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PERFORMANCE SPECIFICATION

PLASTIC TILES, VIBRATION DAMPING

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers four classes of flexible, water and fuel-resistant, fire-retardant plastic tiles for damping the flexural vibration of shipboard metal structures.

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

Class 1	-	For damping vibration of steel plates in the temperature range of 35 to 55 °F (1.7 to 12.8 °C).
Class 2	-	For damping vibration of steel plates in the temperature range of 55 to 80 °F (12.8 to 26.7 °C).
Class 2.5	-	For damping vibration of steel plates in the temperature range of 60 to 95 °F (15.6 to 35 °C).
Class 3	-	For damping vibration of steel plates in the temperature range of 80 to 155 °F (26.7 to 68.3 °C).

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.

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-DTL-5624	-	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-A-24456	-	Adhesive for Plastic Vibration-Damping Tile

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

Comments, suggestions, or questions on this document should be addressed to Commander, Naval Sea Systems Command, ATTN: SEA 05B5, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

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

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

S9510-AB-ATM-010 - Nuclear Powered Submarine Atmosphere Control Manual

(Copies of this document are available from the Naval Logistics Library, 5450 Carlisle Pike, Mechanicsburg, PA 17055 or online at http://nll.ahf.nmci.navy.mil).

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

AMERICAN NATIONAL STANDARDS INSTITUTE

ANSI S2.61 - Guide to the Mechanical Mounting of Accelerometers

(Copies of this document are available from American National Standards Institute, 25 W. 43rd St, 4th Floor, New York, NY 10036 or online at http://webstore.ansi.org/).

ASTM INTERNATIONAL

ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

ASTM D2240 - Standard Test Method for Rubber Property - Durometer Hardness

(Copies of these documents are available from ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 or online at www.astm.org).

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC-SP 10 - Near-White Blast Cleaning

(Copies of this document are available from SSPC Publication Sales, 40 24th Street, 6th Floor, Pittsburgh, PA 15222-4656 or online at www.sspc.org).

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

3. REQUIREMENTS

3.1 Qualification. The plastic vibration damping tiles furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.3).

3.1.1 Requalification in case of reformulation. Any changes in the formulation of the vibration damping tiles submitted for qualification testing shall be cause for requalification of the product.

3.2 Materials. The formulations for the tiles shall consist of the ingredients necessary to obtain the damping characteristics and physical properties described herein.

3.2.1 Toxicity. When evaluated in accordance with 4.4.9, the plastic vibration damping tiles shall have no adverse effect on the health of personnel when used for its intended purpose and shall not pose any environmental problems during waste disposal (see 4.4.9 and 6.5).

3.2.2 Off-gassing. The plastic vibration damping tiles shall be certified for, and assigned, a usage category of either “Permitted” or “Limited” in accordance with the Submarine Atmospheric Control Manual, NAVSEA S9510-AB-ATM-010 (see 4.4.10 and 6.7).

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 Weight. The average weight of the tiles shall be as specified in table I (see 4.4.1 and 6.2).

TABLE I. Average weight of vibration damping tiles.

Nominal Thickness (Inches)	Average Weight Classes 1, 2, and 3 (lb/ft²)	Average Weight Class 2.5 (lb/ft²)
1/8	0.9±0.05	--
3/8	2.8±0.1	3.1±0.1
5/8	4.5±0.2	--

3.4 Dimensions. Unless otherwise specified (see 6.2), the tiles shall be 12±1/16 by 12±1/16 inch in width and length. The nominal but not limiting thickness is 1/8 inch for tiles having a weight of 0.9 pounds per square foot (lb/ft²), 3/8 inch for tiles having a weight of 2.8 or 3.1 lb/ft², and 5/8 inch for tiles having a weight of 4.5 lb/ft². Tiles supplied under one contract or order from one manufacturer shall not differ in thickness by more than 1/16 inch except for tiles having a weight of 0.9 pounds per square foot which shall not differ in thickness by more than 1/32 inch. Tiles shall be of uniform thickness, square, and edges shall be perpendicular to faces (see 4.4.2).

3.5 Flame retardance. Tiles shall be rated at least self-extinguishing (see 4.4.3).

3.6 Fuel and water resistance. Tile weight gain shall be not greater than 0.2 percent as a result of immersion in JP-5 fuel in accordance with MIL-DTL-5624 and shall be not greater than 0.5 percent as a result of immersion in distilled water (see 4.4.4).

3.7 Adhesion. Bond strength between the tile and the adhesive shall be equal to or greater than the cohesive strength of the tile (see 4.4.5). The average cohesive strength of the tile shall be not less than the following:

Class 1 - 80 pounds per square inch (lb/in²)

Class 2 - 250 lb/in²

Class 2.5 - 250 lb/in²

Class 3 - 300 lb/in²

3.8 Vibration damping performance.

3.8.1 Initial damping performance. Initial vibration damping performance shall be as specified in tables II, III, IV, and V, as appropriate (see 4.4.6).

3.8.2 Damping performance after oven aging. Vibration damping performance after oven aging shall be as specified in tables II, III, IV, and V, as appropriate, and individual values shall be at least 70 percent of the initial damping values (see 4.4.6).

3.9 Hardness. The average hardness of the tiles shall be not greater than ±10 durometer points from the values obtained on tiles submitted for qualification tests (see 4.4.7).

3.10 Permanent compressibility (class 1 only). Decrease in tile volume shall be not greater than 5 percent (see 4.4.8).

3.11 Identification. 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 ¼ inch wide. The paint shall not become sticky due to migration of plasticizers from within the tiles (acrylic-type paints have been found satisfactory for this purpose). The identifying colors shall be as follows:

Class 1 - Blue

Class 2 - White

Class 2.5 - Yellow

Class 3 - Red

TABLE II. Class 1 tiles (4.5 lb/ft²), vibration damping characteristics.

Lengthwise Flexural Mode Number	Nominal Frequency at 55 °F (12.8 °C) of ⅜ × 3 × 40" Covered Bar (Hertz (Hz))	Percent Critical Damping at Indicated Temperatures (Minimum)	
		35 °F (1.7 °C)	55 °F (12.8 °C)
1	45	6.0	2.5
3	275	7.0	6.0
5	710	5.5	6.5
7	1330	4.0	6.0
9	2100	3.5	4.5
11	3015	2.5	4.0
13	4050	2.0	3.5

TABLE III. Class 2 tiles (4.5 lb/ft²), vibration damping characteristics.

Lengthwise Flexural Mode Number	Nominal Frequency at 55 °F (12.8 °C) of ⅜ × 3 × 40" Covered Bar (Hz)	Percent Critical Damping at Indicated Temperatures (Minimum)	
		55 °F (1.7 °C)	75 °F (12.8 °C)
1	45	7.0	2.0
3	260	7.5	5.0
5	670	7.0	6.5
7	1250	5.0	6.0
9	1990	4.0	5.0
11	2890	3.5	5.0
13	3830	3.0	4.5

TABLE IV. Class 2.5 tiles (3.1 lb/ft²), vibration damping characteristics.

Lengthwise Flexural Mode Number	Nominal Frequency at 75 °F (12.8 °C) of ⅜×3×40" Covered Bar (Hz)	Percent Critical Damping at Indicated Temperatures (Minimum)	
		75 °F (23.9 °C)	95 °F (35.0 °C)
1	45	5.4	3.0
3	260	5.8	5.3
5	670	5.2	6.5
7	1250	4.4	6.5
9	1990	3.4	6.0
11	2890	3.0	5.0
13	3830	2.8	5.0

TABLE V. Class 3 tiles (4.5 lb/ft²), vibration damping characteristics.

Lengthwise Flexural Mode Number	Nominal Frequency at 115 °F (46.6 °C) of ⅜×3×40" Covered Bar (Hz)	Percent Critical Damping at Indicated Temperatures (Minimum)			
		95 °F (35.0 °C)	115 °F (46.1 °C)	135 °F (57.2 °C)	155 °F (68.3 °C)
1	50	6.0	5.0	2.0	---
3	305	6.0	7.0	5.0	1.0
5	770	4.5	6.0	5.5	2.0
7	1425	4.5	6.0	6.0	3.0
9	2220	3.5	5.0	5.0	3.0
11	3200	3.5	5.0	5.0	3.0
13	4290	3.5	5.0	5.0	3.0

3.12 Workmanship. The tiles shall be examined for defects and workmanship. The finished tiles shall be free of segregated particles. Blisters shall not exceed a height of 1/16 inch. Minor surface voids and minor cracks will not be cause for rejection. The surface shall be free of wax or other substances which may interfere with subsequent adhesion (see 4.3.3).

4. VERIFICATION

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

a. Qualification inspection (see 4.2).

b. Conformance inspection (see 4.3).

4.2 Qualification inspection. Qualification inspection shall be conducted at a laboratory satisfactory to the Naval Sea Systems Command (NAVSEA). Government representatives may witness qualification inspections. Qualification tests shall consist of the examination of 4.3.3 and the tests of 4.4.

4.2.1 Samples for qualification tests. The samples for qualification testing of Classes 1, 2, and 3 shall consist of 10 tiles, each 12 by 12 inches and weighing 4.5±0.2 lb/ft². The samples for qualification testing of Class 2.5 tiles shall consist of 10 tiles, each 12 by 12 inches and weighing 3.1±0.1 lb/ft².

4.3 Conformance inspection. Conformance inspection shall include the examination and tests specified in 4.3.3 and 4.3.4. Government representatives may witness conformance inspections.

4.3.1 Identification of lot. For purposes of sampling, examinations, and tests for conformance, a lot shall consist of all the tiles, not exceeding 500 square feet of material, produced in one plant under essentially the same conditions, and offered for delivery at one time.

4.3.2 Sampling for conformance inspection. For the examination and tests specified in 4.3.3 and 4.3.4, 10 tiles shall be selected at random from each lot of tiles furnished under the contract or order.

4.3.3 Examination. Each of the tiles selected in accordance with 4.2.1 and 4.3.2, as appropriate, shall be examined for identification marking and visual defects and workmanship.

4.3.3.1 Rejection. If any of the 10 tiles in the sample are found not to be in conformance with the requirements of this specification, an additional set of 10 tiles shall be taken from the lot of tiles. If any of the 10 tiles in the second sampling are found not to be in conformance with the requirements of this specification, this shall be cause for rejection of the entire lot.

4.3.4 Conformance tests. Each of the tiles selected in accordance with 4.3.2 shall be tested to determine conformance to the following requirements:

Requirement	Paragraph
Weight	3.3
Dimensions	3.4
Hardness	3.9
Permanent compressibility (Class 1 only)	3.10

4.3.4.1 Rejection. If any of the tiles representing a lot are found not to be in conformance with the requirements of this specification, this shall be cause for rejection of the entire lot represented by the tile.

4.3.5 Recertification. To maintain qualification, each class of damping tile shall be tested for conformance to 3.8.1 every three years and to 3.2.1 and 3.8.1 each time there is a change in formulation or tile manufacturing is moved to a location or plant other than the location or plant at which the tiles tested for qualification were manufactured. The formulation shall be considered to have changed if there is an introduction or elimination of an ingredient, a replacement or change of an ingredient, a change in the source of supply of an ingredient, or the replacement of an ingredient with an equivalent ingredient from the same manufacturer. Results shall be submitted for evaluation and approval for use as specified (see 6.4).

4.4 Test methods.

4.4.1 Weight. The weight of each of the 10 tiles in the sampling shall be measured to the nearest 0.01 pound and the 10 results averaged.

4.4.2 Dimensions. Each of the 10 tiles shall be conditioned at 80±9 °F (27±5 °C) for not less than 16 hours. The dimensions of each of the tiles shall be measured at 80±9 °F (27±5 °C) by the following procedure. The tile shall be laid on a flat surface and measured for length and width with a steel ruler graduated in $\frac{1}{64}$-inch units. The thickness of the tile shall be measured with a nominal 6-inch deep-throat micrometer, or equal, at not less than six points distributed over the area of the tile and at least 1 inch (2.5 cm) from the edge of the tile. The average of the six or more thickness readings shall be computed and considered to be the thickness of the tile.

4.4.3 Flame retardance. Flame retardance shall be determined in accordance with ASTM D635 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 any of the specimens are not at least self-extinguishing, the procedure in the ASTM method which specifies tests in groups of 10 specimens (cut from the same tile) shall be followed.

4.4.4 Fuel and water resistance. Six specimens, each measuring 1 by 3 inches, shall be cut from one tile. Three samples shall be immersed in JP-5 jet fuel in accordance with MIL-DTL-5624, and three samples shall be immersed in distilled water. At least 1 liter of test fluid shall be employed and each specimen shall be isolated so that all surfaces are exposed to the test fluid and each specimen is completely immersed. The samples shall be weighed to the nearest 0.01 gram prior to immersion. Immersion shall continue at 80±9 °F (27±5 °C) for 96±½ hour. Upon completion of this period, the specimens shall be removed from the immersion media, excess fluid wiped off, and the sample weighed again immediately. Percent weight change shall be computed from the following equation:

$$\text{Percent weight change} = \frac{\text{final weight} - \text{initial weight}}{\text{initial weight}} \times 100$$

The results from the three specimens for a given immersion medium shall be averaged.

4.4.5 Adhesion. Adhesion shall be determined as specified in 4.4.5.1 and 4.4.5.2.

4.4.5.1 Specimen preparation.

4.4.5.1.1 Specimen components. Three large and three small mild-steel disks shall be prepared in accordance with figure 1. The large steel disks shall be ½ inch thick, have a 4-inch diameter and a centrally-located ½-20 UNC threaded stud approximately 1 inch long on one face. The threaded stud may be machined as part of the disk or may be a separate stud threaded into an appropriately tapped hole. Three small steel disks shall be similarly prepared and shall be ½ inch thick and be 1.597±0.005 inch in diameter. The studs shall be normal to the disk faces. Three discs, each 4 inches in diameter, shall be cut from one of the damping tiles.

4.4.5.1.2 Specimen assembly. Each damping tile disk shall be cleaned with PF Degreaser (formerly known as PF-145HP, available from PT Technologies, 4647 Hugh Howell Road, Tucker, GA 30084) or equal degreaser and allowed to dry thoroughly in ambient conditions. The face of the steel disks without the stud shall be cleaned with PF Degreaser or equal, then abrasive blasted to SSPC-SP 10 and cleaned with PF Degreaser or equal after blasting. The degreaser shall be allowed to dry completely before blasting and before specimen assembly. The final degreaser cleaning shall occur immediately prior to specimen assembly. MIL-A-24456 adhesive shall be mixed in accordance with manufacturer's instructions and shall be applied with a notched trowel. The notches in the trowel shall be equilateral triangles $\frac{3}{16} \pm \frac{1}{32}$ inch deep. The triangles shall intersect each other. A damping tile disc shall be pressed firmly down onto the prepared surface of a large steel disc. Then a small steel disc shall be pressed firmly down onto the damping tile disc. Excess adhesive shall be removed from the sides of the tile disk where the steel disks are bonded. Repeat this process for the remaining tile and steel disks (for a total of three sets of adhered disks). The assembled specimens shall be allowed to set at 80±9 °F (27±5 °C) for not less than 96 hours prior to testing for adhesion. A drawing of an assembled test specimen is shown on figure 1.

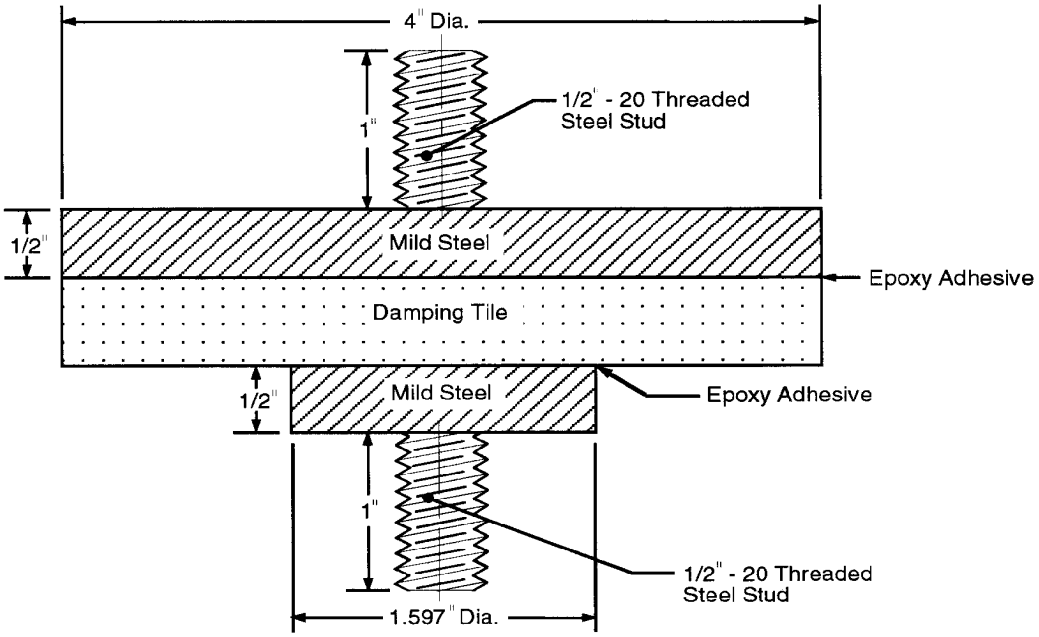

FIGURE 1. Adhesion test specimen.

4.4.5.2 Testing. The testing shall be conducted at 80±9 °F (27±5 °C). The test specimen shall be placed in a tension testing machine and the force required to separate the small disc from the specimen determined. The rate of separation of the tension testing machine fixtures shall not exceed 1 inch per minute. The test shall be repeated on each of the remaining specimens. The results from the three specimens shall be averaged.

4.4.6 Vibration damping characteristics. Vibration damping characteristics shall be determined as specified in 4.4.6.1 through 4.4.6.4.

4.4.6.1 Test specimens. The test specimens for determining vibration damping characteristics shall be as follows:

a. One flat steel bar, ⅜ by 3 by 40 inches.

b. Three flat steel bars, each ⅜ by 3 by 40 inches, with strips of damping tile completely covering one 3- by 40-inch face on each bar (the bar from 4.4.6.1.a. may be used after measurement of bare bar damping characteristics). Starting at one end, three strips of damping tile, nominally 3 by 12 inches, shall be bonded to each bar followed by a final strip, nominally 3 by 4 inches, applied to the opposite end. The 3-inch edge of each strip shall be square and butted up against the edges of adjacent strips. The damping tile strips shall be bonded to the steel bars in accordance with the procedure detailed in 4.4.6.2.

4.4.6.2 Bonding procedure. The damping tile strips (see 4.4.6.1.b) shall be cleaned with PF Degreaser or equal (see 4.4.5.1.2) and allowed to dry thoroughly in ambient conditions. The face of each steel bar to which damping tile strips will be applied shall be cleaned with PF Degreaser or equal, then abrasive blasted to SSPC-SP 10 with a 2- to 4-mil profile and cleaned again with PF Degreaser or equal after blasting. The final degreaser cleaning shall occur immediately prior to bar assembly. The degreaser shall be allowed to dry completely after each use. 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. MIL-A-24456 adhesive shall be mixed in accordance with the manufacturer's instructions and shall be applied with a notched trowel. The notches in the trowel shall be equilateral triangles $\frac{3}{16} \pm \frac{1}{32}$ inch deep. The triangles shall intersect each other. The damping tile strips shall be pressed firmly down onto the prepared surface of the three bars. Adhesive shall not be applied in the seams between the tiles. Excess adhesive shall be removed from the sides of the tile strips and steel bars. The assembled test specimens shall be allowed to set at 80±9 °F (27±5 °C) for a minimum of 96 hours prior to temperature conditioning for the vibration damping tests.

4.4.6.3 Testing. The equipment and procedure for determining the vibration damping characteristics of the test specimens are detailed in 4.4.6.3.2 and 4.4.6.3.3, respectively. The bare bar shall be conditioned at 75±2 °F (24±1.1 °C) for a minimum of 2 hours and tested at this temperature. The covered bars shall be conditioned and tested at each of the temperatures specified in tables II, III, IV, and V, as appropriate. Covered bars shall be conditioned for at least 16 hours at the temperature specified prior to testing, and the specified temperature maintained within ±2 °F (±1.1 °C) during conditioning and testing.

4.4.6.3.1 Accelerated aging. After completion of the initial damping measurements, the covered bars shall be placed in a forced-draft oven for 168±1 hours at 212±2 °F (100±1.1 °C). Vibration damping measurements shall then be repeated. The covered bars shall be conditioned and tested at each of the temperatures specified in tables II, III, IV, and V, as appropriate. Covered bars shall be conditioned for at least 16 hours at the temperature specified prior to testing, and the specified temperature maintained within ±2 °F (±1.1 °C) during conditioning and testing.

4.4.6.3.2 Equipment. A spectrum analyzer shall be used to take vibration damping measurements. The specific arrangement of equipment used must meet all requirements of 4.4.6.3.3. A laboratory calibration shall be made of all vibration measuring instrument components, including accelerometers, within 12 months prior to each use, or after exposure to mechanical shock or other unusual disturbance, or upon request by a Government inspector. All calibration instrumentation shall have been calibrated within six months prior to each use traceable to the National Bureau of Standards. The laboratory calibration of the components shall be accurate within the instrument manufacturer's specifications.

4.4.6.3.3 Procedure.

4.4.6.3.3.1 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 a number 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 percent 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 (decibels(dB)/second)

Q = "quality factor" at the resonant mode

4.4.6.3.3.2 Excitation. The test specimens (bare steel bar and steel bars with damping material bonded to one side) shall be excited using a vibration exciter. The location of the excitation point for the bar shall be at the geometric center of the 3- by 40-inch side of the bar not covered by the damping material. A sinusoidal signal source shall be used to drive the vibration exciter. The amplitude of excitation shall be adequate to provide an accelerometer signal at least 40 dB greater than the combined effects of ambient vibration and measurement system noise at each frequency. A 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.

4.4.6.3.3.3 Accelerometer. An accelerometer weighing no more than 1 ounce and having a mounted resonance of 20 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 (see 6.8). Accelerometers shall be mounted in accordance with the mounting guidance provided in ANSI S2.61, except that no oil or grease shall be used. It is permissible to remove sufficient damping tile as required to permit attachment.

4.4.6.3.3.4 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 percent 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 and may be accomplished by translation ("zoom") analysis if the limiting decay criteria is met.

4.4.6.3.3.5 Testing. Each test bar shall be suspended from two lightweight nylon or cotton cords at least 24 inches long. The bar may be suspended edgewise or flat, as appropriate for the type of vibration exciter being used. The suspension cords are to be attached to the bar at the appropriate nodal points of the first flexural mode of vibration (approximately 9 inches from each end of the bar). 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 ⅜ inch in diameter and located nominally 1 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, III, IV, and V, as appropriate. 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.

4.4.6.3.3.6 Measurement system damping. The percent critical damping at each mode of the bare bar shall be measured at 75 °F (24 °C). This test shall be conducted to demonstrate that the data acquisition system and physical test set-up do not impose extraneous damping on the measurement. The percent critical damping of the bare bar shall not exceed 0.5 percent at any mode.

4.4.6.4 Calculation. The percent critical damping at each mode found for the three coated bars at each of the test temperatures shall be averaged and compared with the requirements in tables II, III, IV, and V.

4.4.7 Hardness. Hardness of 10 sample tiles shall be measured at 73.5±2.0 °F (23.0±1.1 °C) on whole tiles which have been conditioned at this temperature for not less than 16 hours. This test shall be performed on Class 1 and Class 2 tiles with a durometer conforming to ASTM D2240, Type A. The hardness of Class 2.5 and Class 3 tiles shall be measured with a durometer conforming to ASTM D2240, Type D. The durometer shall be read 15 seconds after the presser foot makes firm contact with the tile. Hardness measurements shall be made at five points in accordance with ASTM D2240 except that each test point shall be spaced not less than 2½ inches from any other test point. The average of the five determinations shall be reported.

4.4.8 Permanent compressibility (class 1 only). The percent decrease in volume of a tile caused by 22 hours at 1000 lb/in² gage water pressure shall be found. The volume of the tile in cubic centimeters shall be measured at 80±9 °F (27±5 °C) by weighing the tile in air and in water with a balance sensitive to 0.1 gram. This measurement shall be repeated within 1 hour after exposing the tile to the hydraulic pressure at ambient room temperature. The percent decrease in volume shall be calculated as follows:

$$\text{Percent decrease in volume} = \frac{V_1 - V_2}{V_1} \times 100$$

Where:

$V_1 = W_1 - W_2$

$V_2 = W_3 - W_4$

W_1 = weight of tile in air before pressure treatment

W_2 = weight of tile in water before pressure treatment

W_3 = weight of tile in air after pressure treatment

W_4 = weight of tile in water after pressure treatment

This test shall be performed on three whole tiles. The average of the results shall be recorded.

4.4.9 Toxicity. The plastic vibration damping tiles shall be evaluated by the Navy-Marine Corps Public Health Center (NMCPHC). Sufficient data to access the health hazards associated with the handling, application, use, removal and disposal of the vibration damping tiles shall be provided by the manufacturer/distributor to the NMCPHC for conducting the Health Hazard Assessment (HHA) (see 3.2.1 and 6.5).

4.4.10 Off-gassing. The plastic vibration damping tiles shall be tested in accordance with the Submarine Atmospheric Control Manual, NAVSEA S9510-AB-ATM-010, by a Government-approved testing facility and results submitted for evaluation and approval for use as specified (see 3.2.2 and 6.7).

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. This material is intended to be installed in accordance with the procedures of MIL-STD-2148 for use as a vibration damping material for steel plates in free-layer, restrained-layer and constrained-layer configurations. The choice of tile class and weight depends respectively on the temperature and thickness of the steel plating to be damped. For toxicity reasons this material should not be used at temperatures over 200.0 °F (93.3 °C).

6.1.1 Tile applications. The weight per unit area of the tiles to be used on different thicknesses of steel is as follows:

TABLE VI. Type II damping applications.

Steel Plate Thickness (Inches)	Tile Unit Weight lb/ft²		Outer Layer
	(Classes 1, 2, & 3)	(Class 2.5)	
Less than ⅛	0.9	N/A	None, or glass-reinforced plastic sheet held with studs, nuts, and washers
⅛ to 5⁄16, inclusive	2.8	N/A	None, or glass-reinforced plastic sheet held with studs, nuts, and washers
Over 5⁄16 but less than ¾	4.5	3.1	None, or glass-reinforced plastic sheet held with studs, nuts, and washers
¾ to 2, inclusive	2.8	N/A	Steel plate adhered to tiles held with studs, nuts, and washers

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.

b. Class of tile desired (see 1.2).

c. Weight in lb/ft² of tile desired (see 3.3 and 6.1.1).

d. Size of tile if other than 12 by 12 inches (see 3.4).

e. Requirements for reporting toxicity test results (see 4.4.9 and 6.5).

f. Requirements for reporting off-gas test results (see 4.4.10 and 6.7).

g. Packaging requirements (see 5.1).

h Material Safety Data Sheet, when required (see 6.6).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 23653 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Commander, Naval Sea Systems Command, ATTN: SEA 05B5, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at http://assist.daps.dla.mil.

6.4 Recertification. Requests for recertification and recertification results should be provided in writing to Commander, Naval Sea Systems Command, ATTN: SEA 05B5, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160.

6.5 Toxicity evaluation. The NAVENVIRHLTHCEN requires sufficient information to permit an HHA of the product. Any questions concerning toxicity and requests for HHA should be addressed to the Commanding Officer, Navy and Marine Corps Public Health Center (NMCPHC), ATTN: Industrial Hygiene Department, Acquisition Technical Support Division, 620 John Paul Jones Circle, Suite 1100, Portsmouth, VA 20378-2103. Upon receipt of the HHA, a copy should be provided to the Naval Sea Systems Command, ATTN: SEA 05B5, 1333 Isaac Hull Ave., SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to CommandStandards@navy.mil.

6.6 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 (see 6.2).

6.7 Off-gassing. Material certification. Materials to be installed in submarines are to be controlled to prevent off-gassing, which contaminates the atmosphere and can result 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. 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 the Naval Sea Systems Command, SEA 05B5, 1333 Isaac Hull Ave., SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to CommandStandards@navy.mil. The certification request is accompanied by detailed information, including descriptions of the material, method of application, usage, and storage. 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 the Naval Sea Systems Command, SEA 05B5, 1333 Isaac Hull Ave., SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to CommandStandards@navy.mil. 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.

6.8 Accelerometer mounting. Previous testing has shown that a stud-mounted accelerometer is capable of meeting the vibration measurement requirements of this specification. Other mounting methods permitted herein may also be suitable, but care should be exercised to ensure the installed accelerometer meets all vibration measurement requirements.

6.9 Subject term (key word) listing.

constrained-layer

free-layer

plating, steel

restrained-layer

structures, metal

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.

Custodians:
Navy – SH
DLA – GS

Preparing Activity:
Navy – SH
(Project 9330-2007-008)

Review Activity:
DLA – IS

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.