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DEPARTMENT OF DEFENSE
STANDARD PRACTICE

VIBRATION DAMPING MATERIALS, PROCEDURES FOR INSTALLATION, MAINTENANCE, AND REPAIRS

AMSC N/A FSC 93GP

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND

Washington, DC 20362

Vibration Damping Materials, Procedures for Installation, Maintenance, and Repairs

MIL-STD-2148(SH)

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

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

1. This Military Standard provides instructions for the selection, installation, maintenance, and repair of vibration damping materials.

2. Noise radiated from a ship into the sea is in part due to the resonance response of the ship's structures to applied vibratory forces. These forces, for the most part, originate in machinery or equipment supported on foundations, bulkheads, and decks. The turbulent flow of water around the hull of a surface ship or submarine produces hydrodynamic forces which excite the hull plates in vibratory motion. Damping treatments applied on these structures reduce the amplitudes of motion and force at their numerous resonance frequencies, and thus reduce radiated noise.

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1. SCOPE

1.1 Scope. This Military Standard establishes uniform standards for the selection, installation, maintenance, and repair of currently-approved vibration damping materials, except those used for mounts and pipe damping. Information on mounts and pipe damping may be found in NAVSHIPS 0939-001-2010. It specifies the types of damping materials to be used in both submarines and surface ships, delineates those areas where the treatments normally are applied, and provides guidelines for their installation and maintenance. This document is intended to supplement individual ship specifications, and to provide guidance in those instances where specific direction has not been made available in the form of ship specifications.

1.2 Classification. Damping materials are of the following types and classes:

Type I - Chromated-felt impregnated with a visco-elastic material (usually polyisobutylene) constructed in accordance with MIL-G-20241. (Not recommended for new design, see 6.1).
Type II - Flexible plastic tiles normally 12 by 12 inches containing graphite constructed in accordance with MIL-P-23653.

Class 1 - Tiles used for damping steel plate in the temperature range of 35 to 55 degrees Fahrenheit (“F).
Class 2 - Tiles used for damping steel plate in the temperature range of 56 to 80°F or 56 to 90°F if constrained.
Class 3 - Tiles used for damping steel plate in the temperature range of 81 to 155°F or 91 to 155°F if constrained.

Type III - Flexible plastic tiles normally 12 by 12 inches of epoxy polyamide resin filled with a large volume of sand in accordance with MIL-P-22581.
Type IV- See 6.2.
Type V - A flexible nitrile rubber tile normally 12 by 12 inches constructed in accordance with MIL-T-24487.

Class 1 - Tiles which are 3/4-inch thick and are used with a 1/8 inch glass reinforced plastic restraining septum for damping metal plate 1/2 inch or less in thickness.
Class 2 - Tiles which are 5/8-inch thick and are used with a 1/8 inch aluminum constraining septum for damping metal plate greater than 1/2 inch in thickness.

2. REFERENCED DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein.

SPECIFICATIONS

FEDERAL

L-P-378 – Plastic Sheet and Strip, Thin Gauge, Polyolefin.
P-S-411 – Skin Protective Compound, Chemical Barrier.
O-T-620 – 1,1,1-Trichloroethane, Technical Inhibited (Methyl Chloroform).
BB-A-1034 – Air, Compressed, For Breathing Purposes.
QQ-A-250/8 – Aluminum Alloy 5052, Plate and Sheet.
VV-P-236 – Petrolatum, Technical.

MILITARY

MIL-I-631 – Insulation, Electrical, Synthetic-Resin Composition, Nonrigid.
MIL-S-901 – Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-C-11796 – Corrosion Preventive Compound, Petrolatum, Hot Application.
MIL-P-15035 – Plastic Sheet: Laminated, Thermosetting, Cotton-Fabric-Base, Phenolic-Resin.
MIL-P-15931 – Paint, Antifouling, Vinyl (Formulas No. 121 and 129).
MIL-C-16173 – Corrosion Preventive Compound, Solvent Cutback, Cold-Application.
MIL-D-16791 – Detergents, General Purpose (Liquid, Nonionic).
MIL-P-17549 – Plastic Laminates, Fibrous Glass Reinforced, Marine Structural.
MIL-R-21607 – Resin, Polyester, Low Pressure Laminating, Fire-Retardant.
MIL-C-22230 – Cleaning Compound, Fuel Tank and Bilge.
MIL-T-22361 – Thread Compound; Antiseize, Zinc Dust-Petrolatum.
MIL-P-22581 – Plastic Sheet, Vibration Damping.
MIL-S-22698 – Steel Plate and Shapes, Weldable Ordinary Strength and Higher Strength: Hull Structural.
DOD-P-23236 – Paint Coating Systems, Steel Ship Tank, Fuel and Salt Water Ballast (Metric).
MIL-P-23653 – Plastic Tiles, Vibration Damping.
MIL-S-24149 – Studs, Arc Welding, and Arc Shields (Ferrules), General Specification for.
MIL-S-24149/l - Studs, Arc Welding, and Arc Shields (Ferrules); Type I, Class 1, 2, 3 and Type II, Class 1, 4, 5, 5A, 6, Ordinary Strength Steel, For Direct Energy Arc Welding.
MIL-S-24149/3 - Studs, Arc Welding, and Arc Shields (Ferrules); Type V, Class 1, 4, 5, 5A, Corrosion-Resistant Steel, For Direct Energy Arc Welding.
MIL-P-24441 - Paint, Epoxy-Polyamide General Specification for.
MIL-P-24441/l - Paint, Epoxy - Polyamide, Green Primer, Formula 150, Type I.
MIL-P-24441/2 - Paint, Epoxy - Polyamide, Exterior Topcoat, Haze Gray, Formula 151, Type I.
MIL-P-24441/3 - Paint, Epoxy - Polyamide, Topcoat, White, Formula 152, Type I.

MIL-P-24441/7 - Paint, Epoxy - Polyamide, Topcoat, Red, Formula 156, Type I.
MIL-P-24441/9 - Paint, Epoxy-Polyamide, Primer, Yellow, Formula 158, Type I.
MIL-P-24441/10 - paint, Epoxy - Polyamide, Green primer, Formula 150R66, Type II.
MIL-P-24441/11 - Paint, Epoxy - Polyamide, Exterior Topcoat, Haze Gray, Formula 151R66, Type II.
MIL-P-24441/12 - Paint, Epoxy - Polyamide, Topcoat, White, Formula 152R66, Type II.
MIL-A-24456 – Adhesive for Plastic Vibration-Damping Tiles.
MIL-A-24485 – Acoustic Reflector Tile, Type AR-l(U).
MIL-A-24486 – Acoustic Absorber Tile, Type AA-4(U).
MIL-T-24487 – Tile, Rubber Vibration Damping, Type MIRL No. 3.
MIL-C-24576 – Cloth, Silica Glass; Cloth, Coated, Glass, Silicone Rubber Coated.
MIL-N-25027 – Nut, Self-Locking, 250°F, 450°F, and 800°F, 125 KSI Ftu, 60 KSI Ftu, and 30 KSI Ftu.
MIL-P-38714 – Packaging and Packing of Two Component Materials in Semkits.

STANDARDS

MILITARY

MIL-STD-1688 – Fabrication, Welding, and Inspection of HY-80/100 Submarine Applications.
MS17829 – Nut, Self-Locking, Hexagon, Regular Height, 250°F, (Non-Metallic Insert) Non-Corrosion-Resistant Steel.
MS17830 – Nut, Self-Locking, Hexagon-Regular Height, 250°F, (Non-Metallic Insert) 300 Series Corrosion Resistant Steel.

PUBLICATIONS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

0900-LP-000-1000 - Ship Hulls Fabrication Welding and Inspection.
0967-LP-412-3010 - Sonar Dome Handbook Volume 1 For AN/SQS-4 and -23 (Sonar Domes).
0967-LP-412-3020 - Sonar Dome Handbook Volume 2 for AN/SQ5-26 (Steel and Rubber Domes).
0967-LP-412-3030 - Sonar Dome Handbook Volume 3 for AN/SQQ-38 (Group Sonar Domes).
0967-LP-412-3040 - Sonar Dome Handbook Volume 4 for AN/SQQ-23 (Rubber Sonar Domes).
0967-LP-412-3050 - Sonar Dome Handbook Volume 5 for W/ERR (Submarine).
S9086-VD-STM-000 - Naval Ships Technical Manual Chapter 631 (Preservation of Ships In Service, Surface Preservation and Painting.)
T9830-AA-DDT-010 - Sonar Dome Window Design Requirements.

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

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A 366 - Steel Sheet, Carbon, Cold-Rolled, Commercial Quality. (DoD adopted)
A 569 - Steel Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality. (DoD adopted)
B 209 - Aluminum and Aluminum-Alloy Sheet and Plate. (DoD adopted)
D 364 - Industrial Grade Xylene. (DoD adopted)

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

NATIONAL FIRE PROTECTION ASSOCIATION

National Electric Code

(Application for copies should be addressed to the National Fire Protection Association, 60 Batterymarch Street, Boston, MA 02110.)

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Rules and Regulations
Rules 102 and 442

(Application for copies should be addressed to the South Coast Air Quality Management District, 9150 E. Flair Drive, El Monte, CA 91731.)

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

Painting Manual, Volume 2, Systems and Specifications, Surface Preparation Specification SP10 - Near White Blast Cleaning.

(Application for copies should be addressed to the Steel Structures painting Council, 4400 5th Avenue, Pittsburgh, PA 15213.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. DEFINITIONS

3.1 Anti-corrosion paint. Anti-corrosion paint is a paint coating intended to control corrosion by isolating the metal surface from the environment. Some anti-corrosion paints also contain metallic elements and other ingredients that provide a measure of cathodic protection and inhibit corrosion.

3.2 Antifouling paint Antifouling paint is a paint coating used to Prevent (or reduce) biotic growth on surfaces exposed to seawater. Present-day formulas usually contain a mechanism that leaches copper or tin ions by which marine organisms, trying to attach themselves to the surface, are poisoned.

3.3 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 3/4 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.

3.4 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.

3.5 Damping material. Damping material is a plastic or rubber-like substance that can be applied to structures to reduce vibrations. It may consist of a tile that can be cemented to the structure, or a material that can be sprayed on.

3.6 Dry film thickness. Dry film thickness is the thickness of a coat of paint after it has dried or cured.

3.7 Epoxy. Epoxy coatings, fillers, and adhesives are tenacious, very strong materials formed by a chemical reaction. The reaction is started by mixing the epoxy resin with a curing agent; the product must then be applied promptly, since the mixture cures in a short time. Some epoxy components are toxic and irritating to the skin.

3.8 Free-layer damping. Free-layer damping are damping tiles which are installed without a constraining or restraining layer. The tiles are attached . to ship's structure with an epoxy adhesive.

3.9 Galvanic corrosion. Galvanic corrosion is the type of corrosion (for example, pitting) resulting from the chemical reaction that takes place when two dissimilar metals are in contact with each other or are immersed in an electrolytic ionic solution (such as seawater). It can also occur if anode-cathode variations in the same alloy exist over the same piece of metal.

3.10 Grit-blasting. Grit-blasting is a surface preparation operation that utilizes only dry sand or grit. The grit-blasting technique is normally employed whenever the metal being cleaned is especially sensitive to rusting due to the presence of water.

3.11 Near-white metal. Near-white metal is a condition of a metal surface which has been grit or sand-blasted where oil, grease, dirt, mil scale, rust, paint, and other foreign material has been removed, except for very light shadows and discoloration (see SSPC-SP10).

3.12 Resonance frequency. In general, the resonance frequency of a structure is the frequency at which the maximum vibration signal can be obtained for a given stimulus.

3.13 Restraining layer. A restraining layer is a glass-reinforced plastic sheet, l/8-inch thick, the purpose of which is to restrain the damping tiles in the event they should become detached by severe mechanical shock forces. The restraining layer is secured to the ship's structure with metal studs. A lubricant is used between the restraining layer and damping tiles in installations external to the pressure hull.

3.14 Sweep-blasting. Sweep-blasting is a surface preparation technique in which the operator moves the stream of sand or grit very rapidly across the surface to give it a light cleaning.

3.15 Template. Template is a gage or pattern, such as a thin plate or board, used as a guide during fabrication of a piece or component to ensure that it conforms to the shape or contour desired.

3.16 1,1,1 trichloroethane. 1,1,1 trichloroethane (methyl chloroform) is an organic compound, used as a solvent to remove grease and oil from steel surfaces and damping material.

3.17 Zinc. Zinc is a block of metal alloy commonly used as a sacrificial anode to protect the ship's structure from galvanic corrosion.

3.18 Zinc chromate. Zinc chromate is an alkyd-based coating containing the rust inhibitive pigment zinc chromate.

4. GENERAL REQUIREMENTS

4.1 Discussion. Specific areas to be damped, along with the type and quantities of damping materials *to* be installed, are delineated in individual ship specifications or in detail drawings. In the absence of those specific details, the following guidelines describe the general areas of usage and the considerations governing use of damping materials. In general, those areas to be damped shall have a minimum of 80 percent average coverage.

4.2 General. Damping treatments shall not be installed in the following areas on either submarines or surface ships:

(a) To curved surfaces having a radius of 18 inches or less.
(b) To either side of a structure in way of lead ballast, bulkheads with lead shielding, and filled voids.
(c) To the underside of deck areas that are covered with ceramic tiles or trowel-on deck covering on the top side.
(d) Tiles shall not be installed where the panel to be damped is less than 3 inches wide or 64-square inches in area.
(e) Tiles shall not be installed on webs of channel, T and I-beams and sides of angle bars and structural tubes where width of tile would be less than 3 inches, or distance between supports or boundaries is less than 1 foot.
(f) Tiles shall not be installed where constraining or restraining layer width would be less than 3 inches.

(g) In reactor compartments.
(h) On pressure hull of submarines.
(i) In way of zincs.
(j) The interior of potable water tanks, sanitary tanks, depth control tanks, bilge collecting tanks, hydraulic oil tanks, and lubricating oil tanks.

4.2.1 Interference from other systems. Where interferences such as piping and wireways are encountered, at least 2/3 of the panel area shall be damped, but the total area shall have a minimum of 80 percent average coverage.

4.2.2 Pre-forming damping materials. Constraining layers and damping tiles shall be preformed, if necessary, to provide intimate contact with the surface to be damped. However, it is not necessary to cut damping tiles installed on the web of curved hull frames to conform to the curvature of the frame (see 4.3.4 and figure 1).

4.2.3 Areas with reinforced members. There is no requirement to apply damping material over areas with underlying stiffeners (see figures 2 and 3). However, there is no harm in damping over underlying stiffeners, and this shall be done if attempts to avoid the stiffeners complicate the damping installation.

4.2.3.1 Areas with irregularly shaped members. Where staying within tolerance from welds on irregularly shaped areas requires excessive trimming, straight line approximations, which exceed drawing tolerance, may be used, provided at least 2/3 of the area is damped.

4.2.4 Damage preventive measures. Damping treatments are susceptible to damage or destruction by heat. No burning or welding shall be performed in the vicinity of such installations without first removing the damping material in way of the heated plate, and covering the damping material in the vicinity with glass cloth blankets in accordance with MIL-C-24576 or equal as protection from weld spatter.

4.2.5 Constraining layers. Constraining layers may be cut to the size of the damping tile, but shall be no less than 3 inches in width *or* 64-square inches in area.

4.2.5.1 Studs, nuts, and washers. Corrosion-resistant steel (CRES) 304 or 316 studs, nuts, and washers shall be used in spaces subject to immersion in water or oil where restraining or constraining of the damping tiles is required. This includes bilges and fuel tanks. Ordinary strength steel studs, washers, and nuts are used in non-floodable spaces which require restraining or constraining of the damping tiles. Prior to assembly of CRES nuts and studs, threads shall be coat with an antiseize compound in accordance with MIL-T-22361, to prevent galling.

4.2.5.1.1 Replacement of studs. When replacing missing studs, restraining or constraining layers (if installed) shall be removed, and the damping tile cut away over an area approximately 4 by 4 inches, centering on the holding point. The surface shall be ground to bare metal in way of the stud attachment point. Adhesive and tile particles shall be removed over the remaining area. New studs shall be installed using the automatically-timed arc welding technique

originally employed. Studs shall be preserved and tiles replaced as described in the appropriate section of this standard. Studs shall not be welded in place without first removing the approximately 4 by 4 inches of tile around the holding point. Proper surface preparation prior to stud attachment, followed by preservation after welding, is critical to minimize galvanic and other types of corrosion. (Removal of constraining layer shall be in accordance with 5.2.9.3.)

4.2.6 Materials installed in combination with damping treatments.

4.2.6.1 Acoustic absorptive or thermal insulation. Some areas require the application of either acoustic absorptive or thermal insulation (fibrous glass batting) over damping tiles. When installed over free layer damping tiles, at least 75 percent of the total number of 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, 7/8 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 may be attached directly to the damping tiles. The studs in this case shall be welded to a pad or baseplate, at least 2 inches square, of the same type metal as the stud, and the pad in turn shall be bonded to the damping tiles using adhesive in accordance with MIL-A-24456. When acoustic absorptive or thermal insulation is installed over constrained damping, the studs shall be welded directly to the constraining layer, provided 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 ship's structure in the same manner as when installing acoustic or thermal insulation over free-layer damping. Holes 7/8 inch in diameter, shall be cut in the damping tiles and the constraining layer to provide passage for the studs. Figure 4 shows details of typical installation of acoustic absorptive or thermal insulation over both constrained and free-layer damping tiles.

4.2.6.2 Reflector and decoupler tiles. Acoustic reflector and decoupler tiles, such as type AR-1 in accordance with MIL-A-24485, do not provide damping to the structure on which they are attached. Accordingly, it is necessary to install damping materials either on the reverse side of the structural member or under the reflector *tile.* If the damping tile is installed on the reverse side of the structure, installation shall proceed in the manner described in the appropriate section. If damping tile is to be installed under the reflector tile, the following steps shall be taken:

(a) The damping treatment shall be selected based on the thickness of the structure to be damped without regard to the reflector tile.
(b) Stud length shall be Increased to account for the thickness of the reflector tile.
(c) Stud spacing may vary slightly due to the requirement to maintain a 1-1/2 inch space between holes for studs and the reflector tile edge. Attempts shall be made to conform as closely as possible with damping treatment stud locations.
(d) Reflector tiles shall replace restraining layers where applicable.

(e) Reflector tiles shall be bonded to the outer side of the damping treatment in a manner similar to that for bonding constraining layers to damping tiles.
(f) Nut tightening and torque requirements for reflector tiles shall be followed when installing damping tile under reflector tile.

4.2.6.3 Acoustic absorber tiles. Acoustic absorber tiles, such as type AA-4 in accordance with MIL-A-24486, do provide some measure of damping to the structure to which they are attached. Currently, damping material is not applied to those areas where acoustic absorber tiles are installed.

4.2.6.4 Cableway hangers. In some instances, cableway hangers and light hangers have been welded to damping treatment constraining layers. Repair and replacement of these installations shall proceed in a manner which will not damage the damping treatment. Individual ship specifications shall be referenced as guidance for additional applications of this technique. Design aspects such as shock, cost reduction, and repair of damping shall be considered.

4.2.6.5 Air pollution regulations. Air pollution regulations to limit the amount of certain solvents are being invoked in many states. For example, in California, the South Coast Air Quality Management District, Los Angeles, invokes Rules 102 and 442 (previously Rule 66) to limit the use of solvents. These rules are applicable to paint in accordance with MIL-P-24441. Accordingly, specifications covering paint in accordance with MIL-P-24441 which comply with California rules are indicated by the addition of the subscript "R 66" after the individual formula numbers. Where MIL-P-24441 paints are specified, type II formulas conforming to California rules shall be used wherever those air quality rules are applicable.

4.3 Submarines.

4.3.1 Main ballast tanks. Damping materials shall be installed on the inboard side of outer shell plates and on one side of all transverses, longitudinals, and flats within the tanks. Materials installed in ballast tanks shall be restrained to prevent detached material from falling to the bottom of the tanks and thus clogging dewatering ports. Type II, class 1 tiles, bonded to the steel structures and restrained or constrained as specified in tables I and II, and type V, class 1 tiles restrained with l/8-inch thick glass-reinforced plastic sheets normally are used in this area. Damping shall be installed such that it will not interfere with transducers or sonar arrays. A typical installation is shown on figure 5.

TABLE I. Weight per unit area and nominal thickness of tile to be applied on different thicknesses of metal plate up to 11/16 inches.

Thickness of metal plate to be damped (inches)	Tile unit weight (lb/ft^2)	Nominal thickness (inches)
1 /Less than 1/8	0.9	1/8
l/8 to 5/16	2.8	3/8
Over 5/16 but less than 3/4	4.5	5/8

See footnote at top of next page.

1/ On some SSN 688 and SSBN 726 class submarines, 0.9 pound per square foot (lb/ft^2) tiles have been installed on plating less than 1/4 inch in thickness. This is not recommended for new design.

TABLE II. Constraining layer requirements for heavy weight plates using type II tile weighing 2.8 lb/ft^2.1/

Thickness of steel structure to be damped (inches)	Thickness of steel constraining layer (inch)	Thickness of aluminum constraining layer (inch 2/)
3/4 to 13/16 inclusive	0.110 (Gage No. 12)	5/16
Over 13/16 to l-3/16 inclusive	0.180 (Gage No. 7)	1/2
Over 1-3/16 to 1-9/16 inclusive	1/4	3/4
Over 1-9/16 to 2 inclusive	5/16	1

1/ On some SSBN 726 class submarines 0.9 lb/ft^2 tiles have been used in constrained layer damping.
2/ Aluminum constraining layers have been used with type II damping in the past. Current practice is to install steel constraining layers, except where damping constrained with aluminum is being repaired. In those instances, the aluminum may be re-installed or renewed.

4.3.2 Tanks-bilge-collecting, main lubricating oil and lubricating oil settling, shaft lubricating oil sump, surge, depth control, sanitary, and potable water. Damping materials are installed only on the dry sides of these tanks. In some cases, the entire area of the tank is covered, depending upon accessibility and the possibility of resonance excitation of the structures. The areas on these tanks to which damping material is applied usually are inside the pressure hull and thus generally are at temperatures above that of seawater temperature. However, the average surface temperature of the steel shall be used in determining the class of type II tile to be used to damp these tanks. Classes of type II tile shall be in accordance with tables III and IV. Steel plate in these tanks may range in thickness from 1/8 inch to over 1 inch, depending on the type of tank. Free-layer type II tiles weighing 2.8 or 4.5 lb/ft^2, or constrained with steel plate, depending on the thickness of the steel plate to be damped, shall be used in these areas. Type II tile weights and constraining layer thickness shall be in accordance with tables I and II. Typical installations are shown on figures 2 and 3.

TABLE 111. Selection of type II tile by class based on operating temperature on lightweight plate, 11/16 inch and below.

Operating temperature (°F)	Class of tile to be installed
35 to 55	1
56 to 80	2
81 to 155	3

TABLE IV. Selection of type II tile by class based on operating temperature on heavyweight plate, 3/4 inch and up.

Operating temperature (°F)	Class of tile to be installed
35 to 55	1
56 to 90	2
91 to 155	3

4.3.3 Superstructure, fairwater, and other free-flooded spaces. Only the inboard side of shell plates (non-pressure hull), fairwater plates, and one side of all transverses, longitudinal, flats, and supports shall be damped. The extent of installation depends on the design of the particular ship. The requirements for damping material are the same as those used in ballast tanks, except that the tiles shall be restrained only in those areas where their dislodgement could damage sensitive equipment.

4.3.4 Hull frames. The webs of hull frames that support machinery or noise-critical equipment foundations usually are damped for a distance of at least 3 feet on either side of the foundation attachment point. Damping materials shall be installed only on one side of the web. If webs on frames are 11/16 inch or less, damping shall be in accordance with table I, however, if the webs or frames are 3/4-inch thick or greater, damping treatment shall consist of *type* 11 tiles weighing 2.8 lb/ft^2, constrained with a steel plate in accordance with table II. Figure 6 shows a typical installation of this type of damping treatment. Figure 7 provides details. It is not necessary to cut damping tiles on the web to conform to the frame curvature, and they may be installed as shown on figure 1 (see 4.2.2).

4.3.5 Machinery or noise-critical equipment foundations, bulkheads, and girders. Damping material shall be installed on only one side of all members acting as machinery or noise-critical equipment foundations when vibrational energy can be transmitted to the foundation. It also is applied to one side of the bulkheads, girders, and decks, except those shielded with lead, that support machinery, noise-critical equipment, or foundation attachments which will transmit vibration to the hull. Type II tiles shall conform to the weights and the constraining layer requirements of tables I and II. Classes of type II tile shall be selected based on the average surface temperature, as specified in tables III and IV. For example, the reduction gear casing and the foundation supporting the reduction gear requires type II, class 3 tile. A typical installation of damping tiles on a foundation made from heavy steel plates is shown on figure 8. Figures 9 and 10 show an installation of type II, class 3 tiles on two sections of a reduction gear case. Figures 11 and 12 show details of typical installations of tiles on bulkheads made from heavy-weight steel plate. Figures 13 and 14 show typical installations of constrained tiles installed on girders.

4.3.6 Platform decks and supporting beams. Damping material shall be installed on the underside of platform decks, except those decks that have ceramic tile or trowel-on deck covering installed on the top side. Type II tile in accordance with tables III and IV shall be used in these areas dependent upon average surface temperature. Figure 15 shows a typical installation of damping material on the underside of a platform deck. A typical installation on a deck beam supporting a platform deck is shown on figure 16.

4.3.7 Sonar domes. Requirements for damping materials are specified in the particular submarine class specifications and installation plan drawings. Type II, class 1 tiles and type V, class 2 tiles are used in the sonar access trunk, and are constrained. NAVSEA 0967-LP-412-3050 provides guidance in working with submarine sonar domes.

4.4 Surface ships.

4.4.1 Hull, frames, longitudinal stiffeners, and keel. Damping material shall be installed on the inboard side of the hull, below the waterline, on one side of webs of frames, one side of longitudinal stiffeners and on the top and one side of the keel. If the structures to be damped are-in the vicinity of the sonar dome, type III plastic tiles shall be used. The fore and aft distance from the sonar dome to which structures shall be damped depends on the location of the sonar dome and the distribution of machinery in spaces above the dome. When the dome is located at the bow of the ship, damping material normally shall be installed above the dome and to at least the first watertight bulkhead aft of the dome. If the dome is positioned aft of the bow, damping material normally is applied to at least the first watertight bulkheads fore and aft of the dome. A single layer of type III tiles shall be installed on steel plate up to 1/2 inch in thickness; two layers of type III tile shall be applied to plates of greater thickness. If the structure to be damped is in or near machinery spaces, type II tiles normally are used. The weight of tile to be applied for various thicknesses of steel plate to be damped shall be in accordance with tables I and II. Selection of the class of type II tile to be applied based on constraining layer and operating temperature requirements, if any, shall be in accordance with tables III and IV.

4.4.2 Bulkheads and platform decks. Within the space limits delineated in 4.4.1, damping materials shall be installed on one side of all bulkheads and on the underside of platform deck plating, except decks that have ceramic tile or trowel-on deck covering on the top side of the plating. The types of damping materials discussed in 4.4.1 shall be Installed on these structures; type II tiles in or near machinery spaces and type III tiles in vicinity of sonar domes.

4.4.3 Surface ship machinery foundations. Damping materials are installed on one side of all members located in the vicinity of sonar domes as delineated in 4.4.1 which can impart vibrational energy to the hull. Type III plastic tiles normally are installed on steel structure up to 11/16 inch In thickness. For foundations of greater thickness, constrained type II, class 2 tiles weighing 2.8 lb/ft2 shall be used. Damping materials also are installed on one side of selected machinery foundation members located within machinery spaces as outlined in ship specifications. Type II, class 2 tiles normally are applied in these areas. For areas which operate at temperatures above ambient room temperature, such as the reduction gear casing and foundation, type II, class 3 tiles are used.

4.4.4 Fuel oil and salt water tanks. Damping material shall be installed on one side of the boundaries of oil and salt water tanks located in the vicinity of sonar domes within the limits delineated in 4.4.1. Where practicable, damping material shall be installed on the dry side of the tanks. Type III plastic tiles shall be installed on these structures. Damping material shall not be installed inside JP-4, JP-5, lubricating oil, or hydraulic system tanks. However, it is permissible to install type III damping materials inside tanks containing diesel oil, distillate fuel oil, Navy special fuel. oil, or salt water, provided they are protected by a paint coating from deterioration due to immersion in the liquids. A single layer of type III tiles shall be installed on steel plate up to l/2-inch in thickness. Two layers of type III tile shall be installed on plates of greater thickness. Type II tiles shall be applied to these tanks when located in machinery areas, and do not require protection against immersion.

4.4.5 Sonar domes. Damping and special acoustic materials shall be installed on specified interior surfaces of surface ship sonar domes. The type and extent of materials to be applied normally are contained in individual ship specifications. NAVSEA 0967-LP-412-3010, 0967-LP-412-3020, 0967-LP-412-3030, 0967-LP-412-3040 and T9830-AA-DDT-010 provide guidance on areas to be covered and on installation procedures.

4.5 General health and safety requirements. This section addresses minimum health and safety aspects of applying damping materials with epoxy paints and adhesives. Information which applies to a particular type of damping material is included with the specific material installation procedures.

4.5.1 General health hazards. Several aspects of tile installation expose personnel to conditions and situations that represent actual or potential danger to themselves and to others in the area. The frequent necessity to use toxic and flammable materials, pressurized equipment, ladders, scaffolding, and rigging always represents a potential hazard. Hazards also may be caused through ignorance or carelessness of the operator.

4.5.1.1 Paint materials. Most paint materials are hazardous to some degree. The majority are flammable, toxic, and can irritate the skin.

4.5.1.1.1 Epoxy paints. Uncured epoxy resins and polyamide, amine, or polyamine coring agents in epoxy paint systems in accordance with MIL-P-24441 have been shown to cause dermatitis. Major problems in handling epoxy systems occur as a result of the caustic nature of the amine curing agents. These agents may cause burns (ph of 13 to 14) and sensitization. Inhalation of amine fumes may cause mucous membrane irritation and asthmatic symptoms. Overexposure to the solvents in these systems may cause headache, nausea, dizziness, and unconsciousness. Solvent content includes: N-butyl alcohol, naptha, and ethylene glycol monoethyl ether.

4.5.1.1.2 Vinyl antifouling paints. Vinyl paints are irritating to the skin. The solvent vapors, at low concentrations, can cause mucous membrane irritation and at high concentrations may result in drowsiness, and unconciousness, Chemical content includes: methyl isobutyl ketone xylene and tricresyl phosphate.

4.5.1.2 Adhesive materials. Uncured epoxy adhesives can cause dermatitis and sensitization. Odors from the adhesive component are offensive to some individuals.

4.5.1.3 Damping materials. In general, damping materials are thermoplastic epoxy or molded rubber. They do not represent severe health hazards under normal circumstances.

4.5.1.4 Surface preparation materials. Preparation of a surface for painting and bonding often requires the use of solvents and cleaners, which will harm the skin unless used with care. Paint removers are very irritating to the skin and some are highly toxic. High pressure abrasive blasting methods can be hazardous. Pressures as low as 10 to 15 pounds per square inch (lb/in^2) have been known to cause serious injuries. Carelessness during abrasive blasting operations can also result in lung disease after continued exposure. Steam cleaning procedures employ both high heat and pressure, and can be hazardous to the operator and personnel in the vicinity if not properly handled.

4.5.2 General safety measures. Potential hazards in all tile installation operations make a continuing and enforced safety program essential. Adequate safety procedures will provide protection against the three major types of hazards; accidents, fire, and health. Personnel shall be thoroughly familiar with safety rules. Each worker is responsible for adhering to established precautionary programs.

4.5.2.1 Working environment. The working environment shall be examined before sending workers into any work area. Hazards, such as poor ventilation and noxious vapors, shall be considered. Before a worker is allowed to enter such an area, he or she shall be protected by devices that will allow him or her to work in safety. Special action is required if:

(a) Oxygen concentration is less than 20 percent, or
(b) Combustible gas meter readings show differences between the work space and outside air, or 10 percent below lowest explosive limit (LEL), or
(c) It is known or suspected that the work space may contain toxic vapors or gases that are not practical to measure with equipment on hand (such as distillate fuels, kerosene, or Navy standard fuel oil).

If ventilation is required, outside air shall be provided at a maximum rate of 20 changes per hour, but no less than that needed to provide a safe atmosphere. Otherwise, respiratory protective equipment shall be provided. When exhaust systems are used, such as in a tank, the system shall take suction from the bottom of the tank or a similar area in which the work is being done. The potential of a still area or pocket shall be considered. Individuals shall never work alone in a hazardous area. The discharge from exhaust systems shall be arranged so that contaminated air will not create health hazards in surrounding areas. Personnel shall be provided with suitable eye protection (safety goggles, chemical safety goggles) and appropriate protective clothing such as hard hats and safety shoes, and impervious clothing as necessary.

4.5.2.2 Respiratory protection. Personnel shall wear the proper type of face mask in hazardous areas. Devices shall be approved by the National Institute for Occupational Safety and Health (NIOSH) and Mining Enforcement Safety Administration (MESA).

4.5.2.2.1 Types of respirators. The most important types of respirators are as follows:

(a) Dispersoid respirators, for protection against dusts present when sanding. These respirators contain filters only.
(b) Chemical cartridge respirators, for protection against fumes and organic solvent vapors. These respirators contain activated carbon cartridges which absorb the fumes or vapors.
(c) Supplied-air respirators, for use in closed areas where safe ventilation cannot be supplied. NIOSH-approved fresh air blowers of the positive pressure type shall be provided for each two respirators and the hose limited to 150 feet. Breathing air quality shall conform to BB-A-1034.

4.5.2.3 Eye protection. Safety eyewear, safety glasses and chemical splash goggles, shall be worn in areas where there is a possibility of particulate, mists, vapors, solvents, and adhesives contacting eyes. This may occur during operations involving blasting, sanding, spraying solvent, wiping, or adhesive mixing and spreading. Safety eyewear shall be kept clean and readily available. They shall contain lenses of unbreakable glass or plastic, and allow adequate peripheral as well as straight ahead vision.

4.5.2.3.1 Eyewashes. Emergency eyewashes shall be in proximity to operations where eye irritation may occur. Portable eyewashes shall be available wherever fixtures are not feasible.

4.5.2.4 Protective clothing. Personnel shall wear clean clothing, covering themselves as much as possible, to avoid skin contact with paints, solvents, or uncured adhesives. Safety helmets or hoods shall be worn when using abrasive blasting media. Hard hats and steel-toed safety shoes shall be worn wherever there is any possibility of danger from falling objects. Shoes shall have non-skid rubber soles when working in enclosed spaces, or where flammable vapors may be present.

4.5.2.5 Safety precautions for abrasive blasting. The safety precautions specified in 4.5.2.5.1 through 4.5.2.5.6 are directed towards preventing injury and property damage. They also shall be followed to preclude inadvertent introduction of abrasive blasting materials into ship's spaces, into open ship’s equipment or systems, and onto unprotected equipment while conducting abrasive blasting operations on and in the vicinity of naval ships.

4.5.2.5.1 Preventive measures. Abrasive blasting within the ship shall not be accomplished until steps have been taken to positively prevent contamination and spread of abrasive and dust to adjacent compartments, machinery, and equipment.

4.5.2.5.2 Requirements prior to blasting operations. The ship's force and all shops shall be notified of when and where abrasive blasting operations are to be accomplished. Shops and the ship's force shall take the following precautions to protect equipment and structures:

(a) Drop cloths and masking shall be used to prevent damage from the abrasive material.
(b) Temporary divisional shields and other sealing or blanking-off measures shall be used to prevent abrasives from entering machinery, pipes, seawater inlets, and pump wells through various openings.
(c) Where remote service connections provide water or ventilation, such as seawater for the auxiliary seawater system while the ship is in drydock, the inlet to that connection shall be located and shall be arranged such as to prevent the entry to blasting contaminants.
(d) Additional sealing and protective precautions shall be taken to the extent necessary to protect adjacent ships, buildings, and stores. Abrasives and dust can enter ships through open sea valves, hatches, ventilation systems, temporary openings, and normal entry ways frequently opened and closed, or entry ways forced to remain open due to other work. If there is any possibility that abrasives can enter a ship, even though all possible precautions are taken, critical surfaces and parts of machinery, including electric and electronic equipment, shall be positively sealed or otherwise protected. Machinery components such as reduction gears, open boilers, hotwells, and turbines in various stages of disassembly are especially vulnerable. Personnel in or near the blasting area shall be warned of possible hazardous conditions. In all circumstances, close cooperation between ship and shipyard personnel is required.

4.5.2.5.3 Pre-abrasive blasting inspection. The entire area to be blasted shall be visually inspected. Heavily rusted or corroded areas, damaged metal, and holes in structure or piping shall be investigated for further technical examinations and possible repair prior to commencement of blasting operations. Abrasive blasting hoses routed through compartments shall be identified by a sign (appropriately marked) posted in each compartment that warns against damaging the hoses.

4.5.2.5.4 Post abrasive blasting inspection. The entire area shall again be visually inspected for pits, scabs, and scars. Suspected wall thickness reductions shall be reported for further technical examination.

4.5.2.5.5 Abrasive blasting protective equipment. Blasters shall wear hoods and airline respirators or air helmets of the positive pressure type. Other mandatory clothing includes rubber or leather gauntlet gloves, safety shoes, and coveralls. Personnel, other than blasters, including machine operators and personnel engaged in work in the vicinity of abrasive blasting operations shall wear full eye protection and NIOSH-approved dust respirators. Approved ear protectors shall be worn wherever the airborne noise level is above 85 decibels (dB)(A). Both ear plugs and ear muffs (double protection) shall be worn if the noise level exceeds 108 dB(A).

4.5.2.5.6 Staging. Staging shall be stable and correctly positioned for safety, convenience and comfort of the blast operator.

4.5.2.6 Safety precautions for mixing paint.

4.5.2.6.1 Fire prevention precautions. Smoking, open flame (such as matches and torches), and hot work are prohibited in or near the area where paint, varnishes, lacquers, and their solvents are mixed. Spilled paint or solvents shall be wiped up immediately *to* reduce fire and vapor hazards. Rags or other items used for paint clean-up shall be placed in a separate container, having a closed top for disposal.

4.5.2.6.2 Accidental ignition. Extreme care shall be taken by persons working with solvent-based coatings to eliminate all possible sources of ignition (such as matches, cigarette lighters, and steel buckles) from their persons. Working personnel shall wear canvas boots over their shoes or shall wear rubber footwear when standing on steel decking. Plastic clothing shall not be worn. Loose steel objects shall be removed from the immediate vicinity of coating operations.

4.5.2.6.3 Electrical equipment. Electrical equipment in rooms where extensive paint mixing operations are carried on shall be installed in accordance with class I, group D requirements of the National Electric Code. Explosion-proof lamps with shatterproof lenses shall be used.

4.5.2.6.4 Personnel protective precautions. These precautions apply to ship paints in general. Skin contact, eye contact, ingestion, and breathing of mists or vapors in excess of the threshold limit value shall be avoided. A Navy Environmental and Preventive Medicine Unit or a Navy Regional Medical Center shall be consulted for surveying if doubt exists on acceptability of personnel protective procedures. Shipyard personnel shall contact a Occupational Safety and Health Office representative for surveys or technical advice regarding protective equipment.

4.5.2.6.5 Sensitivity and allergic reactions. Personnel with a history of chronic skin disease, allergies, or respiratory ailments shall not work with paint compounds and solvents. Persons handling these materials shall avoid contact with the skin and the eyes or inhalation of mist or vapors. No food or drink shall be allowed in the paint area. When handling paints and solvents, care shall be exercised to wash hands before eating, drinking, smoking, or using the toilets.

4.5.2.6.6 Vinyl paints. Personnel mixing these paints shall wear solvent-resistant synthetic rubber gloves and apron. Sleeves shall be kept rolled down. NIOSH-approved half-mask respirator with organic vapor cartridge shall be required when air sampling data indicates solvent concentrations in excess of the exposure limit values, or when it is reasonable to assume that solvent vapor concentrations cannot be controlled by ventilation and are expected to exceed the threshold limit value for the solvent involved.

4.5.2.6.7 Epoxy paints. Epoxy paints in accordance with MIL-P-24441 are used in this standard. Commercial epoxy paints conforming to DOD-P-23236 type I, class 1 are considered to be an acceptable alternative to MIL-P-24441, and may be substituted for MIL-P-24441 where referenced in this document. (MIL-P-24441 is preferred, however.) NAVSEA S9086-VD-STM-000, chapter 631 provides additional guidance. Epoxy paints are used as part of the adhesive system. In general, two to three coats of paint are applied prior to bonding of damping titles. The vinyl paint precautions of 4.5.2.6.6 also apply to epoxy paints.

4.5.2.6.7.1 Dermatitis and allergy hazard. As a consequence of ingredients used to provide superior adhesion and high anti-corrosive performance, epoxy paints present greater health hazards than many conventional paints. This requires strict adherence to adequate safety precautions. If epoxy coatings contact the skin, skin shall be cleaned immediately with soap and water. Solvents shall not be used, as they can thin out and spread the paint over the skin, permitting deeper penetration of the paint into the skin and thereby increasing the hazard of irritation or allergic reaction.

4.5.2.6.7.2 Epoxy thinners or solvents. Epoxy thinners or solvents contain such ingredients as ethylene glycol monoethyl ether which is readily absorbed into the body through the skin. Particular attention to skin protection is necessary to prevent skin absorption from adding significantly to overall exposure, especially during cleaning of equipment.

4.5.2.7 Safety precautions for paint application. Safety precautions for mixing shall apply also to application. Additional requirements are presented in this section.

4.5.2.7.1 Danger area. A danger area for each painting operation shall be defined by the local activity and clearly delineated by signs. A danger area is that area in which there Is a possibility that explosive mixtures may collect.

4.5.2.7.2 Application by brush or roller. Precautions for brush or roller application are the same as those for mixing, except that there are increased potential hazards from flammable or toxic solvents. Additional ventilation may be needed *to* comply with requirements for flammable material control. Additional ventilation or use of respirators may also be needed.

4.5.2.7.3 Vinyl and epoxy paints. Personnel applying these paints by brush or roller shall avoid skin contact with the paint or its components by wearing solvent-resistant synthetic rubber gloves and apron. Sleeves shall be kept rolled down. A face shield or chemical safety goggles shall be worn to protect the face and eyes. Protective cream in accordance with P-S-411, type II shall be used on exposed parts of the skin to act as a barrier and to facilitate cleaning after painting. Local exhaust or supply ventilation shall be used to control personnel exposure to solvent vapors.

4.5.2.7.4 Application by spray. The application of paints, varnishes, lacquers, enamels, and other flammable liquids by the spray process is more hazardous than brush applications because of the volume and concentration of the work and because spraying produces a residue which is flammable and deposits which are subject to spontaneous ignition. Health hazards due to the presence of potentially harmful substances may also be present in paint spraying operations. Precautions for paint spraying include those for mixing and brushing as well as the additional requirements of this section.

4.5.2.7.5 Fire prevention precautions. Precautions in addition to those for brushing or mixing are necessary to prevent static sparks and to prevent excessive concentrations of flammable solvents. The flash points of vinyl and epoxy paints are 65°F and 95 to 180°F respectively, and can readily form explosive atmospheres in confined spaces. Danger areas shall extend at least 50 feet from the painting operations and may include an entire drydock for

extensive painting with highly flammable paints. The vicinity of the painting operation shall be roped-off and "DANGER AREA" signs posted to alert personnel of the hazard. These signs are to stipulate the danger area and that smoking, hot work, or open flames are prohibited. Electrical leads within the danger area shall be sealed and equipment requiring grounding shall be grounded. During spray painting operations, fire extinguishing equipment shall be in the ready condition.

4.5.2.7.6 Application in confined spaces. The additional precautions specified in 4.5.2.7.7 through 4.5.2.7.14 shall be observed when coating confined spaces such as tanks.

4.5.2.7.7 Explosion-proof lamps. Explosion-proof lamps with shatter-proof lenses such as Crouse-Hinds Model RCD-6, or equal, shall be installed. Lights shall be completely and properly assembled in operable condition prior to installation in the danger area. There shall be no bulb replacement or repair of any lights within the danger area. Portable lights shall be hung on stiffeners by means of spark-proof hooks and shall never be wrapped around or draped over supports.

4.5.2.7.8 Gas-free testing. Periodic tests to ensure safe gas-free working conditions shall be conducted. The gas-free engineer shall conduct the initial test, with monitors conducting the follow-up tests. Gas testing shall continue as necessary during painting operations to detect dangerous accumulations of hazardous vapors.

4.5.2.7.9 Ventilation. During coating operations, tanks shall be properly force-ventilated. Where the venting of the vapors given off by the coatings will create an explosion hazard outside the compartment being coated, water curtains shall be installed at the vents. Also, ventilation shall be continued for at least 1 hour after the coating operation has been completed and until vapor concentrations remain below 10 percent of the LEL. Brush painting procedures shall comply with general brush painting precautions.

4.5.2.7.10 Personnel protective precautions. Spray painting shall require all the precautions of brush painting, with additional measures to protect personnel from atomization of larger quantities of material.

4.5.2.7.11 Protective clothing. Spray painters shall wear protective garments which fit snugly at the ankles, neck, and wrists. They shall wear gloves and approved airline respirators while spraying in confined spaces, when mixing dry colors, or using other finishing materials which create flammable vapors. They should never inhale the mist from the spray gun.

4.5.2.7.12 Showers. Where paint-spraying operations are conducted extensively, showers be available, and the-employees shall use them after every shift.

4.5.2.7.13 Cleaning spray guns. Spray guns, paint containers, and hose shall be thoroughly cleaned after use, but shall never be cleaned in confined areas.

4.5.2.7.14 Epoxy paints. personnel spray painting with MIL-P-24441 paints in other than approved spray booths shall wear coveralls, gloves, and a NIOSH-approved airline respirator which provides full-face coverage. The air supply to the respirator shall be approved as breathing air. Approved goggles shall be worn, except where eye protection is provided by air-supplied respirators or hoods. Exposed areas of the skin shall be covered with protective cream. The same precautions apply to application of vinyl paints, except NIOSH-approved organic vapor respirators may be substituted for airline respirators when working in open exterior spaces. Where these coatings are applied overhead or on surfaces above waist level of the personnel, approved hoods which completely protect the head, face, and neck shall be worn.

4.5.2.8 Safety precautions for adhesive mixing and application. The epoxy adhesives used for the installation of damping materials are not dangerously flammable. Extra-rigid fire precautions, like those required for painting, are not required for this work. However, the adhesives are irritating to the skin. Frequent or prolonged exposure of the skin to the epoxy adhesive shall be avoided; serious injury may result if any is allowed to come into contact with the eyes. Special precautions are as follows:

(a) To avoid dermatitis, skin cream shall be rubbed over hands and wrists before working with epoxy adhesives. After the cream has been absorbed uniformly, rubber gloves shall be worn. Plastic face shields shall be worn for protection of the eyes. The adhesive shall be mixed only in a well-ventilated area. Skin that comes into contact with any component of the adhesive shall be washed Immediately with soap and water.

(b) personnel with a history of chronic skin disease, allergies or respiratory ailments shall not work with adhesive compounds and solvents. Persons handling these materials shall avoid contact with the skin and the eyes, or inhalation of vapors. No food or drink shall be allowed in the work area. When handling adhesives and solvents, care shall be exercised to wash hands before eating, drinking, smoking, or using the toilets. Sensitivity of personnel shall be reported to the medical department.

(c) Epoxy adhesives do not produce toxic fumes, but adequate ventilation shall be provided in work spaces to prevent discomfort to workers from unpleasant odors given off.

4.5.2.9 Cleaning with decreasing solvents. The solvent 1,1,1 trichloroethane, is used for cleaning tools, damping materials and both painted and unpainted surfaces. It is nonflammable, but its vapor is moderately toxic if inhaled. When this solvent is used in confined spaces, forced air ventilation shall be provided, and all personnel shall wear effective respirators. When used outside of confined spaces, all personnel in the area shall wear effective respirators.

4.5.2.9.1 Eye protection. Eye protection shall be worn by all personnel when working with or near 1,1,1 trichloroethane.

4.5.2.9.2 Skin protection. Protective (rubber or Viton) gloves shall be worn by personnel working with 1,1,1 trlchloroethane to avoid drying and cracking of skin due to the defatting action of this solvent.

5. DETAILED REQUIREMENTS

5.1 Installation of type II, class 1, class 2 and class 3 damping tiles on lightweight plate 1/8 to 11/16-inch thickness (MIL-P-23653).

5.1.1 Materials.

5.1.1.1 Damping tiles. Type II, class 1, class 2, and class 3 tiles shall be 12 by 12 inches in size, weighing 2.8 or 4.5 lb/ft^2, according to need as indicated in table I. Class 1, class 2 and class 3 tiles shall be installed on steel plates exposed to various operating temperature ranges in accordance with table III. Class 1 tiles which are not covered with a constraining plate and are installed In submarine ballast and trim tanks shall be restrained with glass reinforced plastic septum plates.

5.1.1.2 Adhesive. Adhesive for plastic vibration damping tiles shall be in accordance with MIL-A-24456.

5.1.1.3 Restraining materials. The following materials shall be used to restrain the damping tiles:

(a) plastic sheet, glass-reinforced, 1/8-inch thick in accordance with MIL-P-17549, grade 3, made with a fire-resistant resin conforming to MIL-R-21607.
(b) 304 or 316 CRES threaded studs, 3/8-16 UNC 2A by 1-1/2 inches long after weld In accordance with MIL-S-24149 and MIL-S-24149/3, type V.
(c) Flat CRES washers, 2 inches, 1/8-inch thick, inside diameter (id.) to accommodate a 3/8-inch stud. Manufactured from 304 or 316 CRES.
(d) Nut, self-locking CRES 3/8-16 UNC-3B in accordance with MIL-N-25027 along with MS17830.
(e) Petrolatumin accordance with VV-P-236.
(f) Anti-seize compound in accordance with MIL-T-22361.
(g) polyolefin film in accordance with L-P-378.

5.1.1.4 Protective materials. The following materials shall be used to protect the steel plating and damping materials:

(a) Corrosion-preventive grease in accordance with MIL-C-11796, class 3 or MIL-C-16173, grade 1.
(b) Epoxy coating system in accordance with MIL-p-24441/1 formula 150, MIL-P-24441/2 formula 151, and MIL-P-24441/3 formula 152, or MIL-P-24441/10 formula 150R66, MIL-P-24441/11 formula 151R66 and MIL-P-24441/12 formula 152R66, as appropriate.
(c) Insulation sleeving, electrical, flexible plastic in accordance with MIL-I-631, type F, form U, sub-form U_b, grade a, class II, category 1.
(d) Vinyl antifouling paint in accordance with MIL-P-15931, formula 121.

5.1.1.5 Cleaning materials. The following materials shall be used to clean the steel plating and damping materials:

(a) 1,1,1 trichloroethane (methyl chloroform) in accordance with O-T-620.
(b) Detergent, general purpose (liquid, non-ionic) in accordance with MIL-D-16791, type I.

5.1.2 Safety precautions and environmental control.

5.1.2.1 Handling damping tiles. Tiles manufactured in accordance with MIL-P-23653 present no particular health hazard and may be handled without toxic or dermatitis effects due to direct contact with the bare skin.

5.1.2.2 Protective measures used when handling damping materials. Adhesives, sealants, coatings, and cleaning compounds and solvents, depending on the type being used, may present health hazards. Health and safety precautions covering the use of these materials are given in 4.5.

5.1.2.3 Environmental requirements. In order to achieve the desired damping performance, a complete adhesive bond is required between the steel surface and the damping material. This requires that each layer of the bond (all paint coats and adhesives) be fully cured. Epoxy materials-, in general, cure through a chemical reaction. To achieve complete cure, initial mixing of the components shall occur in a reasonably warm work environment, In addition, epoxy compounds will not cure correctly at temperatures below 35°F. The following temperature conditions shall be maintained during the material installation:

(a) During application of MIL-P-24441 paints and MIL-A-24456 adhesives, the temperature of the work area shall be maintained between 35 and 95°F. MIL-P-24441 type II paints conforming to air pollution regulations, shall be applied at temperatures above 55°F.
(b) When the work area temperature is below 50°F, MIL-P-24441 paints shall be mixed and allowed the proper induction time at 70°F or greater (not to exceed 95°F), and then carried to the work site. This is essential to ensure proper curing of the paint.
(c) When the work area temperature is below 50°F, the MIL-A-24456 adhesive components shall be preheated to 70°F, mixed at 70°F or greater (not to exceed 95°F), and then carried to the work site. This is essential to ensure proper curing of the adhesive.

5.1.3 Surface preparation prior to installation of damping tiles.

5.1.3.1 Ballast and trim tank interiors.

5.1.3.1.1 Attachment of studs. Threaded 304 or 316 CRES studs, 3/8 inch In diameter by 1-1/2 inches long, shall be welded by the automatically-timed arc technique to the steel surfaces to be damped. The studs shall be installed on approximately 11-inch centers and spaced so that at least one stud-will be located in all tiles larger than 4 by 4 inches and at each corner of the cover plate. Studs shall be welded and inspected as required by MIL-STD-1688 or NAVSEA 0900-LP-000-1000, as applicable.

5.1.3.1.2 Protection of stud threads. The studs shall be taped, or covered with a short length of plastic tubing or protective cap in order to provide protection during subsequent cleaning operations, surface preparation and tile installation.

5.1.3.1.3 Cleaning and coating the steel surfaces. Surfaces shall be cleaned to near-white metal by grit or sandblasting. Any oil, grease, or waxy contamination present on the steel or on a painted surface before tile application shall be removed with a clean cloth wetted with 1,1,1 trichloroethane. The near-white metal surfaces and the studs shall next be coated with one coat each of formulas 150 of MIL-P-24441/1, 151 of MIL-P-24441/2, and 152 of MIL-P-24441/3, or two to three coats of DOD-P-23236, type 1 or 3, class 1 to achieve a minimum dry film thickness of 8 roils. Each coat shall be allowed a minimum drying time as stated in table V prior to application of the next coat. If the paint can be marked with a fingernail, it shall be given additional drying time. Paint which is allowed to dry for more than 48 hours shall be cleaned by wiping with a clean cloth wetted with 1,1,1 trichloroethane prior to application of the next coat. If painting the threads of the studs is not desired, as a minimum, the studs shall be painted up to the bottom thread. When more than 3 months have elapsed between painting and tile installation, the paint shall be sweep-blasted with fine sand and an additional mist coat of paint shall be applied. If the steel surfaces already have been coated with the DOD-P-23236, class 1 paint system, the studs may be installed, provided the paint shows no sign of checking, cracking, flaking, scaling, peeling, blistering, chalking, or rusting of the underlying metal. The painted surfaces shall then be sweep-blasted with fine sand to remove loose paint or other contaminants, and to remove surface gloss. If oil, grease, or other contamination remains on the painted surfaces, it shall be removed by using a cloth wetted with 1,1,1 trichloroethane. The base of the studs shall be covered with one coat of MIL-P-24441/1, formula 150, after which all painted surfaces shall receive a thin, wet coat of MIL-P-24441/1, formula 150 paint.

TABLE V. Minimum required drying times between coats of MIL-P-24441 epoxy paint.

Temperature (°F)	Hours to dry
35 - 40	24
41 - 60	18
61 - 80	12
81 - 100	8
101 - 120	6

5.1.3.2 Interiors of flooded spaces other than ballast tanks and trim tanks (sonar domes, superstructure areas and fairwaters). The steel surfaces, including those with galvanized coatings, shall be cleaned to near-white metal by grit or sandblasting. Any oil, grease, or waxy substance present on the steel shall be removed using a cloth wetted with 1,1,1 trichloroethane. The near-white metal surfaces shall be coated with the MIL-P-24441 paint system, consisting of one coat each of formula 150 of MIL-P-24441/1, 151 of MIL-P-24441/2, and 152 of MIL-P-24441/3 to achieve a minimum dry film thickness of 8 roils. Each coat shall be allowed a minimum drying time in accordance with table V prior to

application of the next coat. The paint shall be given additional drying time if it can be marked with a fingernail. Paint which is allowed to dry for more than 48 hours shall be cleaned by wiping with a clean cloth wetted with 1,1,1 trichloroethane prior to application of the next coat. When more than 3 months have elapsed between painting and installation of tile, the paint shall be sweep-blasted with fine sand and an additional cover coat applied. If oil, grease, or other contamination is present, it shall be removed from the painted surfaces, regardless of age, before tile application. If the steel surfaces have already been coated with DOD-P-23236, class 1 paint systems, the studs may be installed, provided the paint shows no sign of checking, cracking, flaking, sealing, peeling, blistering, chalking, or rusting of the underlying metal. The painted surfaces shall then be sweep-blasted with fine sand to remove loose paint or other contaminants, and to remove surface gloss. If oil, grease, or other contamination is remaining on the painted surfaces, it shall be removed by using a cloth wetted with 1,1,1 trichloroethane. The surfaces shall then be given a thin, wet coat of MIL-P-24441/1, formula 150 paint.

5.1.3.3 Foundations, bulkheads, platform decks and tanks (dry side only). The steel surfaces shall be prepared for installation of tiles according to the procedures outlined in 5.1.3.2, except that only one coat-each of formulas 150 of MIL-P-24441/1 and 151 of MIL-P-24441/2 or 152 of MIL-P-24441/3 paint system is required. If more than 1 year has elapsed between the time of painting and tile installation, the paint shall be sweep-blasted with fine sand and an additional cover-coat of formula 150 of MIL-P-24441/1 paint applied. When more than 3 months but less than 1 year elapses before tile application, the painted surfaces shall be hand or power-sanded, or sweep-blasted before tile application. If oil, grease, or other contamination is present, it shall be removed from the painted surfaces, regardless of age, before tile application. In addition, where abrasive blasting is impractical due to the proximity of installed machinery or equipment, the surfaces may be mechanically cleaned. In those cases where the steel surfaces were previously painted with the DOD-P-23236 paint system, they shall be mechanically cleaned, and a thin, wet coat of formula 150 of MIL-P-24441/1, 151 of MIL-P-24441/2, or 152 of MIL-P-24441/3 shall be applied.

5.1.3.4 Gear cases and structures which operate at temperatures of 80 to 155°F. The steel surfaces shall be prepared in the same manner as in 5.1.3.2, with the exceptions stated in 5.1.3.3. If sand or grit-blasting is impractical, dirt, scale, or other dry contamination shall be removed by vigorous brushing with a steel wire brush. The clean metal surfaces shall then be coated with formula 150 of MIL-P-24441/1 plus 151 of MIL-P-24441/2 or 152 of MIL-P-24441/3 paint system. When the substrate to be dampened has previously been painted with a MIL-P-23236, type I, class 1 paint system or an alkyd based paint and the paint is in good condition, the painted surfaces shall be lightly sanded to smooth any rough areas and to break the gloss on the old paint.

5.1.3.5 Non-steel surfaces. Non-steel surfaces such as aluminum alloys, CRES, and nickel-copper alloys which require damping shall be cleaned of grease and oil by wiping with a clean cloth wetted with 1,1,1 trichloroethane, and then grit-blasted. The grit-blasting operation shall provide a uniformly roughened surface over the entire area to be damped (smooth or polished areas must be eliminated). (NOTE: Blasting grit previously used to remove copper-based antifoulant paint shall not be re-used for grit-blasting aluminum alloys.) Time between grit-blasting and priming shall be minimized. The blasted surfaces

shall be coated with one coat of primer (yellow) in accordance with MIL-P-24441/9, formula 158 and allowed to dry in accordance with table V. The painted surfaces shall be scrubbed with a clean rag wetted with trichloroethane and sanded by hand using 60 grit emery cloth. Dust shall be removed with a clean brush. Tiles in accordance with MIL-P-23653 shall be bonded to CRES or nickel-copper using the epoxy adhesive as specified in 5.1.5. Aluminum alloy exposed to seawater, oils, or hydraulic fluid shall be given coats of formula 151 of MIL-P-24441/2 and 152 of MIL-P-24441/3 to a total dry paint film thickness of at least 8 roils. Dry spaces shall be given one coat of MIL-P-24441/2 formula 151 paint. Each coat shall be allowed a minimum drying time in accordance with table V prior to application of the next coat. The paint shall be given additional drying time if it can be marked with a fingernail. When more than 3 months has elapsed between painting and installation of tile, the paint shall be sweep-blasted and an additional cover coat of paint shall be applied.

5.1.3.5.1 Galvanized coatings. On surfaces which are galvanized and require damping, the galvanized coating shall be removed by grit-blasting. The metal under the galvanized coating shall be blasted to near-white metal, and then coated with one coat each of formulas 150 of MIL-P-24441/1, 151 of MIL-P-24441/2 and 152 of MIL-P-24441/3. Each coat shall be allowed a minimum drying time in accordance with table V prior to application of the next coat. The paint shall be given additional drying time if it can be marked with a fingernail. When more than 3 months have elapsed between painting and installation of tile, the paint shall be thoroughly hand sanded or sweep-blasted and an additional cover coat of paint applied.

5.1.4 Fitting of tiles.

5.1.4.1 Areas requiring a restraining layer. A 1/8-inch thick glass-reinforced plastic sheet in accordance with MIL-P-17549, grade 3, shall be cut to fit the area to be damped. Holes, 7/8 inch in diameter, shall be made in the plastic sheet to accommodate the studs. This sheet can be used as a template while cutting the tiles to the required shapes.

5.1.4.2 Areas not requiring a restraining layer. If required, a cardboard template may be cut to fit the various areas to be damped and the tiles cut to match the template. However, tailoring usually can be accomplished as the tiles are installed.

5.1.4.3 Fitting around weld beads. Damping tiles shall be close-fitted and cut to fit the surfaces between weld beads. In order to provide for periodic inspection of welds, the following guidelines shall apply (see figures 5, 7, 17, and 18).

(a) Welds shall not be covered by restraining or constraining layers (see figure 17).
(b) Where non-destructive tests (NDT) of a weld are not required, damping shall be applied within 1 + 1/2 inch of the weld (see figure 5 and 17).
(c) Where NDT tests of welds in accordance with NAVSEA 0900-LP-000-1000 and MIL-STD-1688 are required, damping shall be installed within 2 +0, -1/2 inches of welds (see figures 5 and 17).

(d) Damping shall be installed around stiffeners in submarine superstructure and fairwater areas so that a l/2-inch nominal spacing is maintained beyond the overhang of the stiffeners and the damping (see figure 18).

(e) Damping shall be installed in the forward trim tanks of submarines such that 3 +1/2, -0 inches is maintained between the damping and welds.

5.1.4.4 Drilling and punching holes. Holes, 7/8 inch in diameter, shall be cut, drilled, or punched in the tiles to provide passage for the studs. Holes can be cut using a leather punch, or by drilling with a flat-end bit. The tiles shall be kept at a temperature of 75 to 100°F to facilitate cutting, punching, and forming operations. The tiles usually are deformed as a result of cutting or punching operations. Surface deformation shall be corrected so that the tile will conform to the surface to which it will be bonded. Distortion can easily be removed by trimming or pounding with a flat-faced rubber mallet.

5.1.4.5 preforming. Type II, class 3 tiles to be installed on turbine gear cases may require preforming to fit the contours of the gear case. By warming the tiles to about 150°F, they will become pliable and can be made to fit irregular surfaces. Tiles so formed shall be held in position until they cool to ambient room temperature.

5.1.5 Preparation of the adhesive. Adhesive conforming to MIL-A-24456 shall be used to bond the tiles to the structure to be damped. This adhesive is a two-component epoxy system. The components shall be blended together just before application. Adhesive components shall be thoroughly blended to ensure that the adhesive will be uniformly hard when it sets up. Components usually are furnished in two markedly dissimilar colors, so that the blended adhesive admixture will be distinctly different in color with respect to either of the components. Adhesive conforming to MIL-A-24456 may be pre-packaged in barrier kits conforming to MIL-P-38714, type II, and mixed mechanically with automatic mixing equipment designed to be compatible with the barrier kits.

5.1.5.1 Adhesive pot life. Adhesive shall be mixed in quantities which can be used in 1-1/2 to 2 hours. The adhesive shall be mixed in small quantities or have a large surface area exposure to minimize heat build-up produced in the adhesive by the exothermic chemical reaction of the ingredients. About 2 hours after mixing, the adhesive will begin to thicken, indicating that its pot life has been exhausted. Adhesive that has exhausted its pot life and has begun to set shall not be used, since it will result in poor bond strength.

5.1.5.2 Preheating. Adhesive components which are below 70°F in temperature shall be preheated to 70 to 95°F before blending operations.

5.1.5.3 Cleaning. Epoxy adhesives are difficult to remove once they harden, Excess adhesive shall be removed from mixing and application equipment and the equipment cleaned using hot water and detergent in accordance with MIL-D-16791, type 1 before the adhesive has begun to set.

5.1.6 Installation of damping materials.

5.1.6.1 Ballast and trim tank interiors (type II, class 1 tiles only). Prior to the application of adhesive, oil, grease or other contaminants shall be removed from painted surfaces, regardless of age, using a rag wetted with 1,1,1 trichloroethane. The tiles previously fitted shall be bonded to the painted steel structures with epoxy adhesive prepared as described in 5.1.5. The adhesive shall be applied to one face of the tile and to the surface to be damped, using a dog-eared trowel of the dimensions shown on figure 19. When applying adhesive, the dog-eared trowel shall be held at an angle of approximately 30 *to* 45 degrees from the normal to the structure being damped. The entire face of the tile and the metal surfaces to be damped shall be completely covered with adhesive. The base and weld of each stud shall be heavily coated with adhesive, such that adhesive will be forced up and out of the stud hole in the tile when the damping is installed. It is not necessary to apply adhesive on the edges of the tile. The tile shall then be pressed, adhesive side down, onto the coated metal surface, ensuring that pressure is applied over its entire surface, Excess adhesive shall be removed immediately and may be applied to subsequent tiles or to the surface being damped. Remove protective covering from stud and coat the threads with an anti-seize compound in accordance with MIL-T-22361 to prevent galling of CRES nuts and studs.

5.1.6.1.1 Installation of the restraining layer. The surface of the plastic restraining plate which will bear against the tiles shall be coated with a thin, even layer of petrolatum. Application of the petrolatum will be facilitated if it is warmed to a temperature approximately 10°F above its melting point. The plastic sheet shall be positioned, coated side down, over the plastic tiles and the special 2-inch diameter by l/8-inch thick CRES washers and CRES locknuts installed on the protruding studs. The locknuts shall be tightened with a torque wrench using 40 inch-pound plus or minus 10 percent net load. A thin layer of polyolefin in accordance with L-P-378 may be installed between the damping tile and restraining layer as an alternative to applying the petrolatum. If epoxy paint has been inadvertently applied to the threads, the locknuts will cut through the paint, however, the nuts shall be backed off slightly and retightened to a 40 inch-pound plus or minus 10 percent net load. The locknuts shall be tightened immediately after installing the damping treatment (before the adhesive has set). Net load Is defined as the load over and above that required to overcome the turning resistance of the nut on the stud. Figure 5 shows a cross section view of a typical installation in a ballast tank. Re-torquing of nuts after installation is not required unless the washer is loose. After adhesive cure (24 hours minimum), the washers and nuts shall be checked to ensure that none are loose. Nuts on studs with loose washers shall be re-torqued to 40 inch-pounds, plus or minus 10 percent. Welds shall not be covered by the restraining layer. Where NDT inspection of a weld is not required, damping shall be applied within 1 ± 1/2 inch of the weld. When NDT inspection is required, damping shall be installed within 2 +0, -1/2 inches from welds. Damping in the forward trim tanks of submarines shall be installed such that a minimum of 3 +1/2, -0 inches spacing is maintained between the damping and welds (see 5.1.4.3).

5.1.6.2 Installation of type II, class 1, 2, and 3 tiles in areas not requiring a restraining layer. Tiles shall be bonded to the painted structures with epoxy adhesive prepared as described in 5.1.5. The adhesive shall be applied and the tiles installed in the manner described in 5.1.6.1. Tiles shall be fitted together as closely as is practicable, and shall be installed in the vicinity of welds as described in 5.1.4.3. It may be necessary to shore tiles installed on vertical, overhead, curved, and irregular surfaces to prevent them from slipping until the adhesive sets, and to ensure that the tile conforms to the underlying surfaces. It shall be permissible to install 3/8-inch diameter threaded CRES studs, washers, and nuts as needed to support temporary shoring to hold the tiles in position until the adhesive has set. Care must be taken in removing the shoring to prevent damage to the tile. The studs shall be cut off where they would present a safety hazard.

5.1.7 Paint application.

5.1.7.1 Corrosion protection and habitability area paints. Tiles installed inside submarine pressure hulls and in surface ship living or working areas shall be painted with a thin, wet coat of MIL-P-24441/1, formula 150, followed by whatever paint normally is applied in the particular area.

5.1.7.2 Antifouling paints. Damping tiles and plastic constraining covers are not inherently antifouling. In those areas where protection from fouling is required, the damping treatment shall first be painted with a thin, wet coat in accordance with MIL-P-24441, formula 150 paint. Within 4 hours after paint application (after the solvent has evaporated but before the paint has cured), two coats of antifouling paint, formula 121 of MIL-P-15931 shall be applied. The first coat In accordance with the MIL-P-15931 antifouling system, formula 121, must be applied when the epoxy paint coat is in its final tacky stage. If the epoxy becomes too dry, good adhesion of vinyl antifouling will not be achieved. If the epoxy has cured too hard, it must be given a thin, continuous, mist-coat (1 to 2 roils wet film thickness) of the same epoxy paint. This mist-coat shall be allowed to cure to a tacky stage before applying the first coat of vinyl antifouling. The tacky stage is a function of temperature and humidity, and will vary widely with climate conditions and the type of epoxy paint used. It is best defined as that curing (drying) stage when a fingertip pressed lightly against the film leaves only a slight impression and none of the film sticks to the finger.

5.1.8 Maintenance procedures.

5.1.8.1 Cleaning of tiles and restraining layers. Tiles and their restraining covers shall be cleaned of oil, grease, waxy contamination or loose paint. This may be done by using cloth wetted with 1,1,1 trichloroethane. This cleaning may be followed by washing with a mild detergent solution, such as 1/2 ounce of MIL-D-16791, type I detergent per gallon of warm water. (NOTE: Whenever a detergent is used, the surface shall be thoroughly rinsed with fresh water to remove the detergent residue in order to preclude subsequent adhesion problems.) If more vigorous cleaning is required, the surface shall be mechanically or hand sanded, followed by removal of oil, grease, or waxy contamination. The sanding operation may remove any paint which has been applied to the surfaces. If so, repainting shall be performed as described in 5.1.7. (WARNING: DO NOT sandblast. This will damage the restraining plate.)

5.1.8.2 Repair of minor damage to damping treatments. Type II tiles are airly resistant to damage; however, they can be damaged by impact and by strikng with sharp instruments. Since the tiles are thermoplastic, they can be damged quite easily when heated above temperatures of about 120°F. Welding in the ay of tiles will destroy the tiles. Minor damage is defined as any scuffing, earing, gouging, cutting or loosening of tiles in an area not to exceed 10 perent of the damped surface. Damage of this order need not be repaired, unless major repairs or alterations are being made in adjacent damped areas. The repairs shall then be made as described in 5.1.8.3. If the damaged tiles are regarded as potential noise sources, the affected areas shall be trimmed away.

5.1.8.3 Repair of major damage to damping treatments. Tiles affected by major damage shall be removed. Any damaged studs shall be removed, and new studs installed. The underlying surfaces shall be cleaned of all old adhesive. If the paint on the metal has been damaged, the metal surfaces shall be properly prepared and new paint applied. New tiles shall then be installed by the procedure described in 5.1.3 through 5.1.6. If the plastic restraining cover has been damaged, the affected area may be cut away and a new piece of material installed in its place. However, the new portion of the cover shall be held by at least one stud, washer and nut, and the effectiveness of the cover in preventing loss of detached tiles must not be impaired. If its effectiveness is impaired, the entire restraining cover shall be replaced.

5.1.8.3.1 Replacing missing studs. If loss of studs in restrained damping treatments is the only damage noted, replacement of the studs shall be governed by the following conditions:

(a) Missing studs in periphery holding situations, except where two restraining covers join, shall be replaced.
(b) Replacement of studs missing from holding points inside the peripheral holding points shall be made only when the overall protection afforded the restraining cover is considered jeopardized.

To replace missing studs, the restraining cover shall be removed and the tile cut away over approximately a 4 by 4 inch square area centering around the holding point. The surface shall be ground to bare metal in way of the stud attachment point, and adhesive and tile particles shall be removed from the remaining area. Studs shall be replaced by the automatically-timed arc welding technique originally employed. New studs shall be painted, the threads preserved, and the clean metal surface repainted as specified in 5.1.3.2. Tile in the affected areas and the restraining cover shall be replaced using the procedures described in 5.1.6.1.

5.1.8.3.2 Repainting. Antifouling paints damaged or destroyed during repair operations on the damping treatments shall be replaced using the procedure described in 5.1.7.2.

5.2 Requirements for installation of type II damping tiles on heavy steel plate, 3/4 inch or greater.

5.2.1 Materials.

5.2.1.1 Damping tiles. Type H, MIL-P-23653, class 1, 2, and 3 tiles for damping plate 3/4 inch and greater in thickness shall be 12 by 12 inches and weigh 2.8 lb/ft. Nominal tile thickness shall be 3/8 inch.- On some 688 and 726 class submarines 0.9 lb/ft^2 (nominal 1/8 inch) tiles were installed on thick plate. This is not recommended for new design. Class 1, 2 and 3 tiles in constrained layer configurations shall be installed on steel plates exposed to various operating temperatures ranges in accordance with table IV.

5.2.1.2 Adhesive. Adhesive conforming to MIL-A-24456 shall be used for plastic vibration damping tile.

5.2.1.3 Constraining materials. When type II tiles are installed on heavy steel plate 3/4 inch or greater in thickness, they shall be constrained with a steel cover layer, the thickness of which depends on the thickness of the underlying steel plate. The cover layer is secured with studs welded to the surface to be damped, and is bonded to the tiles with the same epoxy adhesive used to bond the tiles to the prepared steel surfaces. The purpose of the constraining layer is to limit extensional distortion of the tile when undergoing mechanical deformation, thereby increasing shear distortion with a consequent improvement in damping efficiency. The constraining layer will ensure that tiles do not become detached by severe mechanical shock forces, thus precluding the requirement for a plastic restraining layer when installed in ballast tanks or other floodable areas. The following materials shall be used to constrain the damping tiles:

(a) Aluminum alloy plates, varying in thickness according to the thickness of the steel plate, as indicated in table II. Plate shall be in accordance with ASTM B 209, alloy and temper 5086-H116, (to be used only for repair of existing installation).
(b) Ordinary strength steel plates, varying in thickness as indicated in table II, according to the thickness of the metal being damped. Sheet steel shall conform to ASTM A 366 or ASTM A 569. Plate steel shall conform to MIL-S-22698, grade A, class P or U, as appropriate.
(c) ordinary strength steel threaded studs in accordance with MIL-S-24149 and MIL-S-24149/1, type II. Size and length of studs shall be as specified in table VI.
(d) 3040 or 316 CRES threaded studs in accordance with MIL-S-24149 and MIL-S-24149/3, type V. Size and length of studs shall be as specified in table VI.
(e) Flat steel washers, 2 inches outside diameter (o.d.), l/8-inch thick i.d., *to* accommodate studs listed In table VI. Manufacture from l/8-inch thick steel plate in accordance with ASTM A 366 or ASTM A 569.
(f) Flat CRES washers, 2 inches o.d., l/8-inch thick, to accomodate studs listed in table VI. Manufacture from 304 to 316 CRES.
(g) Nuts, self-locking in accordance with MS17829 and MIL-N-25027, sized for studs listed in table VI.

(h) Nuts, self-locking CRES in accordance with MS17829 and MIL-N-25027, sized for studs listed in table VI.
(i) Anti-seize compound in accordance with MIL-T-22361.

TABLE VI. Size and length of studs to be used on various thicknesses of steel plate.

Thickness of steel structure to be damped (inches)	Studs		
	Minimum diameter 1/ (inch)	Threads per (inch)	Minimum length 1/ after welding (inches)
3/4 to 1-9/16 inclusive	3/8	16	1-1/2
1-5/8 to 2 inclusive	1/2	13	1-3/4

1/ Length and diameter of stud may vary to suit special conditions.

5.2.1.4 Protective materials. The following materials shall be used to protect the steel plating and damping materials:

(a) Insulation sleeving, electrical, flexible, plastic in accordance with MIL-I-631, type F, form U, subform U_b, grade a, class II, category 1, sized to fit studs specified in table VI. (Required only when an aluminum constraining layer is installed.)
(b) Insulating washer, 2-inches o.d., nominal thickness 0.063, id. to accommodate studs listed in table VII. (Required only when an aluminum constraining layer is installed.) Made from insulation sheet, electrical, non-adhesive, phenolic resin in accordance with MIL-P-15035.
(c) Epoxy coating system MIL-P-24441, formulas 1500 of MIL-P-24441/1, 151 of MIL-P-24441/2 and 152 of MIL-P-24441/3, or formulas 150R66 of MIL-P-24441/10, 151R66 of MIL-P-24441/11 and 152R66 of MIL-P-24441/12 as appropriate, shall be used to protect the surfaces of the steel plating, the damping material, and the constraining devices.
(d) Corrosion preventive grease in accordance with MIL-C-11796, class 3 or MIL-C-16173, grade 1.
(e) Antifouling paint in accordance with MIL-P-15931 (formula 121 and 129).

TABLE VII. Net torque load for stud nuts.

Nut size (inch)	Net torque load (inch/pounds plus or minus 10 percent)
3/8	50
1/2	50

5.2.1.5 Cleaning materials. 1,1,1 trichloroethane (methyl chloroform) in accordance with O-T-620 (1 gallon) shall be used to clean the steel plating.

5.2.2 Safety precautions and environmental control. The precautions and temperature controls outlined in 5.1.2 shall also apply to the installation of tiles on heavy steel plate.

5.2.3 Surface preparation prior to installation of damping tiles.

5.2.3.1 Attachment of studs. Threaded studs of the size and length shown in table VI shall be welded to the structure to be damped by the automatically-timed arc technique. CRES 304 or 316 studs shall be used in all wet areas, and ordinary strength steel studs shall be used in all dry areas. Stud spacing shall be approximately 11 inches; less if the contours of the damped surface require it. A stud shall also be located at each corner of any constraining layer wider than 8 inches. For constraining layers which are less than 8 inches in width, a single row of studs shall be located in the center of the layer. If constraining layers are cut to the size of the damping tile, one stud shall be positioned in the center of each tile and constraining layer combination (see 5.2.4). Studs shall be welded and inspected as required by MIL-STD-1688 or NAVSEA 0900-LP-000-100, as applicable.

5.2.3.1.1 Protection of stud threads. The threaded portion of the studs shall be taped or covered with a short length of tubing or protective cap in order *to* protect the threads during subsequent cleaning operations, surface preparation, and tile installation.

5.2,3.2 Cleaning and coating of the steel surfaces (wet areas only). Any oil, grease, or waxy contamination shall be removed using a clean cloth wetted with 1,1,1 trichloroethane. The surfaces shall then be cleaned to near-white metal by grit or sandblasting. The near-white metal surfaces and the studs shall next be coated with one coat each of formulas 150 of MIL-P-24441/1, 151 of MIL-P-24441/2 and 152 of MIL-P-24441/3 to achieve a minimum dry film thickness of 8 roils. Each coat shall be allowed a minimum drying time in accordance with table V prior to application of the next coat. If the paint can be marked with a fingernail, it shall be given additional drying time. Paint which is allowed to dry for more than 48 hours shall be cleaned by wiping with a clean cloth wetted with 1,1,1 trichloroethane prior to application of the next coat. When painting of stud threads Is not desirable, the-studs shall, at a minimum, be painted up to the bottom thread. Stud threads shall then be covered with a grease conforming to MIL-C-16173, grade 1, or MIL-C-11796, class 3. Where abrasive blasting is impractical due to the close proximity of installed machinery or equipment, the surfaces shall be mechanically cleaned. If the steel surfaces have already been coated with the MIL-P-24441 paint system, and the paint shows no sign of checking, cracking, flaking, scaling, peeling, blistering, chalking, or rusting of the underlying metal, the studs shall be installed. The painted surfaces shall then be sweep-blasted with fine sand or thoroughly hand sanded to remove surface gloss, plus loose paint or other contamination, and given a thin, wet coat of MIL-P-24441/1, formula 150 paint.

5.2.3.3 Cleaning and coating of the steel surfaces (dry areas only). The steel surface shall be cleaned to near-white metal by grit or sandblasting. Oil, grease, or waxy substance, if present, shall be removed by wiping the contaminated area with a cloth wetted with 1,1,1 trichloroethane. The near-white metal surfaces and the studs shall be coated with one coat each of formulas 150 of MIL-P-24441/1 and 151 of MIL-P-24441/2 to achieve a minimum dry film thickness of 5 roils. Each coat shall be allowed a minimum drying time in accordance with table V prior to application of the next coat. If the paint can be marked with a fingernail, it shall be given additional drying time. paint which is allowed to dry for more than 48 hours shall be cleaned by wiping with a clean cloth wetted with 1,1,1 trichloroethane prior to application of the next coat. When painting of stud threads is not desirable, the studs shall, at a minimum, be painted up to the bottom thread. Threads shall then be covered with a corrosion preventive grease conforming to MIL-C-16173, grade 1, or MIL-C-11796, class 3. If more than 1 year has elapsed between painting and installation of the tile, the paint shall be sweep-blasted with fine sand and an additional cover coat of paint applied. If more than 3 months but less than 1 year has elapsed before tile application, the painted surfaces shall be hand or power sanded or sweep-blasted before tile application. Oil, grease, or other contamination, if present, shall be removed from the painted surfaces, regardless of age, before tile application. Where abrasive blasting is Impractical due to proximity of installed machinery or equipment, the surfaces may be mechanically cleaned. Any oil, grease, or other contamination on the painted surfaces shall be removed by wiping with a cloth wetted with 1,1,1 trichloroethane. In cases where the steel surfaces were previously painted with the DOD-P-23236, type 1, class 1 paint system, the surfaces shall be mechanically cleaned, and a thin, wet coat of the MIL-P-24441/1, formula 150 paint system applied. The base of the studs shall be given one coat of MIL-P-24441/1, formula 150 primer, and the entire painted surface shall be given a thin, wet coat of the MIL-P-24441/1, formula 150 paint. When sweep-blasting of the painted surfaces is not feasible, they shall be sanded lightly with 120 grit sandpaper to break the surface gloss. The base of the studs shall be given one coat of the MIL-P-24441 primer, and all painted surfaces shall be given a thin, wet coat of the MIL-P-24441/1, formula 150 paint.

5.2.4 Selecting and fitting of the constraining layer. A steel plate of the appropriate thickness as shown in table II shall be cut to fit the area to be damped. When repairing damping with an aluminum alloy constraining layer, it may be replaced with a new aluminum alloy plate. Constraining layers may be cut to the same plan size as individual tiles. If constraining layers are cut in this manner, a stud shall be located in the center of the tile and constraining layer composite. Constraining layers shall not be installed over welds. Holes, 7/8 inch in diameter, shall be made in the plate for the studs. This plate can be used as a template for fitting damping tiles to the area.

5.2.4.1 Painting. The aluminum or steel constraining layer shall be painted on all faces and edges, including stud holes, with the MIL-P-24441 paint system prior to installation, as follows:

(a) Wet area - prepare and paint in accordance with 5.2.3.2.
(b) Dry area - prepare and paint in accordance with 5.2.3.3.

5.2.5 Fitting of tiles. The damping tiles shall be closely fitted and cut to fit the surfaces between weld beads. Where NDT inspection is not required, spacing between welds and damping shall be maintained at 1 ± 1/2 inch. Where NDT inspection is required, spacing shall be 2 +0, -1/2 inches between welds and damping. Tiles may be applied over welds which are on the reverse side of plating. The determination of whether or not to apply damping over welds which are on the reverse side of the plating shall be based on the possibility of future weld inspection complications due to installed tiles.

5.2.5.1 Drilling and punching holes. Holes, 7/8 inch in diameter, shall be cut, drilled, or punched in the tiles to provide passage for the studs. Holes can be made using a leather punch or a drill with a flat-end bit. The tiles shall be kept at a temperature of 75 to 100°F to facilitate cutting, punching, and forming operations. Tiles usually are deformed by cutting and punching operations. Any surface deformation shall be corrected so that the tile will conform to the surface to which it will be bonded. Distortion can be removed easily by trimming or pounding with a flat-faced rubber mallet.

5.2.5.2 Cutting. Type II, class 1, 2, and 3 tiles may be cut to required shapes by means of a band saw with a blade which has had the teeth removed and the edge of the blade ground to a knife edge. They also can be cut with a utility knife or a hinged knife such as a shingle cutter.

5.2.6 Preparation of the adhesive. Adhesive conforming to MIL-A-24456 shall be used to bond the tiles to the structures to be damped. This adhesive is an epoxy system, with two components which shall be blended together just before application. These components shall become thoroughly blended, so that the adhesive will be uniformly hard when it sets up. Individual components usually are furnished in two markedly dissimilar colors; upon thorough blending of the components, the resulting admixture will be free of streaks and distinctly different in color with respect to either of the components. Adhesive conforming to MIL-A-24456 may be pre-packaged in barrier kits conforming to MIL-P-38714, type II and mixed mechanically with automatic mixing equipment designed to be compatible with the barrier kits.

5.2.6.1 Adhesive pot life. Adhesive shall be mixed in quantities such that it can be used in 1-1/2 to 2 hours. Adhesive shall be mixed in small quantities or have a large surface area exposure to minimize heat build-up produced by the exothermic chemical reaction of the ingredients. Adhesive will begin to thicken approximately 2 hours after mixing, indicating that its pot life has been exhausted, and that it should be discarded. Adhesive that has exhausted its pot life and has begun to set shall not be used, as it will result in poor bond strength.

5.2.6.2 Preheating. Adhesive components which are below 70°F in temperature shall be preheated to 70 to 90°F before blending operations.

5.2.6.3 Cleaning. Epoxy adhesives are difficult to remove once they harden. Excess adhesive shall be removed from mixing and application equipment and equipment shall be cleaned before the adhesive has begun to set, using hot water and detergent in accordance with MIL-D-16791, type 1.

5.2.7 Installation of damping materials.

5.2.7.1 Insulation sleeving. When damping material with an aluminum constraining layer will be in contact with seawater, a short length of insulation sleeving (the length to be equal to the sum of the thickness of the damping tile and-the aluminum constraining layer) shall be placed over each stud (applies only to repair of existing installation).

5.2.7.2 Damping tiles. Tiles which have been fitted previously shall be bonded to the painted structure with epoxy adhesive in accordance with MIL-A-24456, prepared as described in 5.2.6. The tiles shall first be cleaned of any residue and wiped clean with 1,1,1 trichloroethane to remove grease, oil, mold release compounds, wax or other contaminants. Adhesive shall be applied to both the painted steel surface to be damped and to the contacting face of the tile, using a dog-eared trowel as shown on figure 19, held at an angle of approximately 30 to 45 degrees normal to the surface being prepared. The entire face of the tile and the metal surface shall be completely and evenly covered with adhesive. The base and weld bead of each stud shall be heavily coated with adhesive, such that the adhesive will be forced up and out of the stud hole in the tile when the damping is installed. Tiles shall then be pressed, coated side down, onto the painted metal surface. Firm pressure shall be applied over the entire tile surface. Excess adhesive shall be removed immediately and may be applied to subsequent tiles or to the surfaces being damped provided the adhesive pot life has not been exhausted.

5.2.7.3 Constraining layer. Both the surface of the constraining layer which will bear against the tiles and the tiles shall be coated with the epoxy adhesive, to be applied with a dog-eared trowel. The constraining layer shall then be placed, coated side down, over the tiles and firm pressure applied. Excess adhesive shall be removed immediately and may be applied to subsequent tiles or plate provided the adhesive pot life has not been exhausted.

5.2.7.4 Insulating washers. An insulating washer (NOTE: the insulating washer is only required if an aluminum constraining layer is used and the damping will be in contact with seawater), a steel washer and a self-locking nut, in the order named, shall be placed on each stud. Washer and nut shall be CRES for damping treatments installed external to pressure hull. Following removal of protective covering, the stud shall be coated with an anti-seize compound in accordance with MIL-T-22361 to prevent galling of CRES nuts and studs. The lock nuts shall be tightened with a torque wrench to the net load specified in table VII. If paint was used on the threads, the lock nuts will cut through the paint, but shall be backed off slightly and retightened to the specified net load, The locknuts shall be tightened immediately after installing the treatment (before the adhesive has set). Net load is defined as the load over and above that required to overcome the turning resistance of the nut on the stud. Cross-sectional views of typical installations of heavy plate damping treatments are shown on figures 2, 7, and 20. Re-torquing of nuts after installation is not required. After adhesive cure (24 hours minimum), the washers and nuts shall be checked to ensure that none are loose. Washers that can be turned by hand are considered loose. Nuts on studs with loose washers shall be re-torqued to the specified net load.

5.2.8 Paint application.

5.2.8.1 Corrosion protection and habitable area paints. Installations, including exposed ends of studs and washers, of heavy-plate damping treatment which are likely to be in contact with oil or sea water shall be coated with formulas 150 0f MIL-P-24441/1, 151 of MIL-P-24441/2 and 152 of MIL-P-24441/3. In all other areas, the damping treatment shall be given a thin, wet coat of MIL-P-24441/1, formula 150 primer followed by coating with the paint specified for the area.

5.2.8.2 Antifouling paints. If protection from fouling is required, antifouling paint in accordance with formula 121 of MIL-P-15931 shall be applied over the protective coatings. Since these coatings are based on epoxy resins, it is important that the antifouling paint shall be applied after the solvent has evaporated, but before cure of the resin has been completed, in order to obtain satisfactory adhesion between the two paints. Usually, sufficient solvent has evaporated when the coating is tacky to the touch. If the epoxy becomes too dry, good adhesion of vinyl antifouling will not be achieved. If the epoxy has cured too hard, it shall be given a thin, continuous mist-coat (1 to 2 roils wet film thickness) of the same epoxy paint. This mist-coat shall be allowed to cure to a tacky stage before applying the first coat of vinyl antifouling. The tacky stage is a function of temperature and humidity and will vary widely with climate conditions and the type of epoxy paint used. It is best defined as that curing (drying) stage when a fingertip pressed lightly against the film leaves only a slight impression and none of the film sticks to the finger.

5.2.9 Maintenance procedures.

5.2.9.1 Cleaning of damping treatment. Since the outward appearance of heavy-plate damping treatments is that of a painted metal plate, any procedure used to clean the paint in the area can be used to clean the damping treatment.

5.2.9.2 Minor repair of damping treatment. The damping tiles in heavy-plate damping treatments are not likely to be damaged, because they are protected by the heavy aluminum or steel constraining layer. However, they can be damaged by overheating due to nearby welding or cutting operations and by severe mechanical abuse. If the affected area is less than 10 percent of a damped surface, there is no requirement to repair the damping treatment.

5.2.9.3 Major repair of damping treatment. When large-scale repairs (greater than 10 percent of the damped surface) are required, the entire treatment covering the area in question shall be removed and replaced with new materials, using the procedures specified In 5.2.7. Removal of the constraining layer is difficult, since it is bonded to the tiles, which are in turn bonded to the steel surface below. By heating the aluminum or steel plate to a temperature of 250 to 300°F, the bonding agent will soften and the plate can be separated from the tile. Heating can be accomplished by carefully directing a flame over the aluminum or steel surface, or by the use of strip heaters. Adequate ventilation shall be provided and all persons in the space shall wear approved respirators when heating the plates, due to the danger of toxic fumes if the damping tiles should become overheated. (Safety note: A fire watch shall be established and maintained during the heating operation. Fire extinguishers of the carbon dioxide type shall be available throughout the work area.)

5.3 Requirements for installation of type III damping tiles.

5.3.1 Materials.

5.3.1.1 Damping tiles. Type III damping tiles in accordance with MIL-P-22581 shall be 12 by 12 by 5/8 inches in size.

5.3.1.2 Adhesive. Adhesive for type III vibration damping tile shall be in accordance with MIL-A-24456.

5.3.1.3 Protective materials. The following materials shall be used to protect the surfaces of the steel plating and damping material:

(a) Epoxy coating system in accordance with MIL-P-24441 (formulas 150 of MIL-P-24441/1, 151 of MIL-P-24441/2 and 152 of MIL-P-24441/3, or formulas 150R66 of MIL-P-24441/10, 151R66 of MIL-P-24441/11 and 152R66 of MIL-P-24441/12, as appropriate).
(b) Antifouling paint in accordance with formula 121 of MIL-P-15931 (5 gallon).

5.3.1.4 Cleaning materials. The following materials shall be used to clean the steel plating and damping materials:

(a) Five-degree xylene in accordance with ASTM D 364 (xylol).
(b) 1,1,1 trichloroethane (methyl-chloroform) in accordance with 0-T-620 (1 gallon).
(c) Cleaning compound in accordance with MIL-C-22230 (55 gallon).
(d) Detergent, general purpose (liquid, nonionic) in accordance with MIL-D-16791, type 1 (1 gallon).

5.3.2 Safety precautions and environmental control.

5.3.2.1 Handling damping tile. Tiles in accordance with MIL-P-22581 present no health hazard and may be handled without any toxic effects or dermatitis effects due to direct contact of the tiles with the bare skin.

5.3.2.2 Handling of bonding materials. Adhesives, sealants, coatings, cleaning compounds and solvents, depending on the type being used, may present health hazards. Personnel using solvents in closed spaces with limited ventilation shall wear air-lined masks with forced air ventilation. Specific health and safety precautions which apply to the use of the materials are given in 4.5.

5.3.2.3 Environmental requirements. In order to achieve the desired damping performance, a complete adhesive bond is required between the steel surface and the damping material. This requires that each layer of the bond {all paint coats and the adhesive) be fully cured. Epoxy materials, in general, cure through a chemical reaction. To achieve complete cure, the initial mixing of the components shall occur in a reasonably warm work environment. Also, epoxy compounds will not cure correctly at temperatures below 35°F. The following temperature conditions shall be maintained during the material installation:

(a) During the application of MIL-P-24441 paints and MIL-A-24456 adhesives, the temperature of the work area shall be maintained between 35 and 95°F. MIL-P-24441 type II paints conforming to air pollution regulations shall be applied at temperatures above 55°F.

(b) If the work area temperature is below 50°F, MIL-P-24441 paints shall be mixed and given the proper induction time at 70°F or greater (not to exceed 95°F), then carried to the work site. This is essential to ensure proper curing of the paint.

(c) If temperature of the work area is below 50°F, the MIL-A-24456 adhesive components shall be preheated to 70°F and mixed at 70°F or greater (not to exceed 95°F), then carried to the work site. This is essential to ensure proper curing of the adhesive.

5.3.3 Surface preparation prior to installation of tiles.

5.3.3.1 Hull, keel, frames, bulkheads and underside of platform decks (dry spaces only). Surfaces, including those which have galvanized coatings, shall be cleaned to near-white metal by either grit or sandblasting. Any oil, grease, or waxy contaminant present on the steel, or on any previously painted surface, shall be removed by wiping with a clean cloth wetted with 1,1,1 trichloroethane prior to blasting. Where abrasive blasting is impractical due to the proximity of installed machinery or equipment, the surfaces may be mechanically cleaned. Immediately after the blasting operations, the cleaned steel surfaces shall be painted with one coat each of formulas 150 of MIL-P-24441/1 and 151 of MIL-P-24441/2. Each coat shall be allowed a minimum drying time in accordance with table V prior to application of the next coat. If the paint can be marked with a fingernail, it shall be given additional drying the. If more than 3 months but less than 1 year elapse before tile application, painted surfaces shall be hand or power sanded, or sweep-blasted, before the tile installation. Oil, grease, or other contamination shall be removed from the painted surfaces, regardless of age. The surface shall then be given a thin, wet coat of paint in accordance with formula 150 of MIL-P-24441/1 or 151 of MIL-P-24441/2.

5.3.3.2 Bilges, bilge wells, peak tanks and sumps (wet spaces only). The metal surfaces shall be cleaned as specified in 5.3.3.1. Immediately after cleaning operations, the near-white surfaces shall be painted with one coat each of formulas 150 of MIL-P-24441/1, 151 of MIL-P-24441/2 and 152 of MIL-P-24441/3 or 156 of MIL-P-24441/7 paint system to achieve a minimum dry film thickness of 8 mils. Each coat shall be allowed a minimum drying time in accordance with table V prior *to* application of the next coat. If the paint can be marked with a fingernail, it shall be given additional drying time. When more than 3 months time have elapsed between painting and installation of tile, the paint shall be sweep-blasted with fine sand and an additional thin, wet coat of paint shall be applied. If the steel surfaces already have been coated with DOD-P-23236, type 1, class 1 paint systems, the studs may be installed, provided the paint shows no sign of checking, cracking, flaking, sealing, peeling, blistering, chalking, or rusting of the underlying metal. The painted surfaces shall then be sweep-blasted with fine sand to remove loose paint or other contaminants, and to remove surface gloss. If oil, grease, or other contamination is remaining on the painted surfaces, it shall be removed by using a cloth wetted with 1,1,1 trichloroethane. The sweep-blasted surface shall be given a thin, wet coat of paint in accordance with formula 150 of MIL-P-24441/1 or 156 of MIL-P-24441/7.

5.3.3.3 Fuel tanks. For new construction, the inside surfaces of the fuel tank shall be cleaned to near-white metal by grit or sandblasting. Immediately after completion of abrasive blasting operations, the metal surfaces shall be coated with one coat each of formulas 150 of MIL-P-24441/1, 151 of MIL-P-24441/2, and 152 of MIL-P-24441/3 to achieve a minimum dry film thickness of 8 rolls. Each coat shall be allowed a minimum drying time in accordance with table V prior to application of the next coat. If the paint can be marked with a fingernail, it shall be given additional drying time. Paint which is allowed to dry for more than 48 hours shall be cleaned by wiping with a clean cloth wetted with 1,1,1 trichloroethane prior to application of the next coat. When more than 3 months time has elapsed between painting and installation of tile, the paint shall be sweep-blasted with fine sand and an additional thin, wet coat of MIL-P-24441/1, formula 150 paint applied. Oil, grease, or other contamination shall be removed from the painted surfaces, regardless of age, before tile application. Tanks which previously have contained fuel oil shall first be cleaned by filling the tank with a cleaning solution consisting of 4 gallons of cleaning compound in accordance with MIL-C-22230, to 1000 gallons of fresh water. The solution shall remain in the tanks for at least 36 hours (soaking period). A steam connection shall be supplied to heat the solution to about 105°F. Means to agitate the solution continuously during the soaking period shall also be provided. Agitation can be accomplished by bubbling air in the solution. After the soaking period has been completed, the tank shall be emptied and the metal surfaces rinsed thoroughly with hot fresh water under 100 lb/in^2 supply pressure. The surfaces shall then be wiped dry with clean cloths. Upon completion of the chemical cleaning of the tank, the cleaned surfaces shall be further cleaned to near-white metal by grit or sandblasting operations. The cleaned metal surfaces shall then be coated with one coat each of formulas 150 of MIL-P-24441/1, 151 of MIL-P-24441/2 and 152 of MIL-P-24441/3, to achieve a minimum dry film thickness of 8 roils and allowed to dry as stated above. If more than 3 months have elapsed between painting and installation of tile, the paint shall be sweep-blasted with fine sand and an additional cover coat applied. Oil, grease, or other contamination shall be removed from the painted surfaces, regardless of age, before tile application.

5.3.3.4 Floodable spaces other than fuel tanks (sonar domes and saltwater tanks). The metal surfaces shall be cleaned as specified in 5.3.3.1. Immediately after completion of cleaning operations, the cleaned metal surfaces shall be painted with one coat each of formulas 150 of MIL-P-24441/1, 151 of MIL-P-24441/2 and 152 of MIL-P-24441/3, to a minimum dry film thickness of 8 roils. Each coat shall be allowed a minimum drying time in accordance with table V prior to application of the next coat. If the paint can be marked with a fingernail, it shall be given additional drying time. When more than 3 months time have elapsed between painting and installation of tile, the paint shall be sweep-blasted with fine sand and an additional thin, wet coat of paint shall be applied. If the steel surfaces have already been coated with MIL-P-24441 or DOD-P-23236, type 1, class 1 paint systems, the studs may be Installed, provided the paint shows no sign of checking, cracking, flaking, scaling, peeling, blistering, chalking, or rusting of the underlying metal. The painted surfaces shall then be sweep-blasted with fine sand to remove loose paint or other contaminants and *to* remove surface gloss, and given a thin, wet coat of paint in accordance with formula 150 of MIL-P-24441/1 or 152 of MIL-P-24441/3. If oil, grease, or other contamination is remaining on the painted surfaces, it shall be removed by using a cloth wetted with 1,1,1 trichloroethane.

5.3.4 Preparation of tiles. The tiles usually are furnished with a polyethylene film on one surface, which shall be detached prior to installation. In those instances when the film cannot readily be peeled off, the polyethylene film shall be wetted with toluene grade B or xylol. After standing several minutes, the film usually will separate easily from the tile.

5.3.4.1 Tile cutting. The tile may be cut with a linoleum knife, utility knife, or a hinged knife such as a shingle cutter. Cutting is most easily accomplished if the tile is at a temperature between 70 to 90°F. In cold climates, tiles shall be stored in a warm room for at least 24 hours before using. If they are kept in their original shipping containers until just before being used on the job, the tiles will stay close to the storage temperature.

5.3.5 Preparation of adhesives. Adhesive conforming to MIL-A-24456 shall be used to bond the tiles to the structure to be damped. This adhesive is a two-component epoxy system. The components shall be blended together just before use of the adhesive. These components shall be thoroughly blended so that the adhesive will be uniformly hard when it sets up. Components usually are furnished in two markedly dissimilar colors, so that upon thorough blending of the components, the resulting admixture will be distinctly different in color with respect to either of the components. Adhesive conforming to MIL-A-24456 may be pre-packaged in barrier kits conforming to MIL-P-38714, type II, and mixed mechanically with automatic mixing equipment designed to be compatible with the barrier kits.

5.3.5.1 Adhesive pot life. Adhesive shall be mixed in quantities that can be used In 1-1/2 to 2 hours. Adhesives shall be mixed in small quantities with large surface area exposure to minimize heat build-up produced in the adhesive by the exothermic chemical reaction of the ingredients. About 2 hours after mixing the adhesive, it will begin to thicken, indicating that its pot life has been exhausted. Adhesive that has exhausted its pot life and has begun to set shall not be used, as it will result in poor bond strength.

5.3.5.2 Preheating. When components of the adhesive are below 70°F in temperature, they shall be preheated to 70 to 95°F before blending operations.

5.3.5.3 Cleaning. Epoxy adhesives are difficult to remove once they harden. It is important to remove excess adhesive from, and to clean application equipment before adhesive has begun to set, using hot water and detergent in accordance with MIL-D-16791, type 1.

5.3.6 Tile installation.

5.3.6.1 Fitting of tiles. One layer of tiles shall be installed on steel plate of 1/2-inch thickness or less and two layers of tile shall be installed on thicker plate. The same adhesive used to bond the tile to the steel surfaces shall be used to bond the tiles to each other. Damping tiles shall be installed on the surfaces designated by the appropriate ship drawing. The tiles shall be close-fitted, from web-to-web between stiffeners and over entire bulkhead surfaces, except for penetrations and fixtures attached to these surfaces, Tiles shall not be installed over welds. When installing tiles around welds, the following spacing shall be maintained between the tiles and welds: When NDT examination of a weld is not required, a spacing of 1 + 1/2 inches shall be

maintained. When NDT examination of welds is required, spacing shall be 2 +0, -1/2 inches between weld and damping material. When two layers of tiles are required, voids and seams in the first layer shall be filled smooth with the epoxy adhesive to provide a smooth surface for installation of the second layer.

5.3.6.2 Preforming. If the tiles are kept warmed to 70 to 90°F, they can be bent to attain conformance to curved surfaces having a radii of 18 inches or more. In cases where compound curvature is extreme, it will be difficult to obtain conformance to surfaces without adequate shoring.

5.3.6.3 Precautions. When air is introduced *to* keep hull plate and bulkheads dry in areas where tile is being installed, necessary precautions shall be taken to remove both moisture and oil from the air being introduced. In the event condensation of moisture on the metal surfaces to be damped is encountered, the moisture shall be removed from these surfaces with clean, dry cloths just prior to application of the adhesive.

5.3.6.4 Bonding. Prior to application of adhesive, oil, grease or other contamination shall be removed from the surface being damped, regardless of age. Tiles shall be bonded to the painted surfaces and to each other with an epoxy adhesive prepared as described in 5.3.5. The adhesive shall be applied to one face of the tile, to the four edges of the tile, and to the surface being damped with a dog-eared trowel, as shown on figure 19. Care shall be taken to obtain complete and uniform coverage of the adhesive over the entire face of the tile. The tile shall then be pressed, adhesivecoated side down, onto the metal surface to be covered and then vigorously hammered with a wooden or rubber mallet to ensure intimate contact between the damping tile and the steel surface. Excess adhesive extruding from underneath the tile shall be removed immediately and may be applied to subsequent tiles or surfaces to be damped. Careful attention to fitting adjoining tiles will minimize the necessity for subsequent grouting of open seams.

5.3.7 Paint application.

5.3.7.1 Preparation. Before protective paint coatings are applied to the exposed surfaces of the damping tiles, the tiles shall be handwashed with an aqueous detergent solution such as 1 ounce of MIL-D-16791, type 1 detergent per gallon of fresh water, to remove any parting compounds or solutions. The detergent solution shall be rinsed away with fresh water and the surfaces of the tiles dried completely before application of any protective coating or paint.

5.3.7.2 Protective coatings. Type III damping tiles subject to immersion in oil or seawater shall be protected with two coats of formula 151 of MIL-P-24441/1, 152 of MIL-P-24441/2 or 156 of MIL-P-24441/7 paint to match the surrounding area or the color specified for the compartment. The coating also shall be applied over tiles installed in inaccessible voids where rust preventive" coatings are required and which are applied by the fill and drain method. Care shall be taken to ensure complete coverage of the damping tiles.

5.3.7.3 Antifouling paints. If protection from fouling is required, antifouling paint in accordance with formula 121 of MIL-P-15931 shall be applied over the protective coatings. Since these coatings are based on epoxy resins, it is important that the antifouling paint shall be applied after the solvent has evaporated, but before cure of the resin has been completed, in order to obtain satisfactory adhesion between the two paints. Usually, sufficient solvent has evaporated when the coating is tacky to the touch. If the epoxy becomes too dry, good adhesion of vinyl antifouling will not be achieved. If the epoxy has cured too hard, it shall be given a thin, continuous mist-coat (1 to 2 mils wet film thickness) of the same epoxy paint. This mist-coat shall be allowed to cure to a tacky stage before applying the first coat of vinyl antifouling. The tacky stage is a function of temperature and humidity and will vary widely with climate conditions and the type of epoxy paint used. It is best defined as that curing (drying) stage when a fingertip pressed lightly against the film leaves only a slight impression and none of the film sticks to the finger.

5.3.7.4 Habitable area paints. Where appearance is important, the tile may be painted with whatever paint is customarily applied to the area. No preparation other than that specified in 5.3.7.1 is necessary.

5.3.8 Maintenance procedures.

5.3.8.1. Cleaning of hull plate and bulkhead tiles. Type III tile, coated and uncoated, applied to hull plates and bulkheads may be cleaned by washing with a mild detergent solution, such as 1/2 ounce of MIL-D-16791, type 1, detergent per gallon of warm fresh water, without any adverse effects. The use of mechanical devices such as chipping hammers, knives, chisels and steel-wire brushes will cause serious damage to the relatively soft tile and shall not be used in cleaning operations.

5.3.8.2 Cleaning of tiles inside fuel tanks. Tile installations inside fuel tanks may be washed with a cleaning solution comprised of 4 gallons of compound in accordance with MIL-C-22230 dissolved in 1000 gallons of fresh water at 105°F. The tank shall be filled with this solution and allowed to soak for at least 36 hours. The solution shall be agitated with compressed air. Fuel tanks shall not be cleaned with live steam when damping tiles have been installed on the tank boundaries. Cleaning of these tanks with live steam may heat the surrounding walls to a temperature sufficiently high to cause serious damage to tile installation.

5.3.8.3 Repair of damping treatment.

5.3.8.3.1 Minor damage. Damping tiles in accordance with MIL-P-22581 are comparatively soft and may be damaged by impact, by striking with sharp instruments and by scuffing action. Minor scuffing need not be repaired, unless it is desired to restore the appearance of the area. In this case, carefully trim away loose material and fill the scuffed area with epoxy bonding agent in accordance with MIL-A-24456. Single applications in thickness greater than about 1/4 inch shall not be made, or unsightly sagging of the filling material is likely to occur. The repaired area may be repainted approximately 6 hours after installation of the filler. If missing, loose or damaged tiles account for less than 10 percent of the damped area, the affected tiles shall be removed and the surface represerved as specified in 5.3.3, If necessary. It is not necessary to install new tiles.

5.3.8.3.2 Major damage. In the case of major damage, all loose or damaged tiles shall be removed, and the underlying metal surfaces cleaned to remove all old adhesives. If the exposed area is greater than 10 percent of the total damaged area, the area shall be cleaned, sandblasted, painted and new tiles installed in the exposed areas as outlined in 5.3.3 through 5.3.7. In those cases where a corrosion-resistant paint was previously applied to the steel surface, the surface shall be properly prepared and new paint applied. If the tile has previously been painted with one of the protective coatings listed in 5.3.7, the new tiles shall be coated to conform with the adjacent tiles. Coatings used to protect the tile from oil and water are also susceptible to damage under the same situations as the tile. When damage to the coating occurs, the underlying tile in affected areas shall be removed and replaced with new tile. Installations in fuel and water tanks shall be examined carefully after cleaning the tiles to determine that the protective coating is intact. This is especially important in the case of fuel oil tanks during ship overhauls, when welding may be required inside the tanks. Although the tiles are initially flame resistant, oil-soaked tiles will present a fire hazard.

5.4 Requirements for the installation of type V, (MIRL No. 3) class 1 damping tiles on steel plate 1/2 inch or less in flooded and non-flooded areas.

5.4.1 Materials.

5.4.1.1 Damping tiles. Type V, (MIRL No. 3) class 1 tiles in accordance with MIL-T-24487 shall be 12 by 12 by 3/4 inches in size, weighing 5.5 lb/ft^2.

5.4.1.2 Adhesive. Adhesive for type V vibration damping tiles shall be in accordance with MIL-A-24456.

5.4.1.3 Restraining materials. The following materials shall be used to restrain the damping tiles:

(a) Plastic sheet, glass-reinforced, 1/8-inch thick in accordance with MIL-P-17549, grade 3, made with a fire resistant resin conforming to MIL-R-21607.
(b) Ordinary strength steel, uncoated, threaded studs, 3/8-16 UNC 2A by 1-3/4-inches long after weld in accordance with MIL-S-24149/1, type II, class 2.
(c) Flat steel, uncoated washers, 2 inches o.d. by 13/32-inches id., fabricated from 1/8-inch thick steel plate in accordance with ASTM A 366 or ASTM A 569.
(d) Nut, self-locking, 3/8-16 UNC-3B in accordance with MIL-N-25027.
(e) CRES 304 or 316 threaded studs, 3/8-16 UNC 2A by 1-3/4 inches long after weld in accordance with MIL-S-24149/3, type V.
(f) Flat CRES washers, 2 inches o.d., 1/8-inch thick, id. to accommodate a 3/8-inch stud. Manufactured from 304 or 316 CRES in accordance with ASTM A 666, grade A.
(g) Nut, self-locking CRES 3/8-16 UNC-3B in accordance with MIL-N-25027 and MS17829.
(h) Petrolatum in accordance with VV-P-236 (5 pounds).
(i) Anti-seize compound in accordance with MIL-T-22361.
(j) Polyolefin sheet in accordance with L-P-378.

5.4.1.4 Protective materials. The following materials shall be used to protect the steel plating and damping materials:

(a) Corrosion preventive grease in accordance with MIL-C-11796, class 3 or MIL-C-16173, grade 1.
(b) Epoxy coating system MIL-P-24441, formulas 150 of MIL-P-24441/1, 151 of MIL-P-24441/2, and 152 of MIL-P-24441/3 (formulas 150R66 of MIL-P-24441/10, 151R66 of MIL-P-24441/11 and 152R66 of MIL-P-24441/12 where air pollution regulations are in effect).
(c) Insulation sleeving, electrical, flexible plastic in accordance with MIL-I-631, type F, form U, Subform U_b, grade a, class II, category 1.

5.4.1.5 Cleaning materials. The following materials shall be used to clean the steel plating and damping materials:

(a) 1,1,1 trichloroethane (methyl chloroform) in accordance with O-T-620 (1 gallon).
(b) Detergent, general purpose (liquid, nonionic) in accordance with MIL-D-16791, type 1 (1 gallon).

5.4.2 Safety precautions and environmental control (see 6.3).

5.4.2.1 Handling of damping tiles. Tiles in accordance with MIL-T-24487 present no particular health hazard and may be handled without any toxic effects or dermatitis effects due to direct contact with the bare skin.

5.4.2.2 Handling of bonding materials. Adhesives, sealants, coatings, and cleaning compounds and solvents, depending on the types being used, may present health hazards. Health and safety precautions which apply to their use are given in 4.5.

5.4.2.3 Environmental requirements. In order to achieve the desired damping performance, a complete adhesive bond is required between the steel surface and the damping material. This requires that each layer of the bond (all paint coats and the adhesive) be fully cured. Epoxy materials, in general, cure through a chemical reaction. To achieve complete cure, the initial mixing of the components shall occur in a reasonably warm work environment. Also, epoxy compounds will not cure correctly at temperatures below 35°F. The following temperature conditions shall be maintained during the material installation:

(a) During application of MIL-P-24441 paints and MIL-A-24456 adhesives, the temperature of the work area shall be between 35 and 95°F. MIL-P-24441 paints conforming to type II air pollution regulations shall be applied at temperatures above 55°F.
(b) If the work area temperature is below 50°F, MIL-P-24441 paints shall be mixed and allowed the proper induction time at 70°F or greater (not to exceed 95°F), then carried to the work site. This is essential to endure proper curing of the paint.
(c) If the work area is below 50°F, the MIL-A-24456 adhesive components shall be preheated to 70°F, mixed at 70°F or greater (not to exceed 95°F), then carried to the work site. This is essential to ensure proper curing of the adhesive.

5.4.3 Surface preparation prior to installation of type V, class 1 damping tiles.

5.4.3.1 Installation of studs. Where restraining layer is required for type V, class 1 tiles (see 5.4.4.1), threaded studs, 3/8 inch in diameter by 1-3/4 inches long, shall be welded by the automatically-timed arc technique to the structure to be damped. CRES studs shall be used in all wet areas and ordinary strength steel studs shall be used in all dry areas. Studs shall be installed on approximately n-inch centers, so that at least one stud will be located in each tile. Furthermore, a stud shall be located in all tiles larger than 4 by 4 inches and at each corner of the restraining layer. Studs shall be welded and inspected as required by MIL-STD-1688 or NAVSEA 0900-LP-000-1000, as applicable.

5.4.3.1.1 Protecting the stud threads. The threaded portion of the studs shall be covered with a short length of electrical insulation sleeving, protective cap, or taped for protection during subsequent cleaning operations, surface preparation and tile installation.

5.4.3.2 Cleaning and painting of steel surfaces inside ballast and trim tanks and inside all other flooded spaces (sonar domes, super-structure spaces and fairwaters). The surfaces shall be cleaned *to* near-white metal by grit or sandblasting. Oil, grease, or other contamination shall be removed using a clean cloth wetted with 1,1,1 trichloroethane. The near-white metal surfaces including studs, shall next be coated with one coat each of formulas 150 of MIL-P-24441/1, 151 of MIL-P-24441/2, and 152 of MIL-P-24441/3 to achieve a minimum dry film thickness of 8 roils. Each coat shall be allowed a minimum drying time in accordance with table V prior to application of the next coat. If the paint can be marked with a fingernail, it shall be given additonal drying time. Paint which is allowed to dry for more than 48 hours shall be cleaned by wiping with a clean cloth wetted with 1,1,1 trichloroethane prior to application of the next coat. When more than 3 months has elapsed between painting and tile installation, the paint shall be sweep-blasted with fine sand, and an additional cover coat of MIL-P-24441/1 formula 150 paint applied. If painting of the threads is not desirable, the studs shall at a minimum be painted up to the bottom thread. Where abrasive blasting is impractical due to the proximity of installed machinery or equipment, the surfaces shall be mechanically cleaned. If the steel surfaces have already been coated with the DOD-P-23236, type 1, class 1 paint system, and the paint shows no sign of checking, cracking, flaking, scaling, peeling, blistering, chalking, or rusting of the underlying metal, the studs shall be installed. If practicable, the painted surfaces shall then be sweep-blasted with fine sand to remove any loose paint or other contamination, and to remove surface gloss. If sweep-blasting of the painted surfaces is not feasible, they shall be sanded lightly with 120 grit sandpaper to break the surface gloss. Following the sweep-blasting or sanding, oil, grease, or waxy contamination on the painted surfaces shall be removed using a cloth wetted with 1,1,1 trichloroethane. The base of the studs shall be given one coat of the MIL-P-24441 primer, and the entire painted surface shall be given a thin, wet coat of the MIL-P-24441/1 formula 150 paint.

5.4.3.3 Cleaning and painting steel surfaces of foundations, bulkheads, platform decks, dry side of tanks and all other non-flooded spaces. The steel surfaces shall be cleaned *to* near-white metal by grit or sandblasting. Any oil, grease, or waxy substance present on the steel shall be removed using a cloth wetted with 1,1,1 trichloroethane. The near-white metal surfaces and the studs shall be coated with one coat each of formulas 150 of MIL-P-24441/1 and 151 of MIL-P-24441/2 to develop a minimum dry film thickness of 5 roils. Each coat shall be allowed a minimum drying time in accordance with table V prior to application of the next coat, If the paint can be marked with a fingernail, it shall be given additional drying time. Paint which is allowed to dry for more than 48 hours shall be cleaned by wiping with a clean cloth wetted with 1,1,1 trichloro-ethane prior to application of the next coat. When more than 1 year has elapsed between painting and installation of the tile, the paint shall be sweep-blasted with fine sand and an additional cover coat of paint applied. If more than 3 months but less than 1 year has elapsed before tile application, the painted surfaces shall be hand or power-sanded, or sweep-blasted before tile application, Where abrasive blasting is impractical due to proximity of installed machinery or equipment, the surfaces may be mechanically cleaned. In cases where the steel surfaces were previously painted with the DOD-P-23236, type 1, class 1 or MIL-P-24441 paint systems, the surfaces shall be mechanically cleaned, and a thin, wet coat of the MIL-P-24441 paint system shall be applied. Oil, grease, or other contamination shall be removed from the painted surfaces, regardless of age, before tile application.

5.4.4 Fitting of tiles.

5.4.4.1 Areas requiring a restraining layer. A 1/8-inch thick glass-reinforced plastic sheet in accordance with MIL-P-17549, grade 3 shall be cut to fit the area to be damped. Holes, 7/8 inch in diameter, shall be made in the plastic sheet for passage of the studs. This sheet can-be used as a template to guide in cutting tiles to the required shapes.

5.4.4.2 Areas not requiring a restraining layer. A cardboard template may be cut to fit the various areas to be damped, and the tiles cut to match the template. In most cases, however, the required tailoring can be accomplished during tile installation.

5.4.4.3 Areas of weld beads. Damping tiles shall be closely fitted, and cut to fit only the flat surfaces between weld beads. The following spacing shall be maintained between the tiles and welds: When NDT examination of a weld is not required, a spacing of 1 + 1/2 inch shall be maintained. When NDT exami-nation of welds is required, spacing shall be 2 +0, -1/2 inches between welds and damping tile. Tiles may be applied over welds which are on the reverse side of plating. Figure 17 shows a typical installation of the damping treatment in the way of welds on plane surfaces. When damping is installed around stif-feners in superstructure and fairwater areas, a 1/2-inch nominal spacing shall be maintained between the damping and the stiffener overhang (see figure 18). A 3-inch spacing shall be maintained between damping and weld beads in submarine's forward trim tanks.

5.4.4.4 Drilling and punching holes. Holes, 7/8 inch in diameter, shall be cut or punched in the tiles to provide passage for the studs. Holes can be made with a leather punch or by a drill with a flat end bit.

5.4.4.5 Cutting. The tiles may be cut to required shapes by means of a band saw or a linoleum knife.

5.4.5 Preparation of the adhesive. Adhesive conforming to MIL-A-24456 shall be used to bond the tiles to the structures to be damped. This adhesive is a two-component epoxy system and components shall be blended together just before use. These components shall become thoroughly blended so that the adhesive will be uniformly hard when it sets up. Components usually are furnished in two markedly dissimilar colors, so that when thoroughly blended, the resulting adhesive mixture will be distinctly different in color with respect to either of the components. Adhesive conforming to MIL-A-24456 may be prepackaged in barrier kits conforming to MIL-P-38714, type II, and mixed mechanically with automatic mixing equipment designed to be compatible with the barrier kits.

5.4.5.1 Adhesive pot life. Adhesive shall be mixed in quantities that can be used in 1-1/2 to 2 hours. It shall be mixed in small quantities or have large surface area exposure to minimize heat build-up produced in the adhesive by exothermic chemical reaction of the ingredients. The adhesive will begin to thicken about 2 hours after mixing, indicating that its pot life has been exhausted. Adhesive that has exhausted its pot life and has begun to set shall not be used, as it will result in poor bond strength.

5.4.5.2 Preheating. When the temperature of the adhesive components is below 70°F, they shall be preheated to 70 to 95°F before blending operations.

5.4.5.3 Cleaning. Epoxy adhesives are difficult to remove once they harden. Excess adhesive shall be removed from mixing and application equipment and equipment cleaned using hot water and detergent in accordance with MIL-D-16791, type 1 before the adhesive has begun to set.

5.4.6 Installation of damping materials.

5.4.6.1 Damping tiles. The tiles which have been fitted previously shall be bonded to the painted structure to be damped with an epoxy adhesive prepared as described in 5.4.5. The adhesive shall be applied to the surface to be damped with the dog-eared trowel shown on figure 19. Care shall be taken to obtain complete and even coverage of the adhesive over the entire face of the metal surfaces. The base and weld bead of each stud shall be heavily coated with the adhesive, such that the adhesive will be forced up and out of the stud hole in the tile when the damping is installed. The tile, grooved side down, shall then be pressed onto the coated surface to be damped. Excess adhesive extruding from underneath the tile shall be removed immediately. Remove protective covering from the studs and coat the threads with an anti-seize compound in accordance with MIL-T-22361 to prevent galling of the CRES nuts and studs.

5.4.6.2 Restraining layer. The surface of the plastic restraining plate which will bear against the type V, class 1 damping tiles shall be coated with a thin, even layer of petrolatum. Application of the petrolatum will be facilitated if it is warmed to a temperature approximately 10°F above its melting point. The plastic sheet shall then be positioned, coated side down over the damping tiles, and the special 2-inch diameter by 1/8-inch thick washers and

locknuts installed on the protruding studs. The locknuts shall be tightened with a torque wrench, applying 40 inch-pounds plus or minus 10 percent net load. If epoxy paint was used on the threads, the locknuts will cut through the paint, but shall be backed off slightly and retightened to give a 40 inch-pound plus or minus 10 percent net load. The locknuts shall be tightened immediately after installing the damping treatment (before the adhesive has set). Net load is defined as the load over and above that required to overcome the turning resistance of the nut on the stud. Re-torquing of nuts after installation is not required. After adhesive cure (24 hours minimum), the washers and nuts shall be checked to ensure that none are loose. Washers that can be turned by hand are considered loose. Nuts on studs with loose washers shall be re-torqued to 40 inch-pounds plus or minus 10 percent. (A thin layer of polyolefin sheet in accordance with L-P-378 may be installed between damping tiles and restraining layer as an alternative to application of the petrolatum.) Welds shall not be covered by the restraining layer. Where a magnetic particle inspection of a weld is not required, damping (tile and the restraining layer) shall be applied to within 1 + 1/2 inch of the weld. When a weld magnetic particle inspection is required, damping shall be installed within 2 +0, -1/2 inches of welds. Damping in the forward trim tanks of submarines shall be installed such that a 3 +1/2, -O inches spacing is maintained between the damping and welds.

5.4.6.3 Installation of tiles in areas not requiring a restraining layer. The tiles shall be bonded to the painted structures with epoxy adhesive prepared as described in 5.4.5. The adhesive shall be applied and the tiles installed In the manner described in 5.4.6.1. It will not be necessary to bond adjacent tiles to each other; however, they shall be fitted together as closely as practicable. Tiles shall not be installed over weld beads. The tiles shall be installed around welds as described in 5.4.4.3.

5.4.6.3.1 Preventing the tiles from slipping. It may be necessary to shore tiles installed on vertical, overhead, curved, and irregular surfaces *in* order to prevent tiles from slipping until the adhesive sets and to ensure that the tile conforms to the underlying surfaces. It is permissible to install 3/8-inch diameter threaded CRES studs, washers, and nuts as needed to support temporary shoring to hold the tiles in position until the adhesive has set. Care must be taken in removing the shoring to prevent damage to the tile. The studs should be cut off where they would present a safety hazard.

5.4.7 Paint application.

5.4.7.1 Corrosion protection and habitability area paints. The exposed ends of studs, washers, and nuts shall be painted with the MIL-P-24441 paint system. Tiles Installed within submarine pressure hulls shall be painted with a thin, wet coat of MIL-P-24441/1 formula 150 paint, followed by whatever paint usually is applied In the particular area.

5.4.7.2 Antifouling paints. Damping tiles and plastic restraining covers are not inherently antifouling. In areas where protection from fouling is required, the damping treatment shall be first painted with a thin, wet coat of MIL-P-24441 formula 150 paint. Within 1 to 3 hours after the paint has been applied (after the solvent has evaporated, but before the paint has cured), two coats of antifouling paint in accordance with formula 121 of MIL-P-15931 shall be applied.

5.4.8 Maintenance procedures.

5.4.8.1 Cleaning of tiles and restraining layers. Tiles and restraining layers may be cleaned of oil, grease, or other contamination by wiping with a cloth wetted with 1,1,1 trichloroethane. This cleaning may be followed by washing with a mild detergent solution, such as 1/2 ounce of MIL-D-16791, type 1 detergent per gallon of warm fresh water. (NOTE: Whenever a detergent is used, the surface shall be thoroughly rinsed with fresh water to remove detergent residue and preclude subsequent paint adhesion problems.) If more vigorous cleaning is required, the surfaces shall be brush-blasted with fine sand, followed by removal of oil, grease, or other contamination. The brush-blasting operations may remove any paint which has been applied to the surfaces. Repainting shall then be performed as described in 5.4.7.

5.4.8.2 Repair of minor damage to damping treatments. Type V, class 1 tiles are fairly resistant to damage; however, they can be damaged by impact and by striking with sharp instruments. The tiles are molded rubber, so they and the adhesive bond can be damaged when heated to temperatures above about 150°F. Welding in way of tiles will destroy the tiles. Minor damage is defined as any scuffing, tearing, gouging, cutting or loosening of tiles In an area not to exceed 10 percent of the damped surface. Damage of this order need not be repaired unless major repairs or alterations are being made in adjacent damped areas. Damaged tiles which are regarded as potential noise sources shall be trimmed away.

5.4.8.3 Repair of major damage to damping treatments. Tiles affected by major damage shall be removed. Any damaged studs shall be removed and new studs installed. The underlying surfaces shall be cleaned of all old adhesive. If the paint on the metal has been damaged, the metal surfaces shall be prepared properly and new paint applied. New tiles shall be installed using the procedure described in 5.4.6. If the plastic restraining layer has been damaged, the affected area may be cut away and a new piece of material installed in its place, provided the new portion of the restraining layer is held by at least one stud, washer and nut, and its effectiveness in preventing loss of detached tiles is not impaired. If the restraining layer cannot effectively prevent tile loss, the entire restraining layer shall be replaced.

5.4.8.3.1 Replacement of missing studs. When loss of studs in restrained damping treatments is the only damage noted, replacement shall be governed by the following:

(a) Studs lost in periphery holding situations, except where two restraining layers join, shall be replaced.
(b) Replacement of studs lost from holding points inside the peripheral holding points shall be made only when the overall protection capability of the restraining layer is considered jeopardized.

To replace missing studs, the restraining layer shall be removed and the tile cut away over about a 4 by 4 inch square area centering on the holding point. The surface shall be ground to bare metal in way of the stud attachment point, and adhesive and tile particles shall be removed from the remaining area. The

studs shall be replaced by the automatically-timed arc welding technique originally employed. New studs shall be painted, the thread preserved and the clean metal surface repainted as specified in 5.4.3.2 and 5.4.3.3. Tile shall then be replaced in the affected areas and the restraining layer replaced using procedures described in 5.4.6.

5.5 Requirements for the installation of type V, (MIRL No. 3) class 2 damping tiles on 9/16 to 3/4-inch steel plate in non-flooded areas.

5.5.1 Materials.

5.5.1.1 Damping tiles. Type V, class 2 tiles (MIRL No. 3) in accordance with MIL-T-24487 shall be 12 by 5/8 inches in size, weighing 4.5 lb/ft^2.

5.5.1.2 Adhesive. Adhesive for type V vibration damping tiles shall be as specified in MIL-A-24456.

5.5.1.3 Constraining materials. The following materials shall be used *to* constrain the damping tiles:

(a) Ordinary strength steel threaded studs, 3/8-16 UNC 2A by 1-1/2-inches long after weld in accordance with MIL-S-24149 and MIL-S-24149/1.
(b) Flat steel, uncoated washers, 2 inches o.d., 1/8-inch thick, id. *to* accommodate a 3/8-inch stud. Manufactured from steel conforming to ASTM A 366 or ASTM A 569.
(c) Nut, self-locking, 3/8-16 UNC-3B in accordance with MIL-N-25027 or in accordance with MS17829.
(d) Aluminum sheet, 1/8-inch thick, manufactured of 5052 alloy conforming to QQ-A-250/8.

5.5.1.4 Protective materials. The following protective materials shall be used:

(a) Insulation sleeving, electrical, flexible plastic in accordance with MIL-I-631, type F, form U, subform U_b, grade a, class II, category 1.
(b) Epoxy coating system in accordance with formulas 150 of MIL-P-24441/1, 151 of MIL-P-24441/2 and 152 of MIL-P-24441/3. (Formulas 150R66 of MIL-P-24441/10, 151R66 of MIL-P-24441/11 and 152R66 of MIL-P-24441/12 where air pollution regulations are in effect).

5.5.1.5 Cleaning materials. The following materials shall be used to clean the steel plating and damping materials:

(a) 1,1,1 trichloroethane (methyl chloroform) which conform to the requirements of O-T-620 (1 gallon).
(b) Detergent, general purpose (liquid, nonionic) which conform to the requirements of MIL-D-16791, type I (1 gallon).

5.5.2 Safety precautions and environmental control.

5.5.2.1 Handling of bonding materials. Adhesives, sealants, coatings, and cleaning compounds and solvents may present health hazards. Health and safety precautions which apply to the use of these materials shall be as specified in 4.5.

5.5.2.2 Environmental requirements. In order to achieve the desired damping performance, a complete adhesive bond is required between the steel surface and the damping material. This requires that each layer of the bond (all paint coats and the adhesive) be fully cured. Epoxy materials, in general, cure through a chemical reaction. To achieve complete cure, the initial mixing of the components shall occur in a reasonably warm work environment. Also, epoxy compounds will not cure correctly at temperatures below 35°F. The following temperature conditions shall be maintained during the material installation:

(a) During application of MIL-P-24441 paints and MIL-A-24456 adhesives, the temperature of the work area shall be between 35 and 95°F. MIL-P-24441 paints conforming to type II air pollution regulations shall be applied at temperatures above 55°F.
(b) If the work area temperature is below 50°F, MIL-P-24441 paints shall be mixed and allowed the proper induction time at 70°F or greater (not to exceed 95°F), then carried *to* the work site. This is essential to ensure proper curing of the paint.
(c) If the work area is below 50°F, the MIL-A-24456 adhesive components shall be preheated to 70°F and mixed at 70°F or greater, then carried to the work site. This is essential to ensure proper curing of the adhesive.

5.5.3 Surface preparation prior to installation of type V, class 2 tiles.

5.5.3.1 Attachment of studs. Threaded, ordinary strength steel studs 3/8 inch in diameter by 1-1/2 inches long shall be welded by the automatically-timed arc technique to the surfaces to be damped. Studs shall be positioned so that at least one stud passes through each tile to be installed as close to its center as possible. If necessary, templates shall be cut to fit the various areas to be damped, as an aid in determining the location of the studs. The studs shall be so located that the tiles to be applied later will be close-fitting. Studs shall be welded and inspected as required by MIL-STD-1688 or NAVSEA 0900-LP-000-1000, as applicable.

5.5.3.1.1 Protecting the stud threads. The studs shall be covered with a short length of electrical insulation sleeving, protective cap, or taped in order to protect the threads during subsequent cleaning operations.

5.5.3.2 Cleaning and painting the steel surfaces. The steels surfaces shall be cleaned to near-white metal by grit or sandblasting. Any oil, grease, or waxy substance present on the steel shall be removed with a cloth wetted with 1,1,1 trichloroethane. Immediately after blasting, the near-white metal surfaces and the studs shall be coated with one coat each of formulas 150 of MIL-P-24441/1 and 151 of MIL-P-24441/2 to develop a minimum dry film thickness of 5 roils. Each coat shall be allowed a minimum drying time in accordance

with table V prior to the application of the next coat, If the paint can be marked with a fingernail, it shall be given additional drying time. Paint which is allowed to dry for more than 48 hours shall be cleaned by wiping with a clean cloth wetted with 1,1,1 trichloroethane prior to application of the next coat. If painting the threads is not desirable, the studs shall at a minimum be painted up to the bottom thread. The threads shall then be covered with a short length of insulation sleeving, or taped for protection. If more than 1 year has elapsed between painting and installation of the tile, the paint shall be sweep-blasted with fine sand and an additional cover coat of paint applied. If more than 3 months but less than 1 year has elapsed before tile application, the painted surfaces shall be hand or power sanded, or sweep-blasted before tile application. Oil, grease, or other contamination shall be removed from the painted surfaces, regardless of age, before tile application. In addition, where abrasive blasting is impractical due to close proximity of installed machinery or equipment, the surfaces may be mechanically cleaned. In cases where the steel surfaces were previously painted with the DOD-P-23236 or MIL-P-24441 paint systems, the surfaces shall be mechanically cleaned, and a thin, wet coat of the MIL-P-24441 paint system shall be applied.

5.5.4 Fitting the type V, class 2 tiles and the constraining layer. Holes, 7/8 inch in diameter, shall be cut in each tile to match the studs installed on the areas to be damped. The tiles shall be trimmed as necessary to avoid overlapping. Tiles shall be applied to within 1 + 1/2 inch of weld beads where NDT inspection of welds is not required. Where NDT inspection of welds is required, damping shall be installed within 2 +0, -1/2 inches of weld. Tiles may be applied over welds which are on the reverse side of the plate being damped. The aluminum sheets shall be placed over the rubber tiles and trimmed if necessary to fit. Edges of the tiles and the constraining layer shall coincide within 1/8 inch when they are pressed against the surface to be damped. No spaces between tiles shall be greater than 1/2-inch wide. A 3/4-inch diameter hole shall be drilled in the aluminum sheet to fit over the stud. Constraining layers shall not extend over any welds. The constraining layer may be cut to the plan size of individual tiles, but shall be no smaller than 8 by 3 inches in surface area.

5.5.4.1 Drilling and punching holes. Holes, 7/8 inch in diameter, shall be cut or punched in the tiles to provide passage for the studs. Holes can be cut in the tiles with a leather punch or by a drill with a flat-end bit.

5.5.4.2 Cutting. The tiles may be cut to required shapes by means of a band saw.

5.5.5 Preparation of the adhesive. Adhesive conforming to MIL-A-24456 shall be used to bond the tiles to the structure to be damped. This adhesive is a two-component epoxy system and components shall be blended together just before use of the adhesive. The components shall become thoroughly blended to ensure that the adhesive will be uniformly hard when it sets up. Components usually are furnished in two markedly dissimilar colors, so that upon thorough blending of the components, the resulting adhesive admixture will be distinctly different in color with respect to either of the components. Adhesive conforming to MIL-A-24456 may be pre-packaged in barrier kits conforming to MIL-P-38714, type II, and mixed mechanically with automatic mixing equipment designed to be compatible with the barrier kits.

5.5.5.1 Adhesive pot life. Adhesive shall be mixed in quantities that can be used in 1-1/2 to 2 hours. Adhesive shall be mixed in small quantities or have large surface area exposure to minimize heat build-up produced in the adhesive by exothermic chemical reaction of the ingredients. About 2 hours after mixing the adhesive, it will begin to thicken, indicating that its pot life has been exhausted. Adhesive that has exhausted its pot life and has begun to set shall not be used, as it will result in poor bond strength.

5.5.5.2 Preheating. If the components of the adhesive are below 70°F in temperature, they shall be preheated to 70 to 95°F before blending operations.

5.5.5.3 Cleaning. Epoxy adhesives are difficult to remove once they harden. Excess adhesive shall be removed from, and mixing and application equipment cleaned before the adhesive has begun to set, using hot water and detergent in accordance with MIL-D-16791, type 1.

5.5.6 Installation of type V. class 2 damping materials.

5.5.6.1 Bonding the tiles to the constraining layer. The 1/8-inch thick aluminum sheets shall be cleaned free of corrosion products and dirt by light abrasive blasting on the side to be next to the tile. Epoxy adhesive, prepared as described in 5.5.5, shall be applied to the sandblasted surface of the aluminum sheets and to the smooth face of the tiles, using the trowel detailed on figure 19. The aluminum sheets shall be placed coated side up on a flat surface, the tiles placed on them so that the adhesive-coated sides are together, and the two pressed firmly together over their entire area. Sand bags or similar weighing devices shall be placed over the tiles, if necessary, to hold them in contact with the aluminum sheets until the adhesive has set. The assemblies shall not be disturbed until the adhesive has set. Setting time will require approximately 18 hours at 70°F.

5.5.6.2 Bonding the tiles and constraining layer to the steel plating. Prior to application of adhesive, oil, grease, or other contamination shall be removed from painted surfaces, regardless of age. The epoxy adhesive, prepared as described in 5.5.5, shall be applied over the steel surface to be damped using the trowel described on figure 19. The tiles, with aluminum sheets bonded to their upper surfaces, shall be placed over the studs and pressed into place. Flat sheet washers, 2 inches in diameter by 1/8 inch thick, shall be placed over the studs. The steel self-locking nuts shall then be placed on the studs and tightened until all portions of the grooved surfaces of the tiles are in contact with the steel surface.

5.5.6.2.1 Providing a smooth surface. When a smooth surface free of protuberances is required, the nuts and washers shall be removed after the adhesive has cured (at least 3 days at 70°F) and the studs cut off flush with the surface of the aluminum.

5.5.7 Paint application.

5.5.7.1 Corrosion protection and habitability area paints. The exposed ends of studs and washers and nuts and the constraining layers shall be painted with a coat of MIL-P-24441/1, formula 150 paint. One coat of the appropriate interior paint shall be applied within 4 hours after the MIL-P-24441 system

paint has been applied (after the solvent has evaporated but before the paint has cured). If the epoxy becomes too dry, good adhesion of the interior paint will not be achieved. If the epoxy has cured too hard, it shall be given a thin, continuous, mist-coat (1 to 2 roils wet film thickness) of the same epoxy paint. This mist-coat shall be allowed to cure to a tacky stage before applying the interior paint. The tacky stage is a function of temperature and humidity, and will vary widely with climate conditions and the type of epoxy paint used. It is best defined as that curing (drying) stage when a fingertip pressed lightly against the film leaves only a slight impression and none of the film sticks to the finger.

5.5.8 Maintenance procedures.

5.5.8.1 Cleaning of damping treatment. Since the outward appearance of heavy-plate damping treatments is that of a painted metal plate, any procedure used to clean the paint in the area can be used to clean the damping treatment.

5.5.8.2 Minor repair of damping treatment. The type V, class 2 damping tiles are not likely to be damaged because they are protected by the aluminum constraining layer. However, they can be damaged by overheating due to nearby welding or cutting operations and by severe mechanical abuse. If the affected area is small (less than 10 percent of damped surface), the damping treatment can be cut through with a circular or saber saw and the damaged section removed. New materials shall be installed according to the procedures given in 5.5.6. At least one stud shall be positioned in the repaired section, and if required, a new stud shall be installed.

5.5.8.3 Major repair of damping treatment. If more than 10 percent of the damped surface is damaged, the damaged treatment shall be removed and new materials reinstalled by the procedures given in 5.5.6. It will be difficult to remove the constraining layer because it is bonded to the tiles, which are in turn bonded to the steel surface below. If the aluminum plate is heated to a temperature of 250 to 300°F, the bonding agent will soften and the plate can be be separated from the tile. Heating can be accomplished by carefully directing a flame over the aluminum surface, or by the use of strip heaters. Adequate ventilation shall be provided and all persons in the space shall wear approved respirators when heating the plates, due to the danger of toxic fumes if the damping tiles become overheated. (SAFETY NOTE: A fire watch shall be established and maintained during the heating operation. Fire extinguishers of the carbon dioxide type shall be available throughout the work area.)

5.6 Quality assurance.

5.6.1 General. The primary attachment mechanism for damping treatments is the adhesive bond formed by the epoxy protective coating and the epoxy adhesive. Inadequate installation practice during any of the installation steps can lead to poor adhesion and early tile failure. Inspection of a completed installation does not provide sufficient information to determine the quality of the bond. In addition, the studs, nuts and washers (where applicable) provide additional support during high stress conditions. Therefore, during installation of damping treatments, including the replacement of tiles due to major damage-, the inspections outlined in this section shall be completed.

5.6.2 Installation inspection. Each step of the installation shall be {amined to ensure compliance to the requirements of this procedure. The fequency of the checks shall be sufficient to establish that work steps are being completed in accordance with the requirements stated herein. The following steps are critical to good adhesion:

(a) Stud welding.
(b) Environmental requirements.
(c) Blast cleaning to near-white metal.
(d) Protective coating; each paint coat fully cured.
(e) Adhesive properly mixed and applied.
(f) Tiles correctly installed.
(g) Excessive adhesive removed from tile exterior.

5.6.2.1 Stud welding. Stud welding procedures and equipment shall be in accordance with the requirements of MIL-STD-1688 or NAVSEA 0900-LP-000-1000, as applicable.

5.6.2.2 Tile location. The damping treatment installation shall be examined for proper location and spacing. Location shall be in accordance with the shipbuilding specifications including all current revisions. Spacing of tiles around and over welds and protrusions shall be in accordance with this procedure. Excess epoxy adhesive on the exterior shall be removed by buffing with an 80-grit sanding disc.

5.6.3 Post sea-trial inspections. Installed damping treatments which are accessible shall be inspected after sea-trials to determine whether the treatments are intact and to ensure that there is no loosening of nuts on studs.

6. NOTES

6.1. Type I damping material. Type I material consists of chromated-felt, impregnated with a viscoelastic material (usually Polyisobutylene), in accordance with MIL-G-20241. The treated felt is used in conjunction with a constraining layer of sheet steel or rigid, glass-reinforced plastic sheet. The combination of the felt and constraining layer is referred to as the felt or septum treatment. It is most efficient in damping mechanical vibrations at about 75°F, however, its efficiency decreases drastically on either side of this temperature. The type I felt or septum treatment is regarded as obsolete and is being replaced by treatments using type II damping materials. However, a similar treatment, consisting of chromated-felt impregnated with silicone currently is being applied to the reduction gear casing on SSN-688 class submarines. Information on installation, maintenance and repair of this treatment may be obtained in the ship specifications.

6.2 Type IV damping material. Type IV damping material was designed for installation either by spraying or troweling on the surfaces to be damped. It has been used primarily in sonar domes and hull structure near the sonar. Acquired under MIL-S-24062, it was furnished as a 3-component system which must be blended together just prior to application. Type IV damping material is no longer used and should be replaced by type III damping tile.

6.3 Health and safety. There may be additional Occupational Safety and Health Administration (OSHA) and state and local requirements applicable to the application and removal of paint, solvents, adhesives, and so forth, referred to in this standard.

Preparing activity
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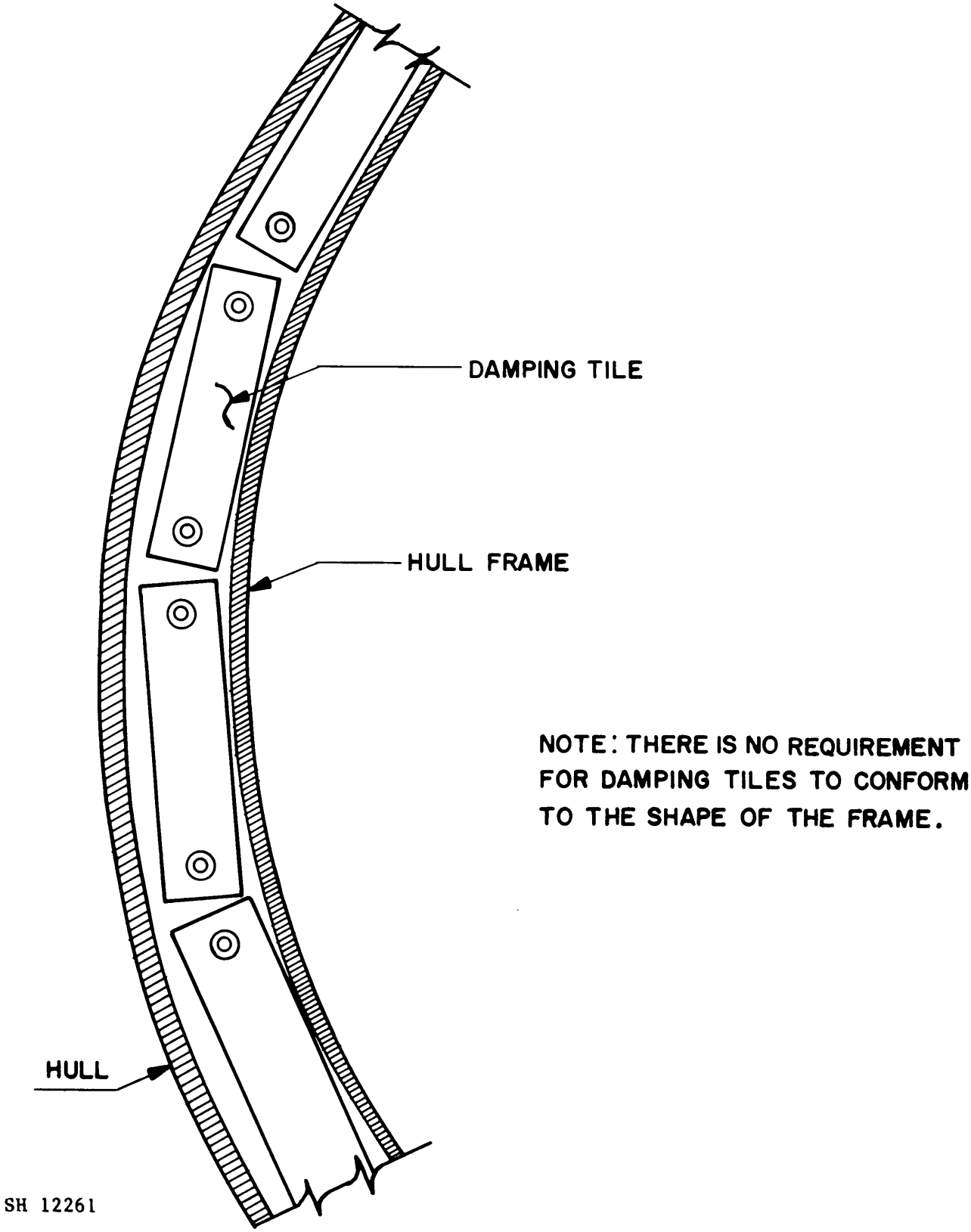
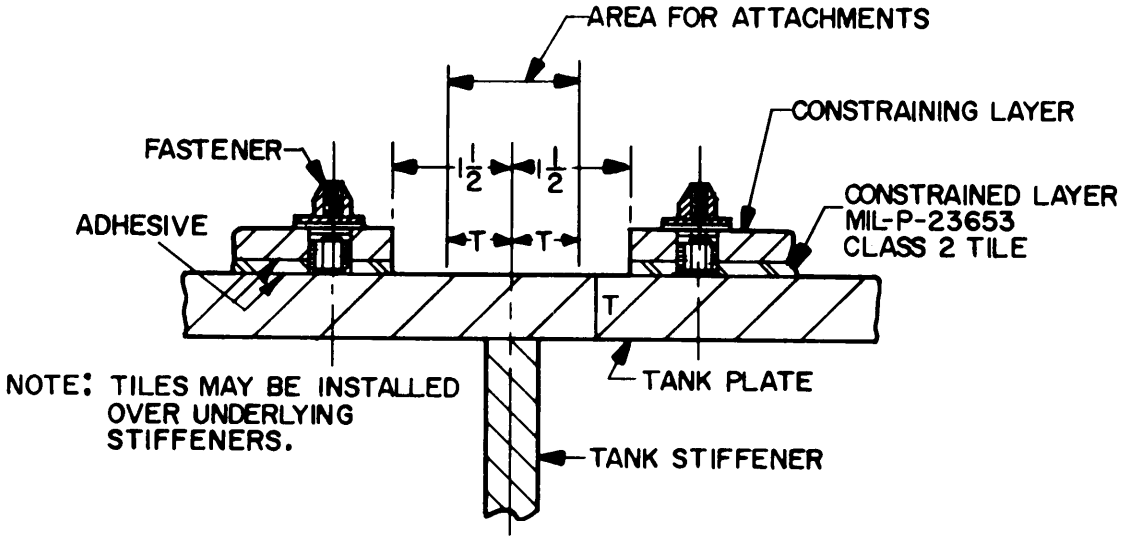
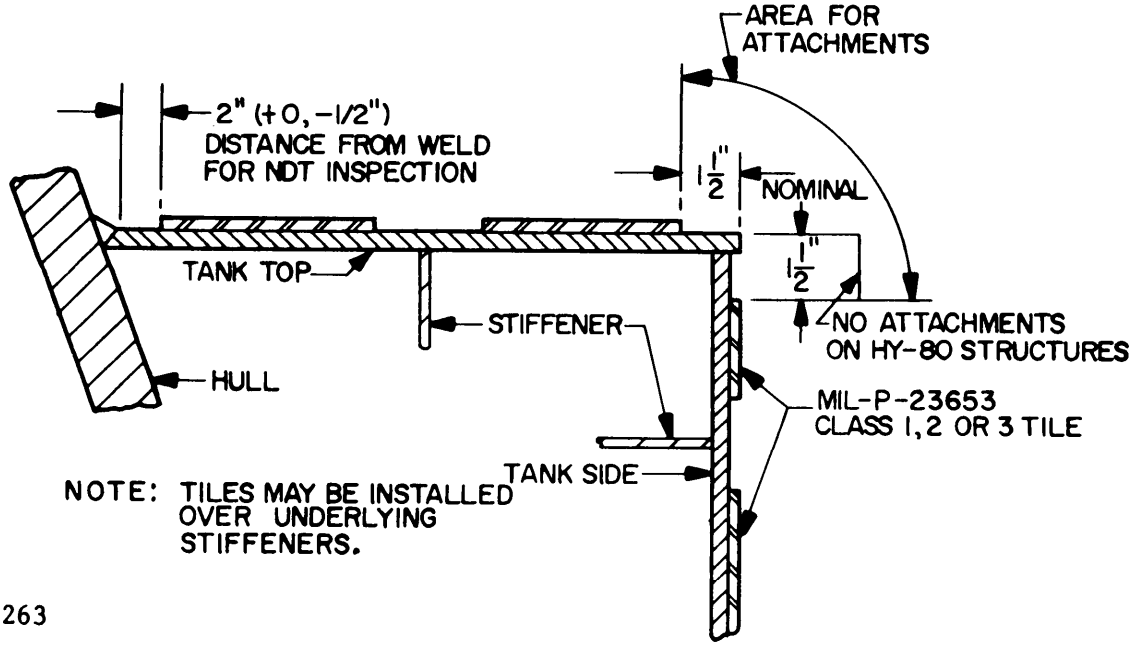


FIGURE 1. Typical installation of damping tiles on hull frames (not to scale).



SH 12262

FIGURE 2. Cross-section veiw of typical installation of constrained MIL-P-23653 tiles at tank top and side where plate is subject to submergence pressure and space is required for attachments (not to scale).



SH 12263

FIGURE 3. Cross-section view of typical installation of unconstrained MIL-P-23653 tiles at tank top and side where plate is not subject to submergence pressure and space is required for attachments (not to scale).

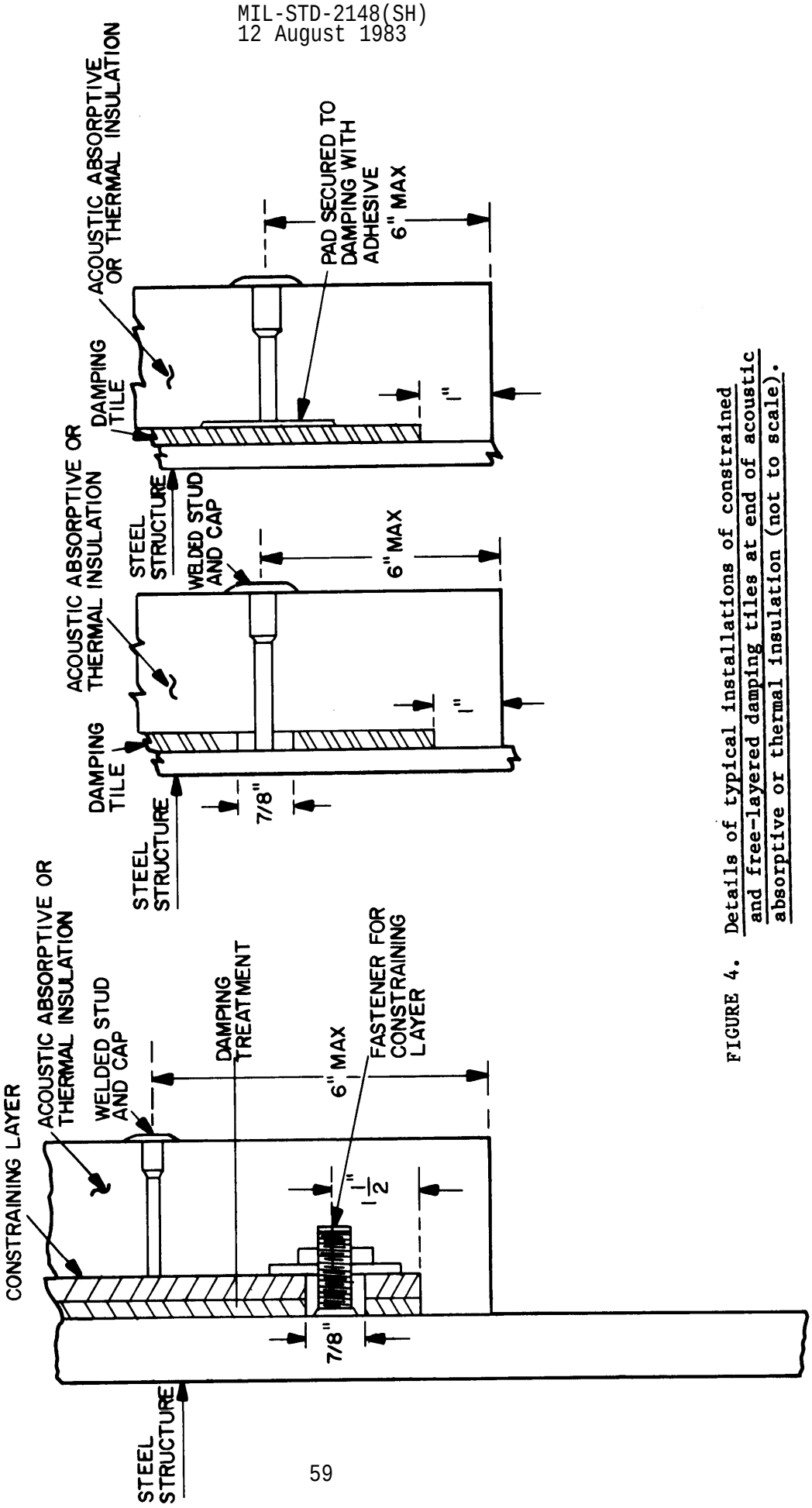
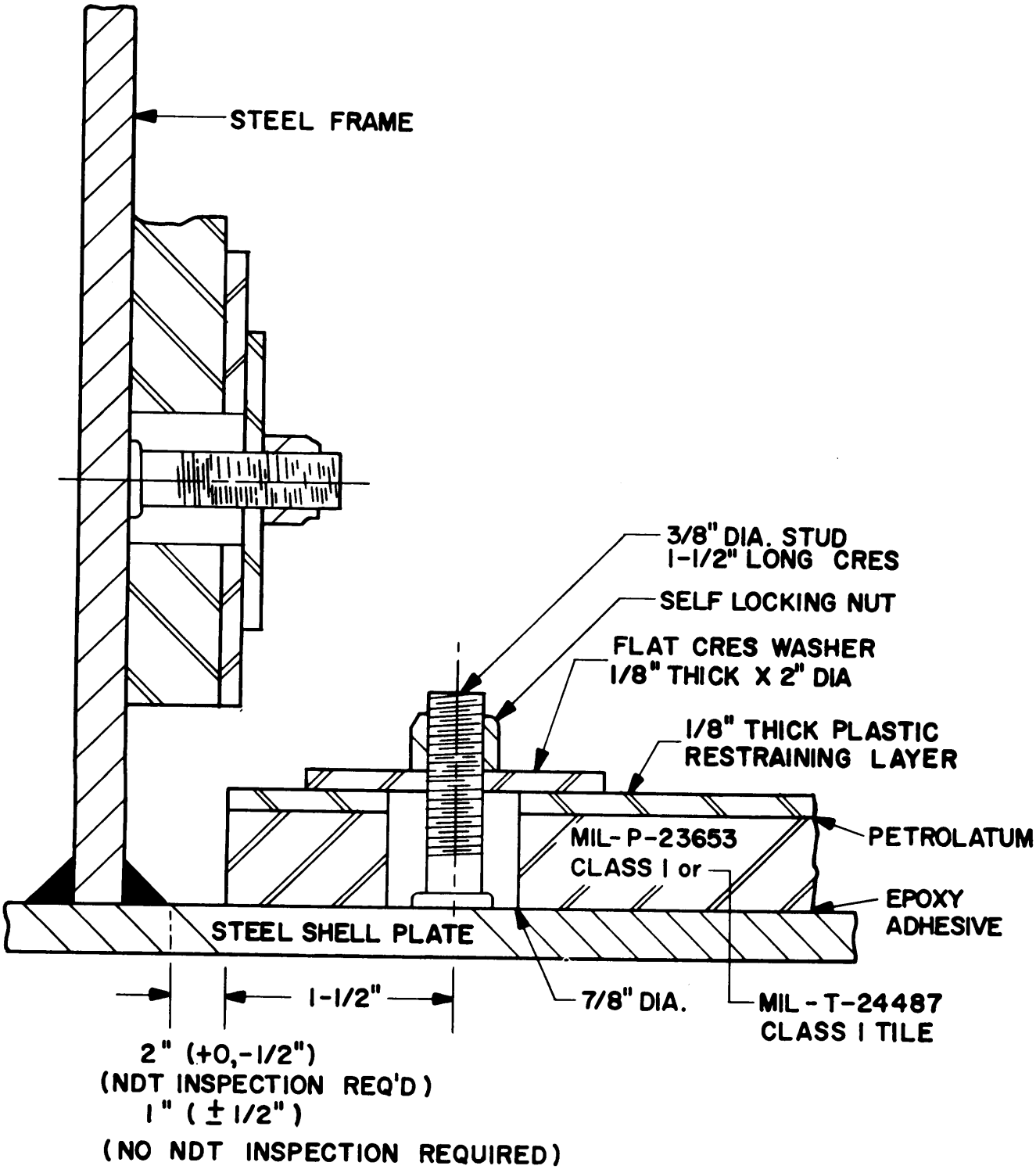


FIGURE 4. Details of typical installations of constrained and free-layered damping tiles at end of acoustic absorptive or thermal insulation (not to scale).

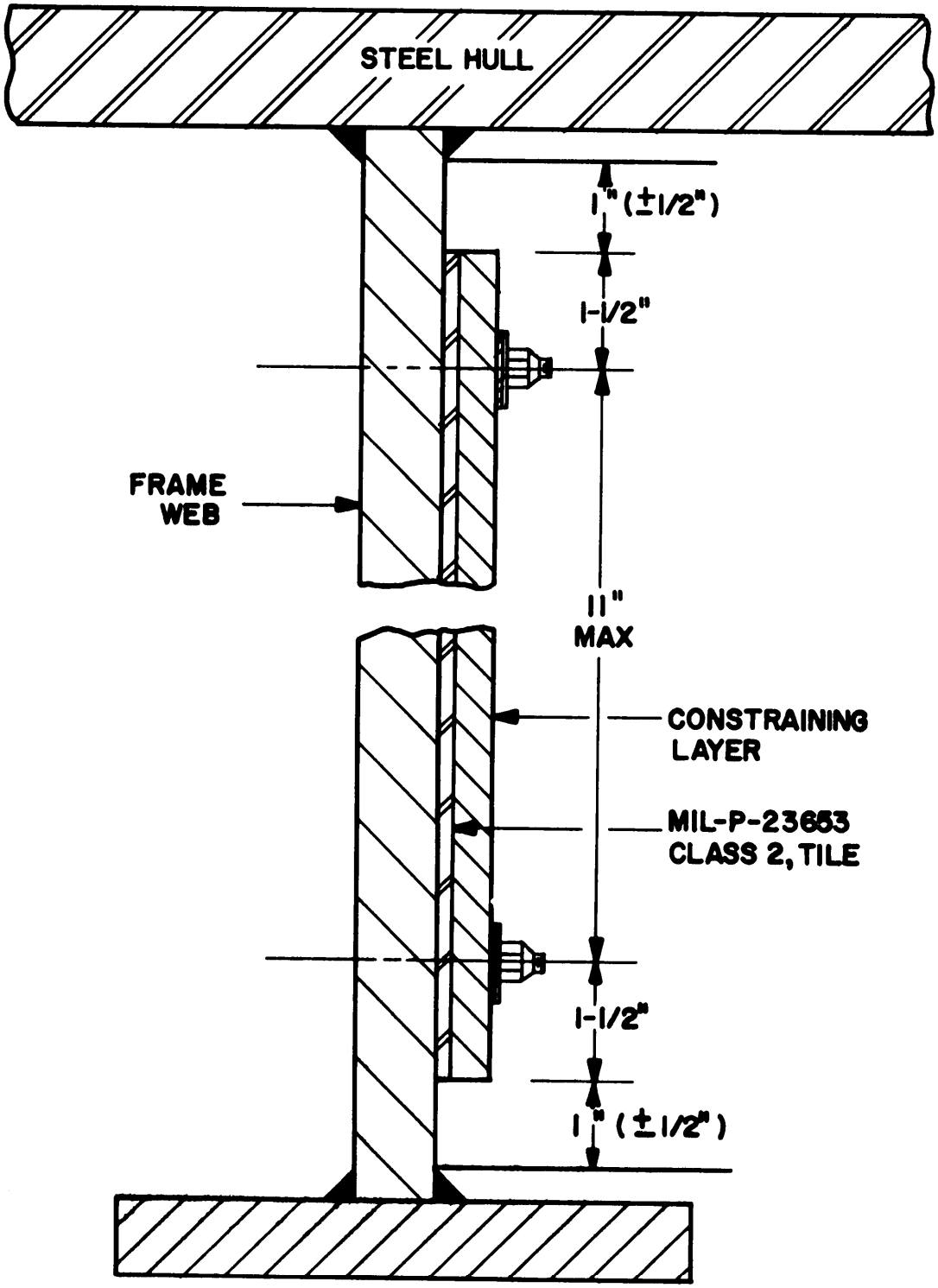


SH 12265

FIGURE 5. Cross-section of typical installation of restained MIL-P-23653 class 1 tile or MIL-T-24487 class 1 tile in submarine ballast tank (not to scale).

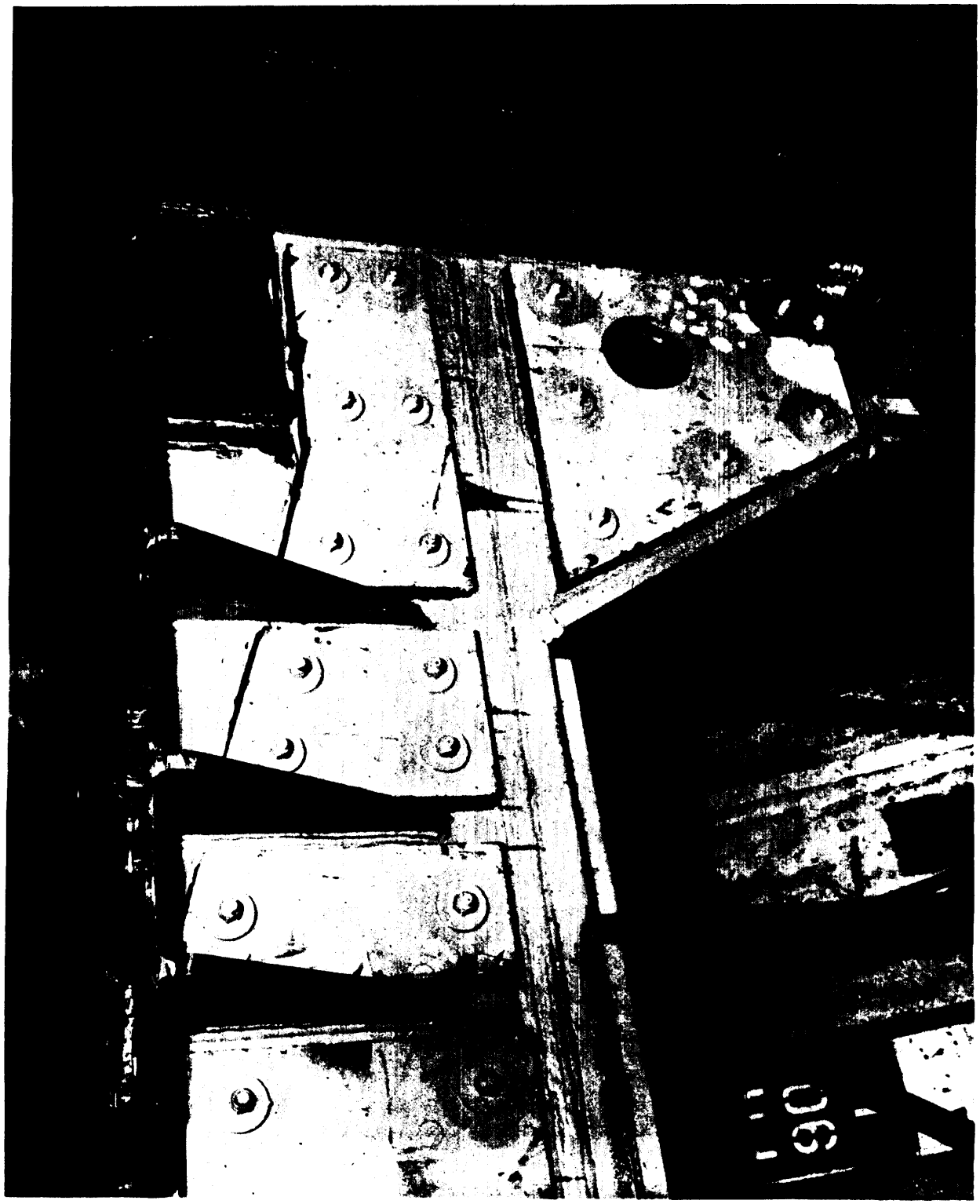
SH 12266

FIGURE 6. Constrained (MIL-P-23653) tiles installed on web of submarine hull frame.



SH 12267

FIGURE 7. Cross-section view of typical installation of constrained (MIL-P-23653) tiles on web of submarine hull frame (not to scale).



SH 12268

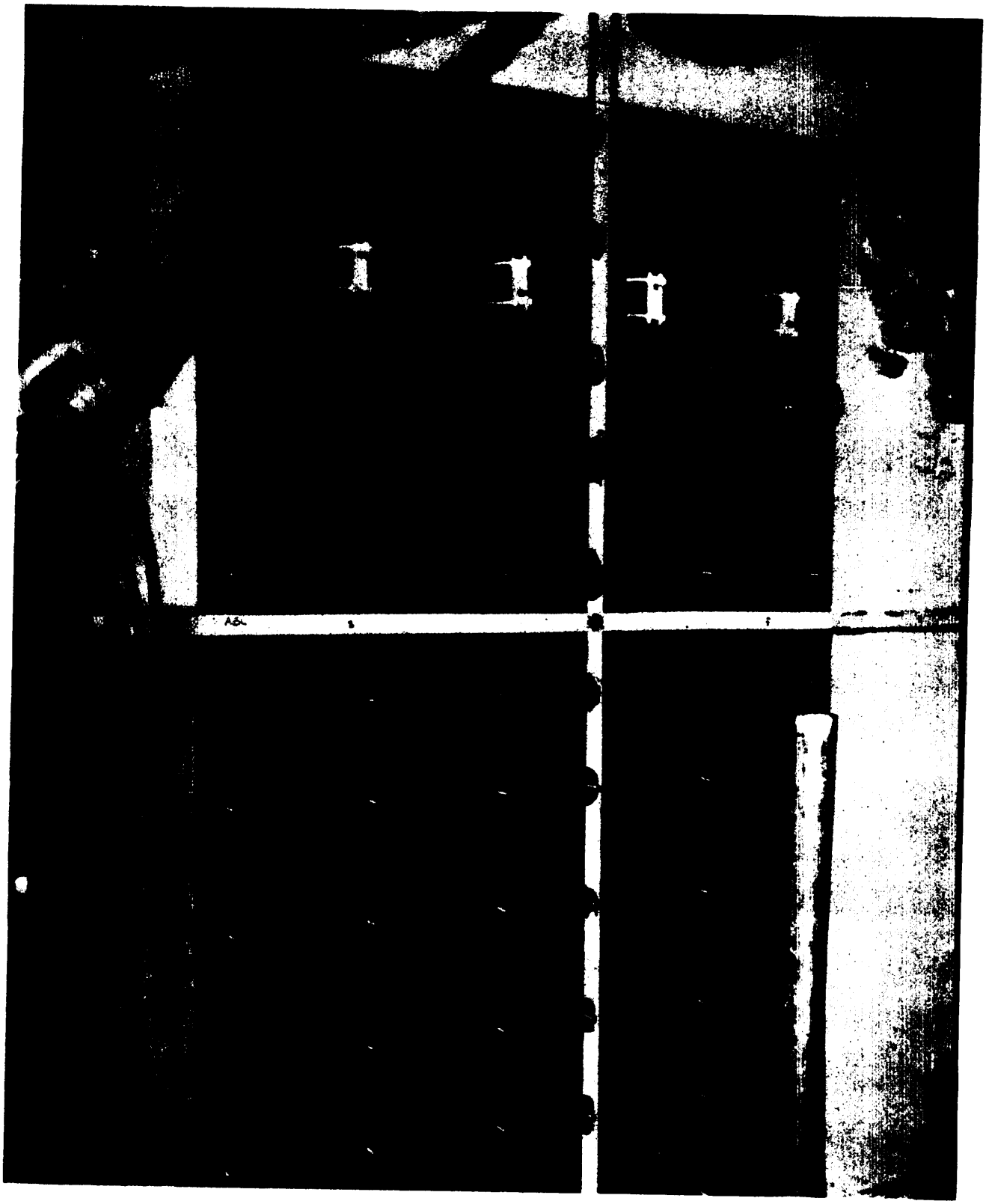
FIGURE 8. Constrained (MIL-P-23653) tiles installed on machinery foundation constructed from heavyweight steel plates.

SH 12269

FIGURE 9. Tiles (MIL-P-23653) installed on middle section of reduction-gear case.

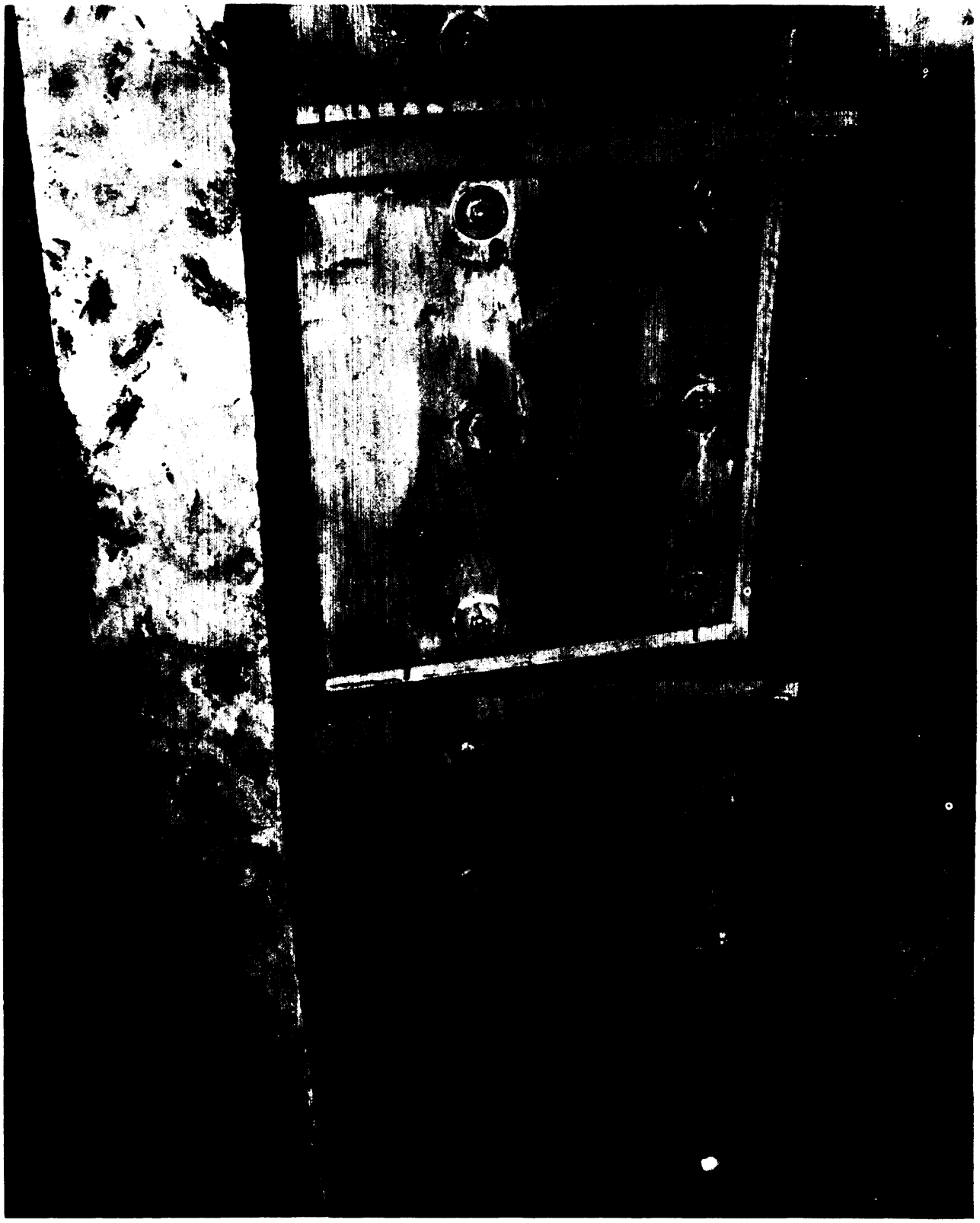
FIGURE 10. Tiles (MIL-P-23653) installed on top section of reduction-gear case.

SH 12270



SH 12271

FIGURE 11. Bulkhead prepared for installation of constrained (MIL-P-23653) tiles.



SH 12272

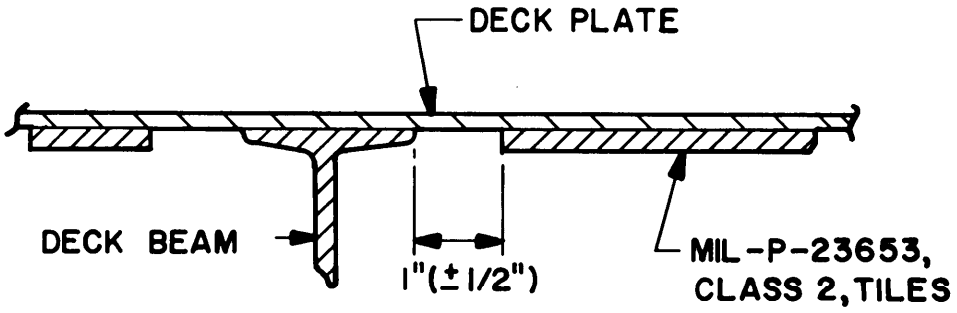
FIGURE 12. Constrained (MIL-P-23653) tiles installed on heavyweight steel bulkhead.

SH 12273

FIGURE 13. Typical installation of constrained (MIL-P-23653) tiles on box girder.

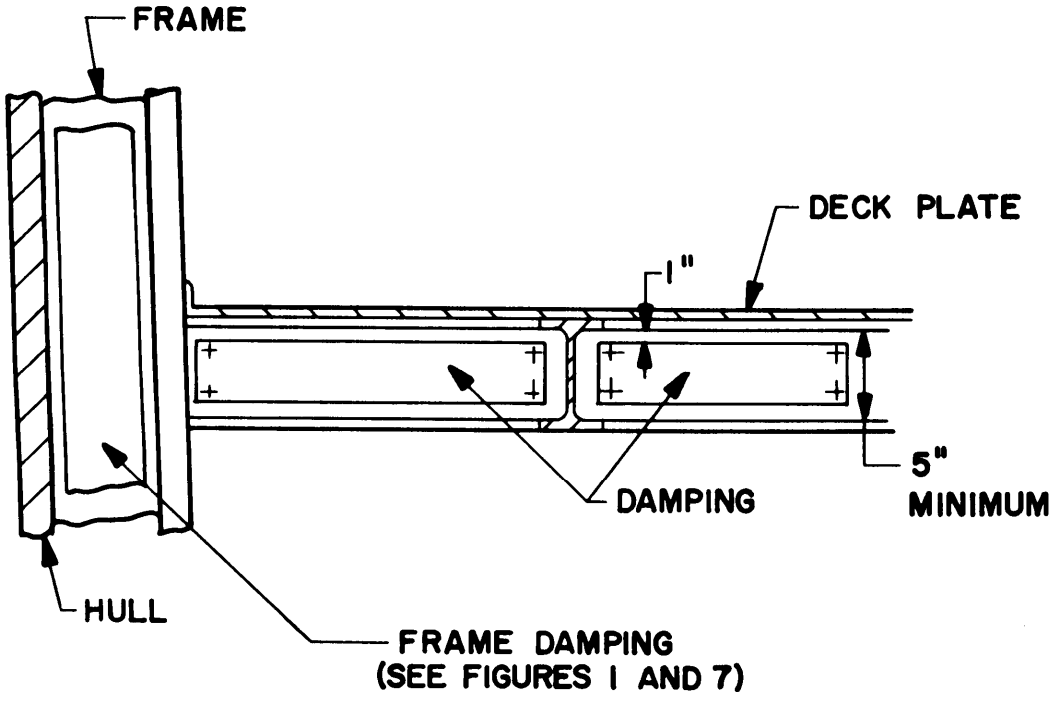
SH 12274

FIGURE 14. Typical installation of constrained (MIL-P-23653) tiles on thwartship girder.



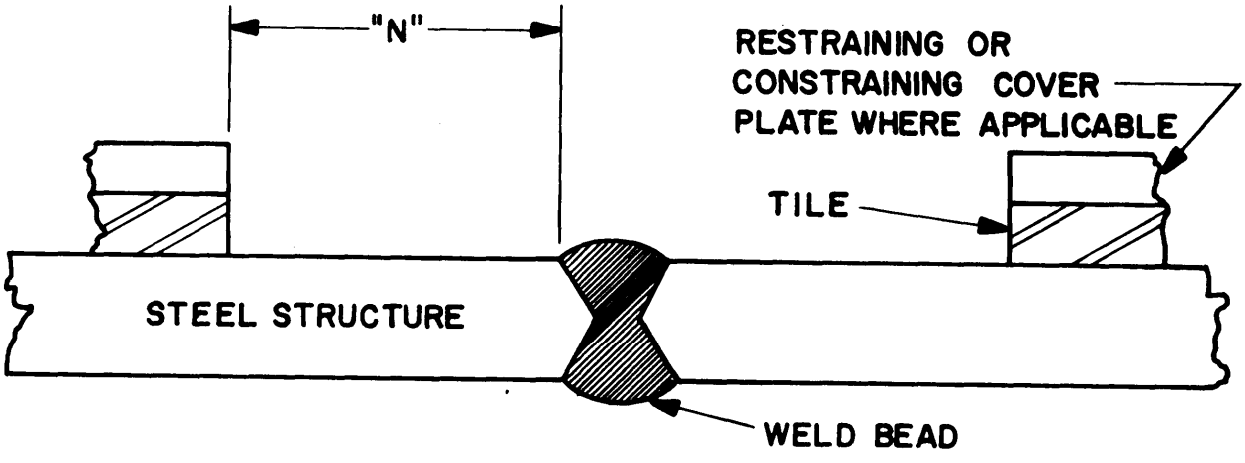
SH 12275

FIGURE 15. Cross-section view of installation of (MIL-P-23653) tiles to underside of platform deck (not to scale).



SH 12276

FIGURE 16. Cross-section view of typical damped deck beam connected to hull frame (not to scale).

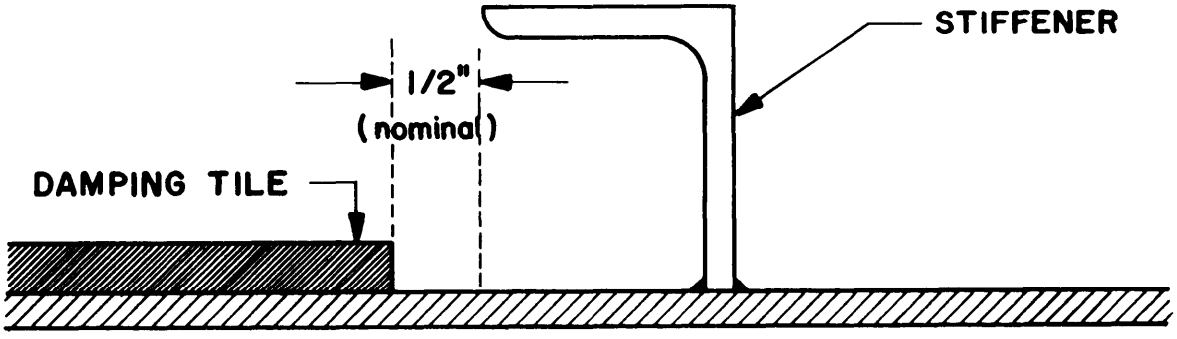


"N" DIMENSIONS			
WELDS SUBJECT TO MAGNETIC PARTICLE INSPECTION		WELDS NOT SUBJECT TO MAGNETIC PARTICLE INSPECTION	
TREATMENT	"N" DIMENSION, INCHES	TREATMENT	"N" DIMENSION, INCHES
CONSTRAINED, RESTRAINED & FREE-LAYERED	$2.0 \pm {}^{0}_{.5}$	CONSTRAINED, RESTRAINED & FREE-LAYERED	$1.0 \pm .5$

"N" DIMENSIONS SHALL BE 3.0 INCHES (+0.5 INCH, -0.0) IN FORWARD TRIM TANK OF SSN'S.

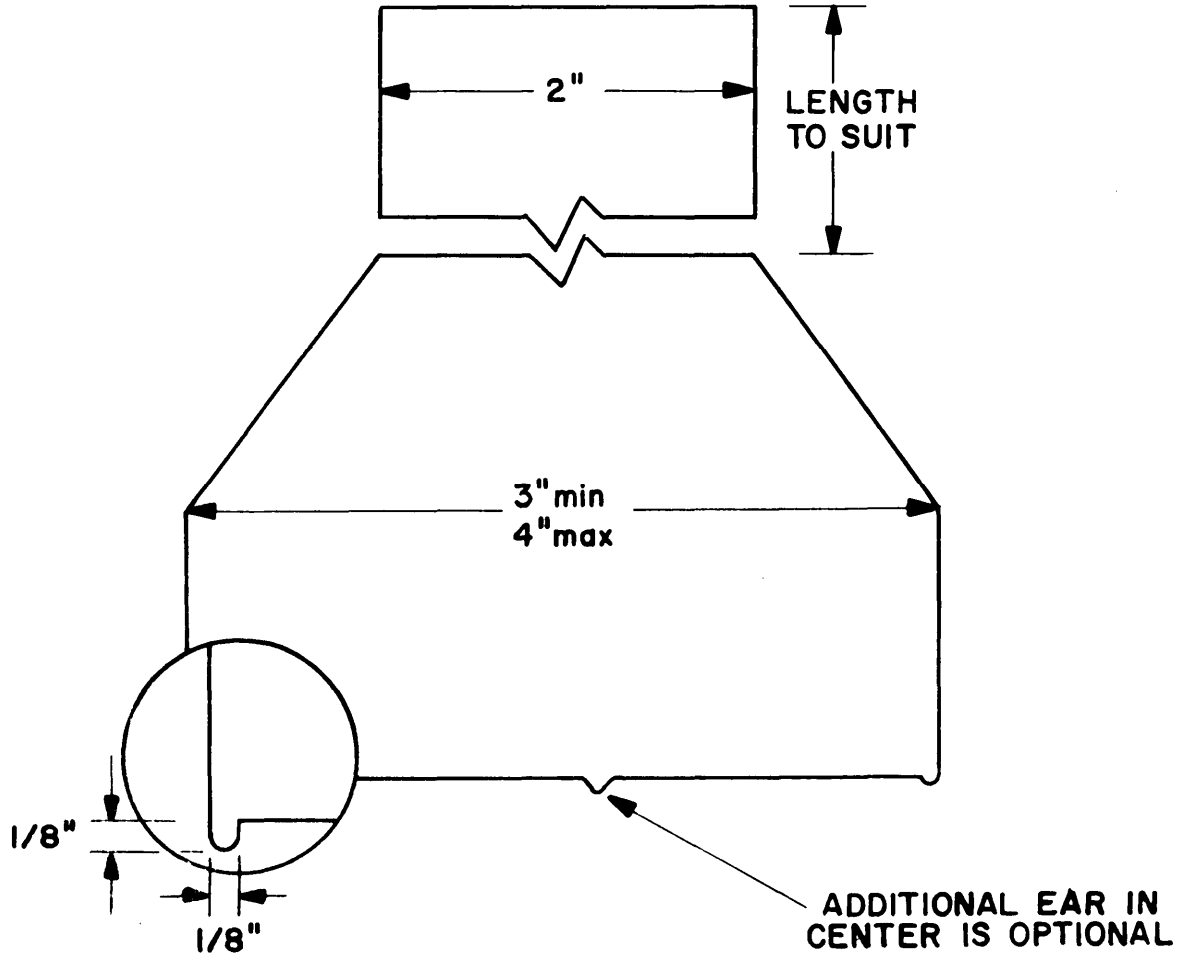
SH 12277

FIGURE 17. Installation of constrained, restrained and free layered damping tiles in way of weld beads on plane surfaces.



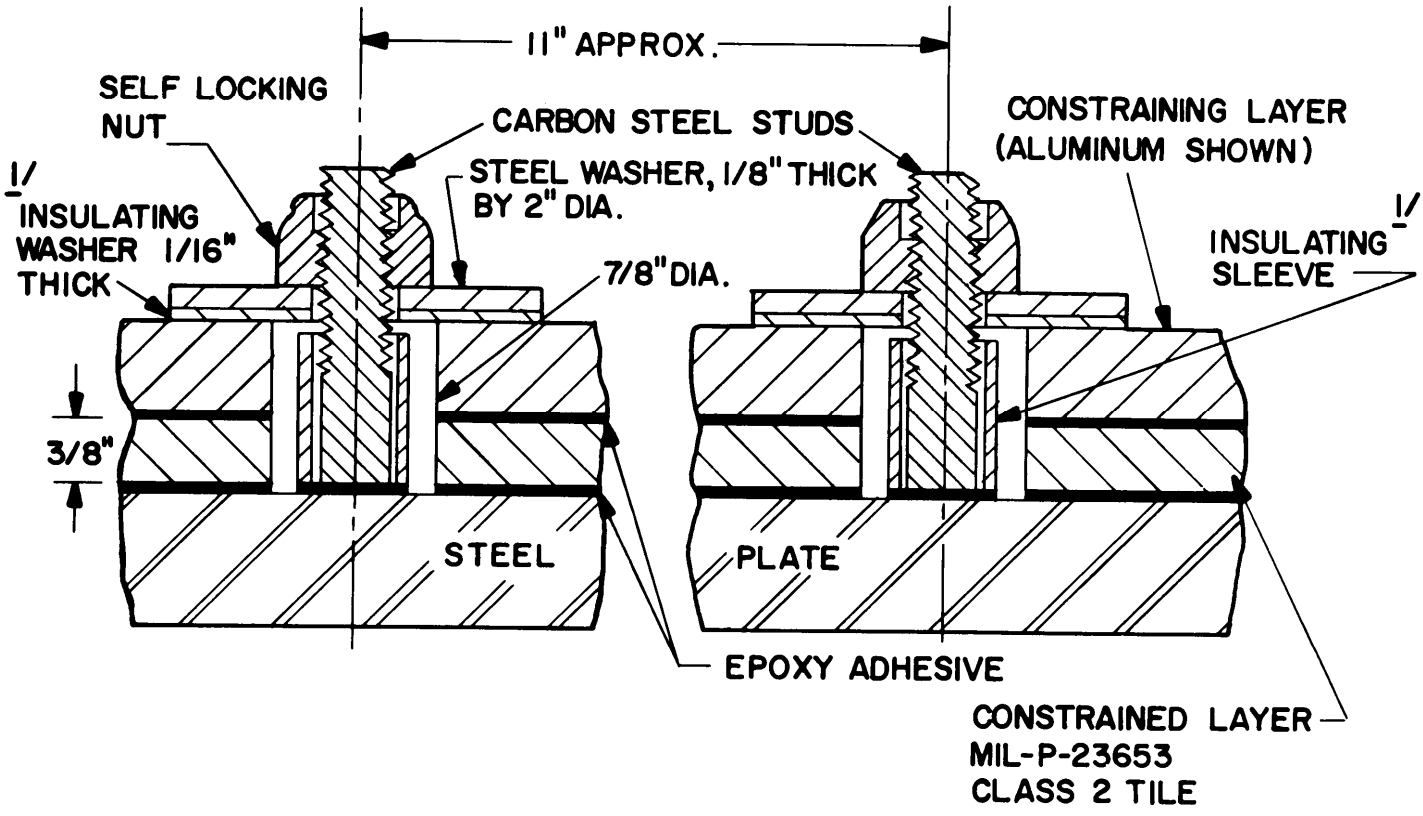
SH 12278

FIGURE 18. Installation of damping around stiffeners in submarine superstructure and fairwater areas (not to scale).



SH 12279

FIGURE 19. Dimensions of a dog-eared trowel.



1/ REQUIRED ONLY WITH ALUMINUM CONSTRAINING LAYER IN CONTACT WITH SEAWATER

SH 12280

FIGURE 20. Close-up view of system for attachment of constrained (MIL-P-23653) class 2 tiles (aluminum constraining layer shown).

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