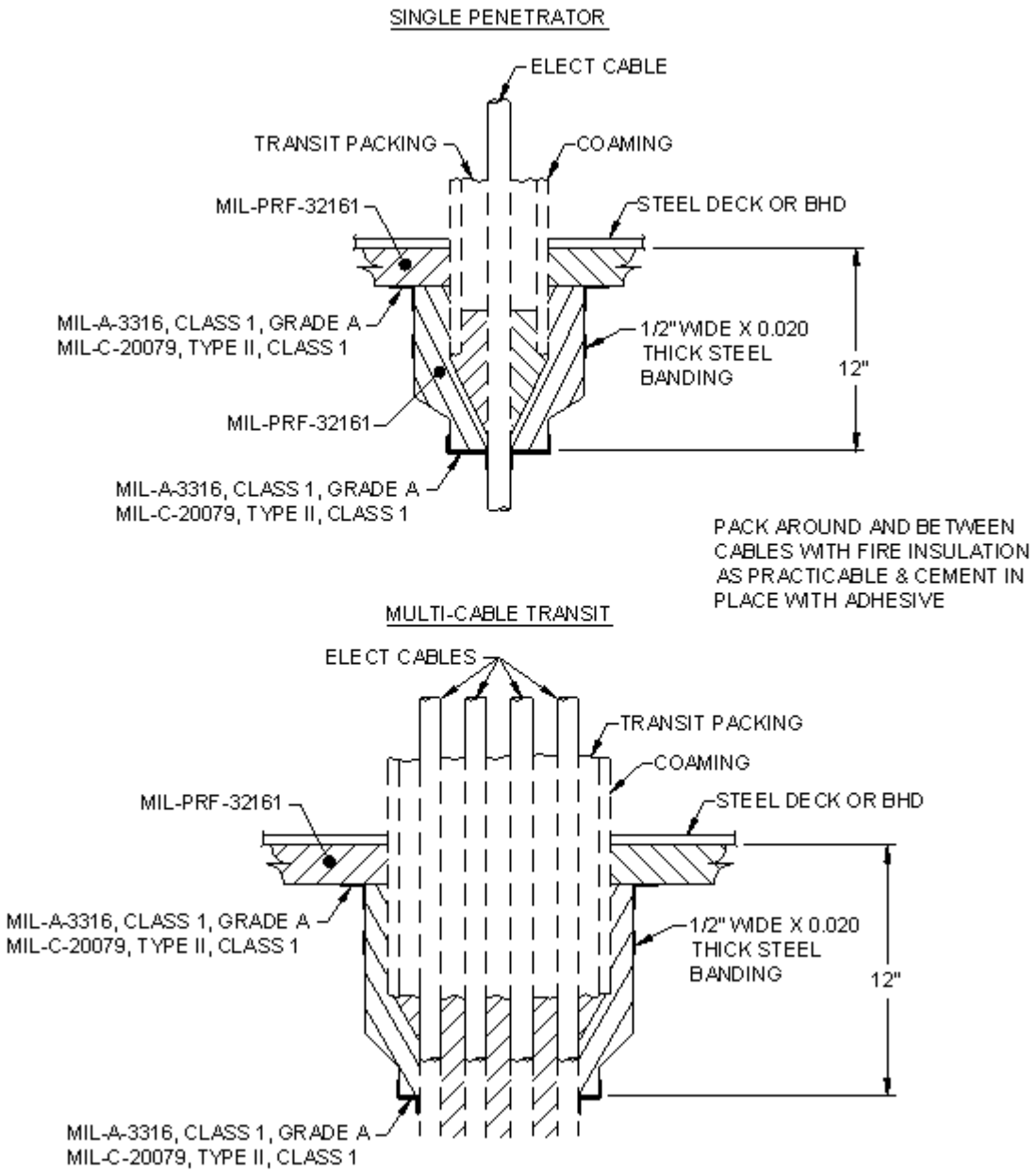

FIGURE 45. High temperature fire insulation around cable penetrations.

5.11.8 Ladders, cable hangers, pipe hangers, and supports. Ladders, cable hangers, pipe hangers, and supports for lighting fixtures and other supports shall be constructed of steel to withstand an intense fire. When these are installed on aluminum ship structures treated with high temperature fire insulation, a bi-metallic support arrangement shall be used with aluminum attachment points welded to the ship's structure. Steel ladders or supports shall be bolted to the aluminum attachment points. Dissimilar metals shall be separated by two layers of isolating tape conforming to MIL-I-24391. Bi-metallic support arrangements for lighting fixtures shall be as shown on figure 46. High temperature fire insulation conforming to MIL-PRF-32161 shall be installed to completely cover the aluminum and steel interface.

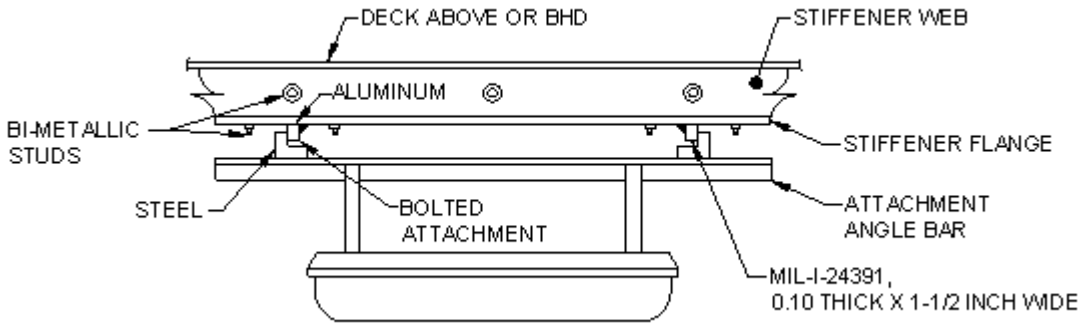

FIGURE 46. Light or electrical equipment attachment to stiffener in accordance with Detail Y of 803-5184182 (fire insulation removed for clarity).

5.11.9 High temperature fire insulation over ballistic or fragmentation protective panels. When high temperature fire insulation is installed over aramid fiber fragmentation protective panels, the installation shall be in accordance with 803-5184182 and figures 47, 48, and 49). The restraining straps shall provide support for the studs which hold the high temperature fire insulation in place (see figure 48). Stud spacing shall be a maximum of 12 inches, except that studs shall be located within 3 inches of the end of a section of high temperature fire insulation, including seams. The requirement for studs within 3 inches of a seam may require the installation of additional restraining straps to provide support for the studs. Care shall be taken to ensure that butt joints in high temperature fire insulation do not coincide with seams between adjacent aramid fiber fragmentation panels (see figure 49).

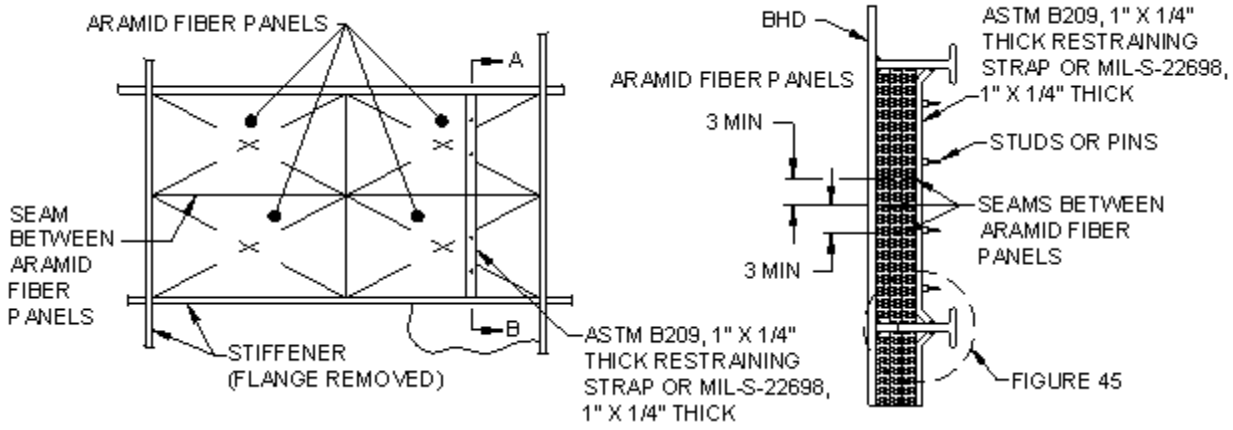

FIGURE 47. Multilayer installation of aramid fiber panels between stiffeners (fire insulation removed for clarity).

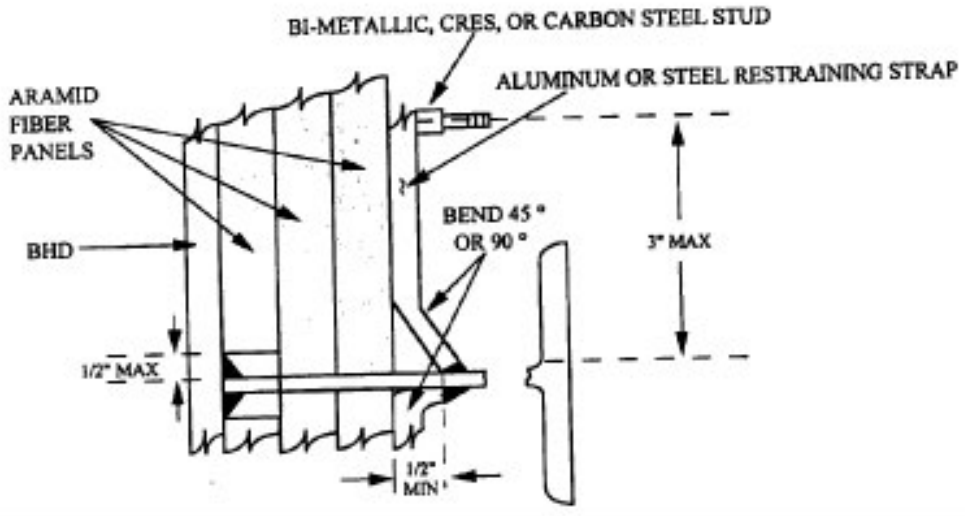

FIGURE 48. Installation of restraining strap and fire insulation studs over layered rigid aramid fiber panels.

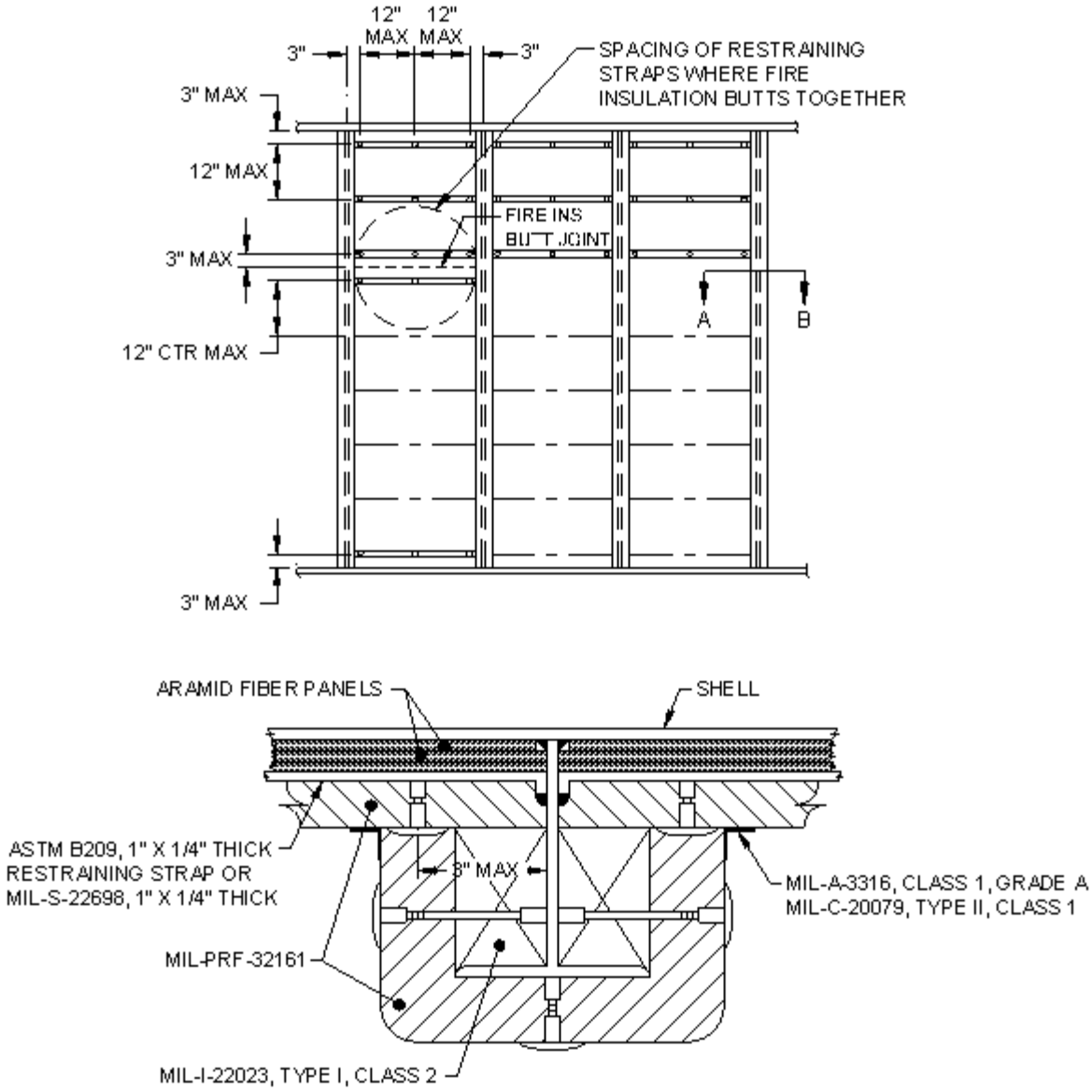

FIGURE 49. Typical installation of aramid fiber panel restraining strap showing fire insulation stud arrangement on bulkhead with vertical stiffeners (fire insulation removed for clarity).

5.11.10 Maintenance of high temperature fire insulation. All high temperature fire insulation shall be periodically inspected for damage. Immediate action shall be taken to repair all damage, including that considered as minor, since the effectiveness of high temperature fire insulation is dependent upon maintenance of its integrity. Damaged sections shall be removed and replaced with new high temperature fire insulation of the same type conforming to MIL-PRF-32161 and the divisions listed in table XI, in accordance with the procedures outlined in 803-5184182 and specified in 5.11.

TABLE XI. List of approved N-class fire-resistant divisions.

SYSCOM No.	Fire Insulation	Substrate	N-class Rating	Test Remarks	NAVSEA Approval	Reference 1/
N-0-01	Uninsulated	Steel deck or bulkhead, 0.18-inch (4.5-mm) plate with 4- × 4-inch (101.6- × 101.6-mm) tee stiffeners spaced 24 inches (609.6 mm) on center.	N-0 steel deck (overhead) or bulkhead.	Stiffened face exposed to fire.	Ser 05P4/055 14 Jun 2005	Test Article IAW MIL-STD-3020
N-0-02	Uninsulated	Steel deck, 0.188-inch (4.77-mm) plate with MT 3- × 2.2-inch (76.2- × 55.88-mm) stiffeners 15.748 inches (400 mm) apart, and deep stiffeners spaced 55.12 inches (1400 mm) apart.	N-0 steel deck (overhead) or bulkhead.	Stiffened face exposed to fire.	Ser 05P4/034 15 May 2006	SwRI Rpt # 01.11809.01.004, February 2006
N-30-01	Structo-Gard® (SG) 2/ insulation, one layer, 1 inch (25.4 mm) thick on each side, for a total of 2 inches (50.8 mm). Areal weight of insulation is 0.67 lbs./sq ft., per side.	Steel bulkhead, 0.18 inch (4.5 mm) thick, with 4- × 4-inch (101.6- × 101.6-mm) stiffeners, IAW MIL-STD-3020.	N-30 steel bulkhead (un-restricted application).	Insulation on both sides. Stiffened face exposed to fire.	Ser 05P4/055 14 Jun 2005	SwRI Rpt # 01.10679.01.001 C, May 2005
N-30-02	Structo-Gard® (SG) 2/ insulation, 3.5 inches thick (two layers, each layer 1.75 inches [44.45 mm] thick) on one side. Areal weight of insulation is 2.23 lbs./sq ft.	Steel bulkhead, 0.18 inch (4.5 mm) thick, with 4 × 4-inch (101.6 × 101.6-mm) stiffeners IAW MIL-STD-3020.	N-30 steel bulkhead (un-restricted application).	Insulation tested in worst case on stiffened non-fire side. Smooth bare steel face exposed to fire.	Ser 05P4/055 14 Jun 2005	SwRI Rpt # 01.10679.01.001 D, May 2005 with errata issued March 30, 2010

TABLE XI. List of approved N-class fire-resistant divisions – Continued.

SYSCOM No.	Fire Insulation	Substrate	N-class Rating	Test Remarks	NAVSEA Approval	Reference 1/
N-30-03	Structo-Gard® (SG) 2/ insulation, 3 inches (76.2 mm) thick (two layers, each layer 1.5 inches [76.2 mm] thick) on each side, for a total of 6 inches (152.4 mm). The total areal weight of insulation on both sides is 4.13 lbs./sq.ft.	Aluminum (5083-116) bulkhead, 0.157 inch (4 mm) thick, flat plate, stiffeners not required.	N-30 aluminum bulkhead (un-restricted application).	Insulation on both sides. No stiffeners on either side.	Ser 05P4/055 14 Jun 2005	SwRI Rpt # 01.10679.01.001 G, May 2005
N-30-04	Structo-Gard® (SG) 2/ insulation, one layer ⅝ inch (15.875 mm) thick. Areal weight of insulation is 0.55 lbs./sq ft.	Composite deck assembly, 3-inch (76-mm) thick balsa core and 0.275–inch (7-mm) fiber reinforced vinylester skin on both sides.	N-30 composite deck assembly (restricted application).	Insulation on the fire side.	Ser 05P4/107 27 Sep 2005	SwRI Rpt # 01.10679.01.003 B, July 2005
N-30-05	FireMaster X 607 Marine Blanket 3/ with VBD foil facing, two layers insulation, 1.5 inches (38.1 mm) thick on fire side. Areal weight of insulation is 1.8 lbs./sq ft.	0.079-inch (2-mm) aluminum deck (overhead) with stiffeners. Insulation is installed over the top of stiffeners creating an air gap of 1.38 inches (35 mm).	N-30 aluminum deck (overhead) or bulkhead (restricted application).	Stiffened face exposed to fire. For deck application, restricted to fire on underside.	Ser 05P4/023 07 Feb 2007	SwRI Rpt # 01.11717.01.003, May 2006

TABLE XI. List of approved N-class fire-resistant divisions – Continued.

SYSCOM No.	Fire Insulation	Substrate	N-class Rating	Test Remarks	NAVSEA approval	Reference 1/
N-30-06	FireMaster X 607 Marine Blanket 3/ with VBD foil facing, two layers of insulation, 1.5 inches (38.1 mm) thick on both sides, for a total of 6 inches (152.4 mm). The total areal weight of insulation on both sides is 3.69 lbs./sq.ft.	0.079-inch (2-mm) aluminum bulkhead with stiffeners. On the stiffened side, the insulation is installed over the top of stiffeners, creating an air gap of 2.36 inches (60 mm).	N-30 aluminum bulkhead (un-restricted application).	Stiffened face exposed to fire. For deck application, restricted to fire on underside.	Ser 05P4/023 07 Feb 2007	SwRI Rpt # 01.11717.06.002 A, July 2006
N-30-07	Structo-Gard® (SG) 2/ insulation, two layers ⅝inch and 1.25 inches (31.75 mm) thick on fire side, for a total thickness of 1⅞inches (47.625 mm). Areal weight of insulation is 1.3 lbs./sq ft.	Steel deck, 0.177 inch (4.5 mm) thick, with 4- × 4-inch (101.6 × 101.6-mm) stiffeners IAW MIL-STD-3020.	N-30 steel deck (overhead) or bulkhead (restricted application).	Stiffened face exposed to fire. Test continued for 1 hour. For deck application, restricted to fire on underside.	Ser 05P4/115 Nov 2006	SwRI Rpt # 01.12043.01.0,03 November 2, 2006
N-30-08	Structo-Gard® (SG) 2/ insulation, single layer, 1⅞inches (47.625 mm) thick on fire side. Areal weight of insulation is 1.4 lbs./sq ft.	Steel deck, 0.177 inch (4.5 mm) thick, with 4- × 4-inch (101.6 × 101.6-mm) stiffeners IAW MIL-STD-3020.	N-30 steel deck (overhead) or bulkhead (restricted application).	Stiffened face exposed to fire. For deck application, restricted to fire on underside.	Ser 05P2/016 2011	SwRI Rpt # 01.16046.01.602 A, December 1, 2010

TABLE XI. List of approved N-class fire-resistant divisions – Continued.

SYSCOM No.	Fire Insulation	Substrate	N-class Rating	Test Remarks	NAVSEA Approval	Reference [1/]
N-30-09	Microtherm Super G overstitched (MT) [4/] insulation, 0.315 inch (8 mm) thick on each side for a total of 0.630 inch (16 mm). Areal weight of insulation is 1.16 lbs./sq ft.	Steel bulkhead, 0.177 inch (4.5 mm) thick, with 4- × 4-inch (101.6 × 101.6-mm) stiffeners IAW MIL-STD-3020.	N-30 bulkhead unrestricted application (fire on either side).	Insulation on both sides. Stiffened face exposed to fire.	Ser 05P/153 2011	SwRI Rpt # 01.14836.A(1) Part 6, October 4, 2010
N-30-10	Microtherm Super G overstitched [4/] insulation, 0.630 inch (16 mm) thick (two layers, each layer 0.315 inch [8 mm] thick and insulation seams off-set by 20.28 inches [515 mm]). Areal weight of insulation is 1.04 lbs./sq ft.	Steel bulkhead, 0.177 inch (4.5 mm) thick, with 4- × 4-inch (101.6 × 101.6-mm) stiffeners IAW MIL-STD-3020.	N-30 steel deck or N-30 restricted bulkhead.	Stiffened face exposed to fire. For deck application, restricted to fire on underside. For bulkhead application, restricted to fire on insulated side.	Ser 05P/153 2011	SwRI Rpt # 01.14836.A(1) Part 4, October 4, 2010
N-30-11	FireMaster Marine Plus Blanket [3/], two layers of insulation, 1 inch (25.4 mm) thick with 2.0 mil aluminum foil inner layer and insulation seams off-set by 18 inches (457.2 mm), for a total thickness of 2 inches (50.8 mm) on fire side. Areal weight of insulation is 1.21 lbs./sq ft.	Steel bulkhead, 0.177 inch (4.5 mm) thick, with 4- × 4-inch (101.6 × 101.6-mm) stiffeners IAW MIL-STD-3020.	N-30 steel deck (overhead) or N-30 restricted bulkhead.	Stiffened face exposed to fire. For deck application, restricted to fire on underside. For bulkhead applications, restricted to fire on insulated side.	Ser 05P/059 2013	SwRI Rpt # 01.14836.01.001 B(1) Part 4.0, October 4, 2010

TABLE XI. List of approved N-class fire-resistant divisions – Continued.

SYSCOM No.	Fire Insulation	Substrate	N-class Rating	Test Remarks	NAVSEA Approval	Reference [1/]
N-30-12	FireMaster Marine Plus Blanket [3/], 1 inch (25.4 mm) thick on each side, for a total of 2 inches (50.8 mm). Areal weight is 1.21 lbs./sq ft.	Steel bulkhead, 0.177 inch (4.5 mm) thick, with 4- × 4-inch (101.6 × 101.6-mm) stiffeners IAW MIL-STD-3020.	N-30 steel bulkhead (unrestricted application).	Insulation on both sides. Stiffened face exposed to fire.	Ser 05P/059 2013	SwRI Rpt # 01.14836.01.001 B(1) Part 5.0, October 4, 2010
N-30-13	FireMaster Marine Plus Blanket [3/], two layers 2 inches and 1.5 inches (50.8 mm and 38.1 mm) thick, with a 2 mil. aluminum foil inner layer on the unexposed stiffened side, for a total of 3.5 inches (88.9 mm). Seams are off-set by 18 inches (457.2 mm). Areal weight of insulation is 1.81 lbs./sq ft.	Steel bulkhead, 0.177 inch (4.5 mm) thick, with 4- × 4-inch (101.6 × 101.6-mm) stiffeners IAW MIL-STD-3020.	N-30 steel bulkhead (unrestricted application).	Insulation installed on the unexposed stiffened side.	Ser 05P/059 2013	SwRI Rpt # 01.14836.06.001 (1), November 2, 2010
N-30-14	FireMaster Marine Plus Blanket [3/], two layers 1.5 inch (38.1 mm) thick, with a 2.0 mil aluminum foil inner layer, for a total thickness of 3 inches (76.2 mm) on the fire side. Seams are off-set by 18 inches (457.2 mm). Areal weight of insulation is 1.65 lbs./sq ft.	Aluminum deck, 0.118 inch (3.0 mm) thick with 6 × 2.5-inch (152.4- × 63.5-mm) C-channel stiffeners spaced on 24-inch (609.6 mm) centers.	N-30 aluminum deck (overhead) or bulkhead (restricted application).	Stiffened face exposed to fire. For deck application, restricted to fire on underside.	Ser 05P/059 2013	SwRI Rpt # 01.15870.03.001, August 27, 2010

TABLE XI. List of approved N-class fire-resistant divisions – Continued.

SYSCOM No.	Fire Insulation	Substrate	N-class Rating	Test Remarks	NAVSEA Approval	Reference 1/
N-30-15	FireMaster Marine Plus Blanket 3/, two layers 1.5 inch (38.1 mm) thick, with a 2 mil aluminum foil inner layer installed on both sides, for a total thickness of 6 inches (152.4 mm). Seams are off-set by 18 inches (457.2 mm). Total areal weight is 3.28 lbs./sq ft.	Aluminum bulkhead, 0.118 inch (3 mm) thick with 6 × 2.5-inch (152.4- × 63.5-mm) C-channel stiffeners spaced on 24-inch centers.	N-30 aluminum bulkhead (unrestricted application).	Insulation on both sides. Stiffened face exposed to fire.	Ser 05P/059 2013	SwRI Rpt # 01.15870.02.001, August 27, 2010
N-30-16	FireMaster Marine Plus Blanket 3/, 12 pcf nominal density, two layers 0.75 inch (19.05 mm) thick, with a 2 mil aluminum foil inner layer and Mylar facing on the outer, for a total thickness of 1.5 inches (38.1 mm) on the fire side. Seams are off-set by 18 inches (457.2 mm). Areal weight of insulation is 1.6 lbs./sq ft.	Steel deck, 0.157 inch (4 mm) thick with large T-shaped stiffeners made from a M10 × 9 beam cut to 8.46-inch (215-mm) deep spaced on 55-inch (1396-mm) centers and 2.5- × 0.25-inch (63.5- × 6.35-mm) flat bar stiffeners perpendicular to large T-shaped stiffeners spaced on 15.75-inch (400-mm) centers.	N-30 steel deck (overhead) and restricted bulkheads.	Stiffened face exposed to fire. For deck and restricted bulkhead application, the use of this system is limited to LCS 5 AF where reduced thickness is required to avoid interference with other shipboard systems.	Ser 05P/060 2013	SwRI Rpt # 01.16046.01.412, November 18, 2011

TABLE XI. List of approved N-class fire-resistant divisions – Continued.

NOTES:

1/ Approval applies when fire-resistant assembly is constructed and insulated (where applicable) in accordance with the description and drawings contained in the referenced fire test report and 803-5184182. This approval does not currently apply to submarines. Additional testing would be required under the submarine material control program.

2/ Structo-Gard® (SG) insulation, or equal as approved by NAVSEA.

3/ FireMaster Marine Plus Blanket, or equal as approved by NAVSEA.

4/ Microtherm Super G overstitched (MT) insulation, or equal as approved by NAVSEA.

5.12 General maintenance of insulation. Scheduled maintenance shall be in accordance with the PMS where PMS is implemented. Where PMS is not implemented, the following inspection requirements shall be used:

a. Visual inspections of the insulation shall be performed at least once a year and preferably at 6-month intervals.

b. All loose insulation, facings, or lagging materials shall be securely fastened in accordance with the instructions herein. If such material is broken, a complete reinstallation shall be required.

c. If insulation is water logged or damaged, the insulation shall be stripped from the surface and new insulation installed in accordance with the instructions herein. This procedure will prevent serious corrosion of piping by insulation that retains a large amount of water after dewatering operations. The procedure for inspecting pipes under the water-damaged insulation in S9086-RK-STM-010 shall be followed. The extent of wetting may be determined by examining insulation for such signs of wetting as moisture, discoloration, distortion, and flaked paint.

d. For detection of heat loss or cracks in insulation causing hot spots, an infrared thermometer, surface pyrometer, or heat gun shall be used in the inspection of insulation to locate hot spots where temperatures exceed the specified surface temperature (see 4.3). Once the hot spots have been located, corrective action shall be initiated (see 5.12.1). This procedure may be used in shipboard maintenance programs and also in pre-overhaul tests and inspections to identify insulation replacement requirements.

NOTE

The insulation items being inspected should be on systems operating normally and which are stabilized at normal operating temperatures.

5.12.1 Repair or replacement of insulation. The following inspection results shall require the following repair or replacement of insulation:

a. Missing or deteriorated insulation: If insulation is missing or deteriorated on pipes or surfaces, the insulation shall be removed and replaced with the specified insulation materials using the installation procedures outlined herein.

b. Oil or water soaked insulation: If insulation is oil- or water-soaked, all affected insulation shall be removed. The source of the oil or water leak shall be repaired prior to insulation being installed. The surface shall be clean and dry prior to installation of insulation.

c. Inadequate thickness of insulation: The actual thickness of the installed insulation shall be verified to be in accordance with the thickness specified for the particular application. Insulation shall be replaced with that of the specified proper thickness.

d. Loose or improperly installed insulation: Insulation found to be loose or improperly installed shall be replaced.

e. Voids under removable covers: Removable covers shall be checked underneath for the presence of voids. Void space shall be filled with layers of fibrous-glass felt conforming to MIL-I-16411 to the thickness of the adjoining pipe covering.

f. PVC/nitrile foam conforming to MIL-P-15280, polyphosphazene elastomeric foam, or polyimide foam conforming to MIL-DTL-24688 used for anti-sweat pipe insulation, that is removed, shall be replaced with anti-sweat insulation materials conforming to MIL-PRF-32514. When repairing or replacing sections of polyimide-foam insulation conforming to MIL-DTL-24688, seal the cut ends of the insulation with a coat of solvent-based vapor barrier conforming to MIL-C-19565, Type II. This shall be done immediately to prevent moisture vapor from becoming entrapped in the foam.

5.12.2 Emergency repairs of hot pipe insulation for ships at sea. Where emergency repairs are necessitated while a ship is at sea and they do not have the identical replacement materials for repair and replacement of hot pipe insulation, the fibrous-glass insulation tape conforming to MIL-C-20079 and fibrous-glass felt insulation conforming to MIL-I-16411, at the thicknesses specified in table XII, may be used on a temporary basis only. Construction details shall be as specified (see figures 50 and 51). Insulation tape shall be replaced with NAVSEA-approved pipe insulation at the earliest opportunity.

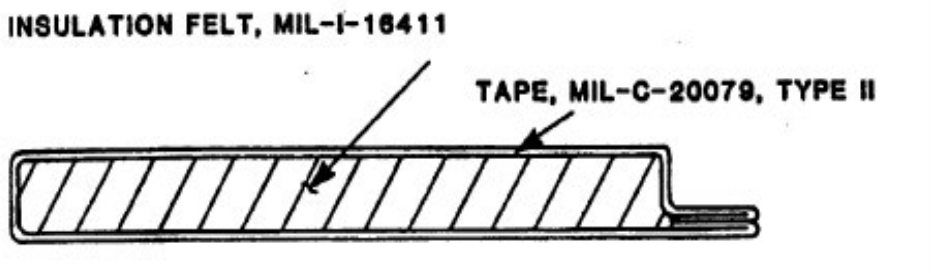

FIGURE 50. Thermal insulation tape.

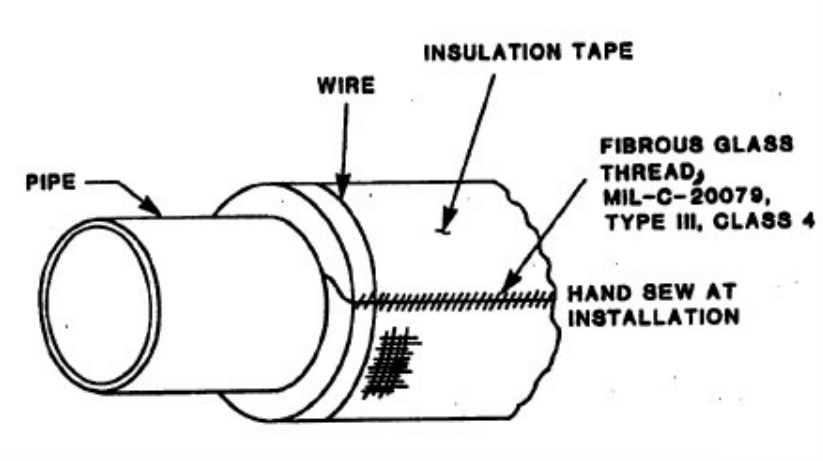

FIGURE 51. Typical lateral wrapped tape application.

5.12.2.1 Thermal insulation tape installation for emergency repairs. Thermal insulation tape may be applied to pipe, sizes ¼- to ¾-inch, for temperatures between 125 and 750 °F, for emergency repairs. Thicknesses shall be in accordance with table XII. The tape is fabricated with a glass cloth jacket, encasing fibrous-glass felt as shown on figure 50. An inner jacket of 0.008-inch crimped, stainless steel mesh is used where pads of thermal insulation tape are required, and where the temperature of the hot surface is 450 °F, or above. Alternatively, the inner (hot) surface of the insulation tape shall be fabricated from wire-reinforced glass cloth conforming to HH-P-31, Type I, Class 1. Laterally wrapped thermal tape shall be secured with wire at both ends and elsewhere as required to shape it to the pipe. The longitudinal seam shall be sewn with wire-reinforced thread conforming to MIL-C-20079, Type III.

TABLE XII. Thickness of insulation tape conforming to MIL-C-20079 and MIL-I-16411 for ¼-to ¾-inch size hot piping. 1/ 2/

Maximum Operating Temperature (°F)	Pipe Size (inches), Nominal	Thickness (inches)
125 to 250	¼, ⅜	⅜
251 to 750	¼, ⅜	1½
125 to 350	½, ¾	½
251 to 388	½, ¾	1
389 to 500	½, ¾	1½
501 to 750	½, ¾	2

NOTES:

1/ To be used only on a temporary basis, such as emergency repair of insulation while ship is at sea. These materials are flexible enough for emergency pipe wrapping. Insulation tape shall be replaced by NAVSEA-approved pipe insulation materials at the earliest opportunity.

2/ Used only as a laminate construction consisting of a glass fabric outer jacket conforming to MIL-C-20079 with a fibrous-glass felt insert conforming to MIL-I-16411. (An inner jacket of 0.008-inch crimped, stainless steel mesh shall be 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.)

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The thermal, high temperature fire, and acoustic insulation specified in this standard is used for the insulation of piping, machinery, uptakes, mechanical equipment, refrigerated spaces, vent ducts, and compartments used by the Navy for individual and classes of ships.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this standard.

b. Specific areas to be insulated and type and thickness of insulation materials to be installed (see 4.1.1).

c. Requirements for preparing surfaces to which insulation is applied (see 4.13).

d. When covering fibrous-glass cloth and tape lagging with one coat of fire-retardant paint conforming to MIL-DTL-24607 is not required (see 5.4.3).

e. Requirements for installing insulation (see 5.4.11).

f. Insulation thickness requirements (see 5.5.1.a, 5.5.1.b, 5.5.1.c, and 5.9.1).

g. When only a portion of the duct is required to be lined (see 5.6.2.a).

h. When application of transmission loss treatments is required for ducts that pass through extremely noisy spaces (see 5.7.1.c).

i. Requirements for the extent of protective high temperature fire insulation to be installed on ship's structures (see 5.11.2.b).

j. The required N-class (see 5.11.2.c).

k. Approval of test procedures (see 5.11.2 f).

6.3 Subject term (key word) listing.

Acoustic

Anti-sweat

Boiler uptakes

Cold and chilled water

Finishing cement

High temperature fire

Metal lagging

Refrigerant

Thermal

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 extent of the changes.

Preparing activity:
Navy – SH
(Project 5640-2013-001)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.