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# DETAIL SPECIFICATION
# TILE, RUBBER VIBRATION DAMPING, TYPE V

This specification 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.

## 1. SCOPE

1.1 Scope. This specification covers rubber tiles intended for damping vibrations in steel structures for shipboard use.

1.2 Classification. The rubber tiles are of the following classes, as specified (see 6.2).

Class 1 - For damping vibration in steel plates 0.5 inch (1.3 centimeters (cm)) thick or less.

Class 2 - For damping vibration in steel plates greater than 0.5 inch (1.3 cm) but less than 0.75 inch (1.9 cm) thick.

1.3 Part or Identifying Number (PIN). The PIN to be used for tiles acquired to this specification are created as follows:

| M | 24487- | X |
|---|---|---|
| Prefix to indicate Military specification | Specification number | Class number (see 1.2) |

## 2. APPLICABLE DOCUMENTS

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

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

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-A-24456 - Adhesive for Plastic Vibration-Damping Tiles.
MIL-DTL-24441/29 - Paint, Epoxy -Polyamide, Green Primer, Formula 150, Type IV.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-407 - Visual Inspection Guide for Rubber Molded Items.
MIL-STD-2148 – Vibration Damping Materials, Procedures for Installation, Maintenance, and Repairs.

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch or http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

BUREAU OF MEDICINE AND SURGERY (BUMED)

BUMED INST 6270.8 - Procedures for Obtaining Health Hazard Assessments Pertaining to Operational Use of a Hazardous Material.

(Copies of this document are available online at https://bumed.med.navy.mil or from Bureau of Medicine and Surgery, Department of the Navy, 2300 E Street, NW, Washington, DC 20372-5300.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

S9510-AB-ATM-010 Rev 2 of 30 July 1992 - Nuclear Powered Submarine Atmosphere Control Manual.

(Copies of this document are available from the Naval Sea Systems Command, Code SEA 05Z9, 1333 Isaac Hull Avenue, SE, Stop 5133, Washington Navy Yard DC 20376-5133.)

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

ASTM INTERNATIONAL

ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate. (DoD adopted)
ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension. (DoD adopted)
ASTM D 471 - Standard Test Method for Rubber Property - Effect of Liquids. (DoD adopted)
ASTM D 573 - Standard Test Method for Rubber - Deterioration in an Air Oven. (DoD adopted)
ASTM D 635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position. (DoD adopted)

ASTM D 792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement. (DoD adopted)
ASTM D 2240 - Standard Test Method for Rubber Property - Durometer Hardness. (DoD adopted)

(Copies of these documents are available from www.astm.org or ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

THE SOCIETY FOR PROTECTIVE COATINGS

SSPC-SP 10 - Near-White Blast Cleaning

(Copies of this documents are available from www.sspc.org or SSPC: The Society for Protective Coatings, 40 24th Street, 6th Floor, Pittsburgh, PA 15222-4656)

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

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.2.

3.2 Rubber properties. The rubber in Class 1 and 2 tiles shall have the properties listed in Table I. Formulations of rubber compounds which have been found to have these properties are given in 6.3.

3.2.1 Toxicity. When evaluated in accordance with 4.5.9, the vibration damping tiles shall have no adverse effect on the health of personnel when used for its intended purpose and shall not cause any environmental problems during waste disposal (see 4.5.9 and 6.5).

3.2.2 Off-gassing. The vibration damping tiles shall meet the requirements in the Nuclear Powered Submarine Atmosphere Control Manual, NAVSEA Technical Manual S9510-AB-ATM-010 Rev. 2, for a usage category of Limited (see 4.5.10 and 6.6).

TABLE I. Physical properties of rubber.

| Properties | Class 1 | Class 2 |
|---|---|---|
| Initial properties: | | |
| Specific gravity | Compare to first article value | Compare to first article value |
| Hardness, durometer points | (See 4.5.3.1) | (See 4.5.3.1) |
| Tensile strength, lb/in$^2$ (kPa), min | 960 (46.0) | 1350 (64.6) |
| Ultimate elongation, percent, min | 500 | 500 |
| Properties after aging in oven: | | |
| Tensile strength, percent of initial, min | 85 | 85 |
| Ultimate elongation, percent of initial, min | 70 | 70 |
| Properties after immersion in water: | | |
| Volume change, percent, max | 15 | 15 |
| Adhesion to painted steel, inches (cm) stripped per hour, max | 1 (2.5) | 1 (2.5) |

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

3.3 Form. The tile shall consist of a rubber sheet having one smooth face and one cross-grooved face. The tile shall be furnished with the face or faces that will be bonded to metal roughened by abrading so that, except for solvent cleaning and adhesive application, no further treatment is required. The cross-grooved face of Class 1 tile shall be roughened. Both faces of Class 2 tile shall be roughened. Abrasion of the tile faces shall break the gloss over at least 95% of the area. The number and size of cross-grooves shall be such that a tile shall easily conform to a curved surface with no wrinkles, buckling or obvious distortions. Tiles prepared with the dimensions as shown in 6.4 have in the past allowed the tile to meet the requirements of the specification.

3.4 Dimensions. Unless otherwise specified (see 6.2), tile dimensions shall be as follows: Plan size 11.875 ± 0.0625 inches (30.16 ± 0.16 cm) by 11.875 ± 0.0625 inches (30.16 ± 0.16 cm); thickness Class 1, 0.750 ± 0.015 inch (1.90 ± 0.04 cm) and Class 2, 0.630 ± 0.015 inch (1.60 ± 0.04 cm). If tiles are ordered with plan dimensions which differ from those provided above, each plan dimension shall conform to the ordered size with a tolerance of plus or minus (±) 0.0625 inch (0.16 cm).

3.5 Weight. The weight of the Class 1 tile shall be 5.0 ± 0.2 pounds per square foot ($lb/ft^2$) (24.4 ± 1.0 kilograms per square meter ($kg/m^2$)). The weight of the Class 2 tile shall be 4.4 ± 0.2 $lb/ft^2$ (21.5 ± 1.0 $kg/m^2$).

3.6 Flame retardance. Tiles shall be self-extinguishing.

3.7 Vibration damping characteristics. Tiles shall conform to the vibration damping characteristics specified in Table II or III, as appropriate.

TABLE II. Class 1 tiles, vibration damping characteristics.

| Lengthwise Flexural mode number | Nominal frequency at 50°F (10°C) of 0.5 x 3 x 26 in. (1.3 x 7.6 x 66 cm) covered bar, Hz | Percent critical damping (minimum) at 50°F (10°C) |
|---|---|---|
| 5 | 1800 | 4.5 |
| 7 | 3700 | 4.5 |
| 9 | 5750 | 1.5 |

TABLE III. Class 2 tiles, vibration damping characteristics.

| Lengthwise Flexural mode number | Nominal frequency at 50°F (10°C) of 0.625 x 3 x 29 in. (1.6 x 7.6 x 74 cm) covered bar, Hz | Percent critical damping (minimum) at 50°F (10°C) |
|---|---|---|
| 5 | 1850 | 2.0 |
| 7 | 3330 | 3.0 |
| 9 | 6650 | 1.0 |

3.8 Identification. Each tile shall be legibly and permanently marked with the contractor's name or trademark, the month and year of manufacture, the contract number and the specification number. In addition, two adjacent edges of each tile shall be marked with one coat of paint or lacquer to identify the class of the tile. The marking shall be at least 0.250 inch (0.64 cm) wide. The identifying colors shall be as follows:

Class 1 - green
Class 2 - orange

3.9 Workmanship. Tiles shall be uniform in quality and condition, having no defects that will affect their installation and use.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.2)
b. Conformance inspection (see 4.3)

4.1.1 Inspection conditions. Unless otherwise specified (see 6.2), all inspections shall be performed in accordance with the test conditions specified herein.

4.2 First article inspection. First article inspection shall consist of the examination and tests specified in Table IV (see 6.3). Government representatives may witness qualification inspections.

4.2.1 Specimens required. The following specimens shall be provided for the first article inspection:

a. Ten tiles, each 11.875 inches (30.2 cm) square, or as specified (see 6.2)
b. Three sheets of the rubber compound, each 6 by 6 by 0.080 ± 0.010 inches (15 by 15 by 0.20 ± 0.025 cm). The sheets shall be made from the same rubber compound as the test tiles and have an equivalent cure.

The specific gravity and hardness of the specimen tiles shall establish the reference values for conformance inspections (see 4.5.2.1 and 4.5.3.1). These tiles shall have no major or minor defects (see 4.4).

TABLE IV. First article inspection.

| Examinations, measurements, and tests | Specimens required | Requirements | Test |
|---|---|---|---|
| Performed on tiles: | | | |
| Specific gravity | 5 tiles | 3.2 | 4.5.2 |
| Hardness | 5 tiles | 3.2 | 4.5.3 |
| Adhesion | 1 tile | 3.2 | 4.5.7 |
| Form | 1 tile | 3.3 | 4.4.1.3 |
| Dimensions | 5 tiles | 3.4 | 4.4.1 |
| Weight | 1 tile | 3.5- | 4.4.2 |
| Flame retardance | 1 tile | 3.6 | 4.5.5 |
| Vibration damping | 3 tiles | 3.7 | 4.5.8 |
| Identification | ---- | 3.8 | 4.4 |
| Performed on rubber sheets: | | | |
| Initial tensile strength and ultimate elongation | 1 rubber sheet | 3.2 | 4.5.4.1 |
| Tensile strength and ultimate elongation after oven aging | 1 rubber sheet | 3.2 | 4.5.4.2 |
| Volume change after water immersion | 1 rubber sheet | 3.2 | 4.5.6 |

4.3 Conformance inspection. Conformance inspection shall consist of the examination and test specified in Table V. Government representatives may witness conformance inspections.

TABLE V. Conformance inspection.

| Examinations, measurements, and tests | Specimens selection | Requirement | Test |
|---|---|---|---|
| Performed on tiles: | | | |
| Specific gravity | Note 2 | 3.2 | 4.5.2 |
| Hardness | Note 1 | 3.2 | 4.5.3 |
| Adhesion | Note 2 | 3.2 | 4.5.7 |
| Thickness | Note 2 | 3.4 | 4.4.1 |
| Weight | Note 1 | 3.5 | 4.4.2 |
| Identification | Note 1 | 3.8 | 4.4 |
| Workmanship | Note 1 | 3.9 | 4.4 |
| Performed on rubber sheets: | | | |
| Initial tensile strength and ultimate elongation | 1 rubber sheet | 3.2 | 4.5.4.1 |

[1]All tiles selected at random from the lot as specified in Table VI shall be used for this inspection.
[2]One tile selected at random from the sampling specified in Table VI shall be used for this inspection.

4.3.1 Lot. A lot shall consist of all the tiles offered for delivery at one time. In each case the number of tiles shall be the lot size.

4.3.2 Sampling for non-destructive inspection. Random samples of tiles shall be selected in accordance with Table VI from each lot for non-destructive inspection.

TABLE VI. Sampling for non-destructive inspection.

| Lot size number of tiles | Sample size number of tiles |
|---|---|
| 1 to 4 | All |
| 5 to 9 | 5 |
| 10 to 25 | 8 |
| 26 to 62 | 13 |
| 63 to 160 | 20 |
| 161 to 410 | 32 |
| 411 to 1,000 | 50 |
| 1,001 to 2,600 | 80 |

4.3.3 Sampling for destructive inspection. The following specimens shall be provided for destructive inspection. This inspection need not be performed if the lot is rejected on the basis of the non-destructive inspection performed in accordance with 4.4.

a. One tile taken at random from those selected in accordance with 4.3.2.

b. Three sheets of the rubber compound, each 6 by 6 inches (15 by 15 cm) by 0.080 ± 0.010 inch (0.20 ± 0.025 cm) thick. The rubber sheets shall have been made from the same rubber compound as the production tiles and have an equivalent cure.

4.4 Non-destructive inspection. Each of the tiles furnished in accordance with 4.3.1 or selected in accordance with 4.3.2 shall be examined to determine major and minor defects. Identification of visible defects shall be in accordance with MIL-STD-407. The dimension, weight, and hardness of each tile shall be determined as specified in 4.4.1, 4.4.2, and 4.5.3, respectively. Defective tiles shall not be offered for delivery. The tiles shall conform to the applicable requirements in section 3. Defects in tiles found by non-destructive observations and measurements shall be graded in accordance with Table VII.

TABLE VII. Classification of defects.

| Category | Defects |
|---|---|
| Critical | None defined |
| Major | |
| 101 | Deviation from weight and dimensions specified in 3.4 and 3.5 (see 4.4.1 and 4.4.2) |
| 102 | Wax or other substances on the surfaces of the tile which might interfere with subsequent adhesion |
| 103 | Tile not roughened by abrading on surfaces to be bonded (see 3.3) |
| 104 | Hardness not within required limits |
| Minor | |
| 201 | Cracks, pin holes, or cavities such as bad fill on the surfaces of the tile |
| 202 | Foreign material embedded in the rubber |
| 203 | Blisters on the surfaces of the rubber component |
| 204 | Improper or incomplete identification of the tiles (see 3.8) |

4.4.1 Dimensions and Form. Prior to measuring dimensions and form, the sample tile shall be conditioned at 80 ± 9 degrees Fahrenheit (°F) (27 ± 5 degrees Celsius (°C)) for at least 16 hours. The plan size of the entire tile and the overall thickness of the tile shall be measured without cutting the tile.

4.4.1.1 Tile plan size. The plan size of the entire tile shall be measured on the cross-grooved face of the tile with a steel ruler graduated in 1/64 inch units to determine conformance to 3.4.

4.4.1.2 Tile thickness. The thickness of the tiles shall be measured with a nominal 6-inch deep-throat micrometer, or equal, having 0.001 inch (0.0025 cm) divisions and accurate to 0.001 inch (0.0025 cm) to determine conformance to 3.4. Each tile shall be measured at four points at least 4 inches (10 cm) apart and at least 1 inch (2.5 cm) from the edge of the tile. Each tile containing a nonconforming measurement shall be considered defective.

4.4.1.3 Form. One tile shall be placed inside a cylinder with a 36 ± 1.0 inches (91.4 ± 2.5 cm) inside diameter and a minimum length of 12 inches (30.5 cm). The tile surface with the cross-grooved face should be placed facing the cylinder inside wall. The tile shall easily conform to the curvature of the inner wall of the cylinder with no wrinkling, buckling or obvious distortions of the tile.

4.4.2 Weight. Sample tiles shall each be weighted to the nearest 0.05 pound (0.023 kilograms (kg)). Results shall be computed to weight per square foot based on the nominal dimensions for the tile. The weight of each tile shall conform to the requirement in 3.5.

4.5 Test methods.

4.5.1 Conditioning. Unless otherwise specified in the procedures, all specimens shall be conditioned for at least 16 hours at 80 ± 9°F (27 ± 5°C) before being tested, and the tests shall be performed within this temperature range.

4.5.2 Specific gravity. The specific gravity of the rubber shall be determined in accordance with ASTM D 792 using specimens cut from the tiles. A Jolly balance, or equal, may be used in lieu of an analytical balance.

4.5.2.1 Reference value. The specific gravity of specimens cut from the five tiles provided for first article inspection shall be measured to a tolerance of plus or minus 0.02 unit and averaged to establish a reference value for conformance inspection.

4.5.2.2 Conformance. The specific gravity shall be determined on specimens cut from the tile which was randomly-selected for destructive conformance tests. The value obtained shall be compared to the average obtained in 4.5.2.1 and shall conform to the requirement in 3.2.

4.5.3 Hardness. The hardness of the tiles shall be measured with a durometer conforming to ASTM D 2240, Type A.

4.5.3.1 Reference value. Hardness shall be determined on each of the five tiles furnished for first article inspection and the results shall be averaged. This average value shall be recorded as a requirement for conformance tests of tiles submitted for delivery by the same contractor.

4.5.3.2 Conformance. For conformance tests, hardness shall be determined on each tile selected in 4.4.2. The values obtained on each tile shall be averaged and compared to the average obtained in 4.5.3.1 and shall conform to the requirement in 3.2 within ± 5 units.

4.5.4 Tensile strength and ultimate elongation. Die C specimens shall be used. The specimens shall conform to 3.2.

4.5.4.1 Initial tensile strength and ultimate elongation. The tensile strength and ultimate elongation of the 0.080 inch (0.203 cm) thick specimens representing the rubber tiles shall be determined in accordance with ASTM D 573 and ASTM D 412.

4.5.4.2 Tensile strength and ultimate elongation after oven aging. The tensile strength and ultimate elongation of the 0.080 inch (0.203 cm) thick specimens representing the rubber tiles shall be determined after oven aging for 166 ± 2 hours at 158 ± 2 °F (70 ± 1.1 °C) in accordance with ASTM D 573 and ASTM D 412.

4.5.5 Flame retardance. Flame retardance shall be determined in accordance with ASTM D 635, except that no wire gauze shall be mounted beneath the specimen and only three specimens cut from the same tile shall be tested. Each of the three specimens shall be rated at least self-extinguishing. If a specimen does not burn to the 4-inch mark after the first or second ignition, it is judged to be “self-extinguishing”.

4.5.6 Volume change after immersion in water. Three specimens, each 1 by 2 by 0.080 ± 0.010 inches (2.5 by 5.1 by 0.20 ± 0.025 cm) prepared from sheets furnished in 4.3.1 or 4.3.3 shall be immersed in distilled water in accordance with ASTM D 471 at a temperature of 130 ± 2 °F (54.4 ± 1.1 °C) for a period of 166 ± 1 hour. The resulting change in volume of each specimen shall be determined by and the results shall be averaged. The volume change shall conform to the requirement in 3.2.

4.5.7 Adhesion of tile to painted steel surface.

4.5.7.1 Specimen preparation. Three specimens each 1 by 11.875 inches (2.5 by 30.16 cm), shall be cut from one of the tiles along the grooves. The edge of the tile shall not be used for adhesion specimens. The rubber specimens shall be cleaned on the grooved side with PF-145HP degreaser (also known as PF High Performance Solvent, available from PT Technologies, 4647 Hugh Howell Road, Tucker, Georgia 30084) and allowed to dry. The grooved side of each specimen shall be bonded to a steel plate prepared to SSPC-SP 10 and painted with MIL-DTL-24441/29 to achieve a nominal dry film thickness (DFT) of 1 - 3 mils, approximately 2 by 14 by 0.125 inches (5.1 by 36 by 0.32 cm), using epoxy adhesive conforming to MIL-A-24456. The adhesive shall be mixed in accordance with manufacturer’s instructions and applied to the central portion of the steel plate which has been previously masked to expose an area which fits the rubber specimen. The adhesive shall be applied evenly and be 0.10 ± 0.01 inch (0.25 ± 0.03 cm) thick. One end of the specimen shall be aligned on the steel plate. The opposite end of the specimen shall be held up and a hand roller shall be used to draw the specimen against the steel surface. The surface of the specimen shall be rolled several times to press it firmly against the steel surface. The excess adhesive shall then be removed by stripping the masking tape before the adhesive sets. The assembly shall be allowed to stand for at least 3 days at room temperature before testing.

4.5.7.2 Test procedure. The measurement shall be made at a 90-degree angle of pull. The assemblies shall be immersed in salt water (3 percent sodium chloride) at room temperature and fastened in a horizontal position with the specimen on the bottom side. One end of the specimen shall be peeled loose from the steel far enough to permit the fastening of a clamp with weight equal to 25 pounds (11.3 kg) (corrected for buoyancy of the salt water). Mark the starting point on the steel where the rubber is still just attached to the steel. The specimens

shall be tested for a period of 6 hours. At the end of the 6 hour period, mark the end point on the steel where the rubber is still just attached to the steel. Measure the distance between the starting and end point marks on the steel and divide by the number of hours over which the test was conducted to determine the inches stripped per hour for the test specimen. Adhesion shall be the average of the values measured for the three test specimens. Adhesion shall conform to the requirement in 3.2.

4.5.8 Vibration damping characteristics. Conformance to 3.7 shall be determined by the procedures described in 4.5.8.1 through 4.5.8.3.

4.5.8.1 Test specimens.

4.5.8.1.1 Test specimens for Class 1 vibration damping treatment. The test specimens for determining Class 1 vibration damping characteristics shall be as follows:

a. Three flat steel bars, each 0.5 by 3 by 26 inches (1.3 by 7.6 by 66 cm). Each steel bar shall be cleaned with PF-145HP degreaser, abrasive blasted to SSPC-SP 10, cleaned again with degreaser and allowed to dry.

b. Three flat steel bars, as above, with strips of damping treatment completely covering one 3 by 26 inch (2.6 by 66 cm) face on each bar (bars from 4.5.8.1.1.a. may be used after measurement of bare-bar damping characteristics).

The damping treatment strips shall be bonded to the steel bars using the bonding procedures detailed in 4.5.8.1.3. A coat of paint, with a maximum dry film thickness of 3 mils, may be applied to the unbonded surfaces of the steel bars to protect against corrosion. The assembled test specimens shall be allowed to set at 80 ± 9 °F (27 ± 5 °C) for at least 96 hours prior to temperature conditioning for the vibration tests.

4.5.8.1.2 Test specimens for Class 2 vibration damping treatment. The test specimens for determining Class 2 vibration damping characteristics shall be as follows:

a. Three flat steel bars, each 0.625 by 3 by 29 inches (1.6 by 7.6 by 73.7 cm). Each steel bar shall be cleaned with PF-145HP degreaser, abrasive blasted to SSPC-SP 10, cleaned again with degreaser and allowed to dry.

b. Three flat steel bars, as above with strips of Class 2 damping treatment completely covering one 3 by 29 inch (7.6 by 73.7 cm) face on each bar (bars from 4.5.8.1.2.a. may be used after measurement of bare-bar damping characteristics). An aluminum constraining layer made of 5052 alloy conforming to ASTM B 209, 0.125 by 3 by 29 inches (0.3 by 7.6 by 73.7 cm) shall completely cover the damping treatment strips. The side of the aluminum constraining layer to be bonded shall be cleaned with PF-145HP degreaser, sweep blasted (light abrasive blasting), cleaned again with degreaser and allowed to dry.

The damping treatment strips shall be bonded to the steel bars using the bonding procedures detailed in 4.5.8.1.3. The aluminum constraining layer shall be bonded to the damping treatment strips in accordance with 4.5.8.1.3. The steel bars and the aluminum layers shall be cleaned with PF-145HP degreaser, abrasive blasted, cleaned again with degreaser and allowed to dry. A coat of paint, with a maximum dry film thickness of 3 mils, may be applied to the unbonded surfaces of the steel bars to protect against corrosion. The assembled test specimens shall be allowed to set at 80 ± 9°F (27 ± 5 °C) for at least 96 hours prior to temperature conditioning and testing.

4.5.8.1.3 Bonding procedure. The grooved face of the damping treatment shall be bonded with adhesive conforming to MIL-A-24456 to a steel bar which has been cleaned with PF-145HP degreaser, abrasive blasted to SSPC-SP 10, cleaned again with degreaser and allowed to dry. Prior to bonding, the grooved face of the damping treatment shall be cleaned with PF-145HP degreaser and allowed to dry. The adhesive shall be 0.10 ± 0.01 inch (0.25 ± 0.03 cm) thick, evenly applied to the steel bar and the damping treatment pressed firmly down onto the prepared bar surface. The aluminum constraining layer shall be bonded to the smooth face of the Class 2 damping treatment previously bonded to the 3 by 29 inch (7.6 by 73.7 cm) steel bar. Adhesive conforming to MIL-A-24456 shall be applied to both the damping treatment surface and to the aluminum constraining layer with a thickness of 0.10 ± 0.01 inch. The constraining layer shall then be pressed firmly down onto the damping treatment surface.

4.5.8.2 Testing. The equipment and procedure for determining the vibration damping characteristics of the test specimens are given in 4.5.8.2.2 and 4.5.8.2.3 respectively. Both bare bars and covered bars shall be conditioned at 50 ± 2 °F (10 ± 1.1 °C) for a minimum of 8 hours and tested at this temperature.

4.5.8.2.1 Accelerated aging. After completion of the initial damping measurements, the test bars shall be placed in a forced-draft oven for 168 ± 1 hour at 212 °F (100 ± 1.1 °C). Vibration damping measurements shall then be repeated as specified (see 4.5.8.2).

4.5.8.2.2 Equipment. A spectrum analyzer shall be used to take vibration damping measurements. The specific arrangement of equipment used must meet all requirements of 4.5.8.2.3. All equipment, including the spectrum analyzer and accelerometers, shall be in current calibration.

4.5.8.2.3 Procedure.

4.5.8.2.3.1 Method. Vibration damping tests shall be conducted by the method of the decay rate of free vibrations. This method requires that the test specimen be excited at several of its free-free flexural resonant frequencies in turn. Resonant frequencies shall be determined by applying a random noise source to the bar. A force at the resonant frequencies is then applied and the vibration of the specimen allowed to stabilize. The force is then removed and the vibration measured while decaying freely. The rate of decay of the test specimen's vibration is measured and related to the percent of critical damping by the relation:

$$\%D = \frac{100}{2Q} = \frac{100}{2\frac{(27.3f)}{R}} = 1.83\frac{R}{f}$$

where:

$\%D$ = percent of critical damping
$f$ = frequency of the vibrational mode excited (Hz)
$R$ = decay rate of vibration (dB/second)
$Q$ = “quality factor” at the resonant mode.

4.5.8.2.3.2 Excitation. The test specimens (steel bars and steel bars with damping treatment bonded to one surface) shall be excited using a vibration exciter. The location of the bar excitation point shall be at the geometric center of the 3-inch by 26-inch (7.6 by 66 cm) or 3-inch by 29 inch side (7.6 by 73.7 cm), as appropriate, that is not covered with damping treatment. A sinusoidal signal source shall be used to drive the vibration exciter. The excitation shall be adequate to provide an accelerometer signal at least 40dB greater than the combined ambient vibration and measurement system noise at each frequency. An spectrum analyzer or oscilloscope shall be used to monitor the source excitation and measurement system response waveforms to verify that signal levels remain within the linear limits of the equipment used.

4.5.8.2.3.3 Accelerometer. An accelerometer weighing not more than 1 ounce (28.3 grams) and having a mounted resonant frequency of 20 kilohertz (kHz) or greater shall be used to sense the vibration decay. The accelerometer shall have a minimum sensitivity of 9 mV/g. The accelerometer shall be attached to the bar opposite to the excitation point with a stud, epoxy adhesive, hard acrylic adhesive or dental cement. It is permissible to remove sufficient damping treatment as required to permit attachment.

4.5.8.2.3.4 Instrumentation. The instrumentation system is used to determine the frequencies of the resonant modes and to determine the decay rate at each required modal frequency. The instrumentation used must be capable of measuring a decay rate corresponding to at least 15% of critical damping. This value shall be verified by electrical impulse applied to the input of the measuring system. The spectrum analyzer shall be configured to obtain a time record. The decay rate shall be determined by capturing the log magnitude of the accelerometer signal

and measuring the slope of the decaying free vibration. Signal conditioning is desirable in this case as well, and may be accomplished by translation ("zoom") analysis if the limiting decay criteria is met.

4.5.8.2.3.5 Testing. Each test bar shall be suspended edgewise from two lightweight nylon or cotton cords at least 24 inches (61 cm) long. The bar may be suspended edgewise or flat, as appropriate for the type of vibration exciter being used. The suspension cords shall be attached to the bar at the appropriate nodal points of the first flexural mode of vibration (approximately 5.83 inches (14.8 cm) from each end of the 26 inch (66 cm) bar for Class 1 damping treatment; approximately 6.50 inches (16.5 cm) from each end of the 29 inch (73.7 cm) bar for Class 2 treatment). Alternatively, each test bar may be suspended vertically from one end of the bar using a single cord. For vertically suspended bars, a hole approximately 3/8-inch in diameter and located nominally one inch from the end of the bar may be drilled through the bar and the damping material. The free bar shall be excited at each of the odd-numbered lengthwise flexural modes of the bar as required in Tables II and III. Care shall be exercised to identify the modes excited and to avoid torsional, longitudinal, and combined modes. Care shall also be taken to prevent overloading of any part of the exciting and sensing circuits to eliminate spurious results. It is very important that the alignment of the vibration exciter be such that the direction of excitation is normal to the face of the test bar to which the vibration exciter is attached. Of primary concern is the need to eliminate the effect of the exciter on the test specimen during the time of the decaying free vibration. After connecting the instrumentation but prior to measuring the damping properties, the resonant frequency response of the test specimen shall be measured. In addition to determining the modal frequencies, this process is used in determining misalignment and overload problems in the exciter and measurement systems.

4.5.8.3 Calculation. The percents of critical damping at each mode found for the three bare bars at 50 °F (10 °C) shall be averaged. Likewise, the percents of critical damping at each mode found for the three coated bars shall be averaged. The corrected percents of critical damping for comparison with the requirements in Tables II and III shall be calculated using the following equation:

$$\text{Percent of critical damping (corrected)} = D_c - D$$

where:

$D_c$ is the averaged damping of the coated bars at the specified mode at 50 °F (10 °C).
D is the averaged damping of the bare bars at the specified mode at 50 °F (10 °C).

4.5.9 Toxicity. The vibration damping tiles shall be evaluated by the Navy Environmental Health Center (NAVENVIRHLTHCEN) using the administrative Health Hazard Assessment (HHA). A flowchart for this process can be found as enclosure (1) of BUMEDINST 6270.8. The HHA is a review of the vibration damping tiles based on information submitted by the manufacturer, to assess health hazards associated with the handling, application, use and removal of the product. Sufficient data to permit a HHA of the product shall be provided by the manufacturer/distributor to the NAVENVIRHLTHCEN. To obtain current technical information requirements specified by the NAVENVIRHLTHCEN, see 6.5.

4.5.10 Off-gassing. The vibration damping tiles shall be tested in accordance with the Nuclear Powered Submarine Atmosphere Control Manual, NAVSEA Technical Manual S9510-AB-ATM-010 Rev. 2, by a Government approved testing facility. The results shall be submitted to the Government for evaluation and approval for use (see 3.2.2 and 6.6).

## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use.

6.1.1 Class 1 tile. Class 1 tile is intended to be installed in accordance with the procedures of MIL-STD-2148 to damp vibrations in steel plates 0.5 inch (1.3 cm) thick or less. The grooved face of the tile is bonded with epoxy resin to the steel plate. The grooved face enables the tile to conform easily to a curved surface. This tile may be used in flooded spaces. If installed in submarine ballast tanks, the tile is restrained with a glass reinforced plastic sheet, CRES studs, nuts, and washers, in accordance with MIL-STD-2148.

6.1.2 Class 2 tile. Class 2 tile is intended to be installed in accordance with the procedures of MIL-STD-2148damp vibrations in a steel plate greater than 0.5 inch (1.3 cm) thick, but less than 0.75 inch (1.9 cm) thick. The grooved face of the tile is bonded with epoxy resin to the steel plate. The grooved face enables the tile to conform easily to a curved surface. This tile is normally constrained by a 0.125 inch (0.32 cm) thick aluminum sheet bonded to the tile with the epoxy adhesive. The tile is not acquired with the aluminum sheet already bonded to it. This assembly is not used in flooded spaces unless the aluminum constraining layer is removed. The tile and aluminum constraining layers are installed in accordance with MIL-STD-2148.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification
b. Class of tile required (see 1.2)
c. First article inspection, when required (see 3.1)
d. Plan size if tile, if other than specified (see 3.4)
e. Inspection conditions, if other than specified (see 4.1.1)
f. Number of specimens to first article (see 4.2.1 (a.))
g. Packaging requirements (see 5.1)
h. Is Material Safety Data Sheet required? (see 6.7)
i. Toxicity conformance (see 3.2.1 and 6.5)
j. Is off-gas testing required? (see 3.2.2 and 6.6)

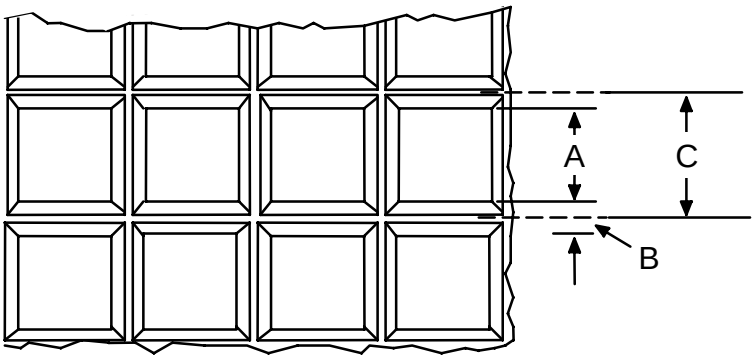
6.3 Suggested formulations for tiles. Tile prepared from the following formulations have been found to meet the requirements of this specification. This information is offered only as a suggestion; the contractor is not obligated to use these formulations. Use of these formulations will not relieve the contractor from having his product tested against the requirements of this specification. Certain ingredients appear as proprietary names since these were the specific ingredients used in the development of the tiles for this specification. It is not intended to limit the choice of the commercial source of an ingredient or to infer that one source is better than another.

TABLE VIII. Suggested formulations.

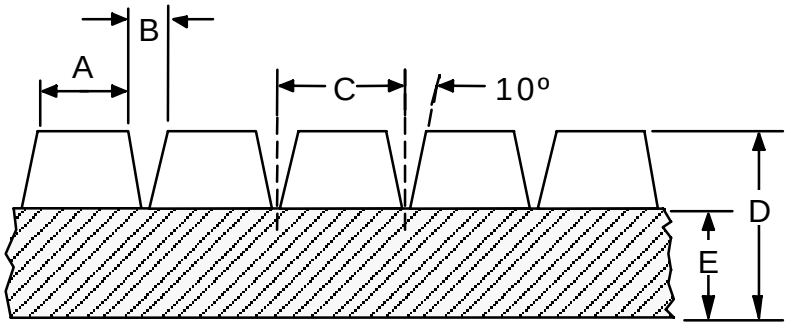
| Ingredients | Class 1 1/ parts by weight | Class 2 2/ parts by weight |
|---|---|---|
| Paracril 18-80 | 100 | 100 |
| Atomite | 100 | 100 |
| Thermoguard S | 15 | 15 |
| HiSil 233 | 10 | 10 |
| Sterling S | 2 | 2 |
| Protox | 5 | 5 |
| Stearic Acid | 2 | 2 |
| Neozone D | 1 | 1 |
| Chlorowax 40 | 30 | — |
| Chlorowax 70 | 20 | 50 |
| Dyphos | 2 | 2 |
| Thionex | 0.5 | 0.5 |
| Sulfur | 2 | 2 |
| | 289.5 | 289.5 |
| Specific gravity | 1.50 | 1.55 |

1/ Class 1 tiles from the above formulation are cured for 15 minutes at 320 °F (160 °C). Approximate shrinkage is 1 percent.

2/ Class 2 tiles from the above formulation are cured for 10 minutes at 320 °F. Approximate shrinkage is 1 percent.




**DETAIL A**




**DETAIL B**

| Dimmension | Inches | Centimeters |
|---|---|---|
| A | 0.375 ± 0.016 | 0.95 ± 0.04 |
| B | 0.125 ± 0.016 | 0.32 ± 0.04 |
| C | 0.497 ± 0.005 | 1.26 ± 0.01 |
| D (Class 1) | 0.750 ± 0.015 | 1.90 ± 0.04 |
| D (Class 2) | 0.630 ± 0.015 | 1.60 ± 0.04 |
| E (Class 1) | 0.425 ± 0.015 | 1.10 ± 0.04 |
| E (Class 2) | 0.295 ± 0.015 | 0.75 ± 0.04 |

FIGURE 1. Tile cross-groove dimensions.

6.4 Manufacturing instructions. Instructions for producing tiles which have been found to conform to this specification may be obtained from the Rubber Laboratory Code 642, Carderock Division, Naval Surface Warfare Center, 9500 McArthur Blvd., West Bethesda, MD 20817-5700. Tiles prepared with the dimensions as shown in Figure 1 have in the past allowed the tile to meet the requirements of the specification. This information is offered only as a suggestion; the contractor is not obligated to use these dimensions. Use of these dimensions will not relieve the contractor from having his product tested against the requirements of this specification. The Government does not guarantee that the use of these dimensions will enable a contractor to produce satisfactory tiles. The contractor should have his product tested against the requirements of this specification even though he uses these dimensions.

6.5 Toxicity evaluation. The NAVENVIRHLTHCEN requires sufficient information to permit a HHA of the product. Any questions concerning toxicity, information required to conduct a HHA, and requests for a HHA should be addressed to the Commanding Officer, Navy Environmental Health Center, ATTN: Hazardous Materials Department, Industrial Hygiene Directorate, 620 John Paul Jones Circle, Suite 1100, Portsmouth, VA 20378-2103. Upon receipt of the HHA, a copy should be provided to Commander, Naval Sea Systems Command, ATTN: SEA 05M3, 1333 Isaac Hull Ave., SE, Stop 5133, Washington Navy Yard, DC 20376-5133.

6.6 Off-gassing. Materials to be installed in submarines are to be controlled to prevent off-gassing, which contaminates the atmosphere and results in health hazards to personnel or deleterious effects on machinery. These controls are accomplished through the Submarine Material Control Program, which is described in the Nuclear Powered Submarine Atmosphere Control Manual, NAVSEA Technical Manual S9510-AB-ATM-010 Rev. 2. Under the Submarine Material Control Program, all materials considered for use on submarines require certification and assignment of a usage category. Under the certification process, candidate materials are selected by Navy activities or contractors, and a request for certification is submitted to Commander, Naval Sea Systems Command, ATTN: SEA 05Z9, 1333 Isaac Hull Ave., SE, Stop 5122, Washington Navy Yard DC 20376-5122. The certification request is accompanied by detailed information, including descriptions of the material. A chemical analysis is conducted, which is normally accomplished through off-gas testing. The off-gas test is required to be conducted in a Government approved laboratory designated by the preparing activity. Information pertaining to this test requirement may be obtained from Commander, Naval Sea Systems Command, ATTN: SEA 05Z9, 1333 Isaac Hull Ave., SE, Stop 5160, Washington Navy Yard, DC 20376-5160. Based on the chemical analysis results, a usage category is assigned to the material defining whether, and to what extent, the material may be used on submarines.

6.7 Material safety data sheets. Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. In order to obtain the MSDS, FAR clause 52.223-3 must be in the contract.

6.8 Tile type. Type V tile was formerly referred to as MIRL No. 3.

6.9 Subject term (key word) listing.

Damping
Damping Tile
Type V
Constrained layer
Steel plate vibration
Steel structure vibration
Vibration damping

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

Preparing activity:
Navy - SH
(Project 9320-0027)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.