

INCH-POUND

MIL-T-24487A(SH)
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SUPERSEDING
MIL-T-24487(SHIPS)
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MILITARY 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

2. APPLICABLE DOCUMENTS

2.1 Government documents.

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

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

AMSC N/A

FSC 9320

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SPECIFICATIONS

FEDERAL

PPP-F-320	Fiberboard, Corrugated and Solid, Sheet Stock (Container Grade), and Cut Shapes
QQ-A-250	Aluminum and Aluminum Alloy Plate and Sheet General Specification for
QQ-A-250/8	Aluminum Alloy 5052, Plate and Sheet

MILITARY

MIL-P-116	Preservation, Methods of
MIL-L-19140	Lumber and Plywood, Fire-Retardant Treated
MIL-A-24456	Adhesive for Plastic Vibration-Damping Tiles

STANDARDS

FEDERAL

FED-STD-601	Rubber Sampling and Testing
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MILITARY

MIL-STD-407	Visual Inspection Guide for Rubber Molded Items
MIL-STD-1186	Cushioning, Anchoring, Bracing, blocking, and Waterproofing, with Appropriate Test Methods
MIL-STD-2073-1	DOD Material Procedures for Development and Application of Packaging Requirements

(Unless otherwise indicated, copies of federal and military specifications and standards are available from the Naval Publications and Forms Center, (ATTN NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099)

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

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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 412	Standard Test Methods for Rubber Properties in Tension, (DOD adopted)
D 573	Standard Test Method for Rubber – Deterioration in an Air Oven, (DOD adopted)
D 635	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position, (DOD adopted)
D 792	Standard Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement, (DOD adopted)
D 2240	Standard Test Method for Rubber Property – Durometer Hardness, (DOD adopted)
D 3951	Standard Practice for Commercial Packaging, (DOD adopted)

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

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

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

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.4) in accordance with 4.3.

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 6.5.

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TABLE I *Physical properties of rubber*

Properties	Class 1	Class 2
<i>Initial properties</i>		
Specific gravity	(See 4 6 2 1)	(See 4 6 2 1)
Hardness, durometer points	(See 4 6 3 1)	(See 4 6 3 1)
Tensile strength, lb/in ² (kPa), min	960 (46 0)	1350 (64 6)
Ultimate elongation, percent, min	500	500
<i>Properties after aging in oven</i>		
Tensile strength, percent of initial, min	85	85
Ultimate elongation, percent of initial, min	70	70
<i>Properties after immersion in water</i>		
Volume change, percent, max	15	15
Adhesion to painted steel, inches (cm) stripped per hour, max	1 (2 5)	1 (2 5)

3.2.1 Recovered materials. Unless otherwise specified herein, all material incorporated in the products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specifically specified.

3.3 Form. The tile shall consist of a rubber sheet having one smooth face and one cross-grooved face as shown on figure 1. 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.

3.4 Dimensions. Unless otherwise specified (see 6 2), tile dimensions shall be in accordance with figure 1. If tiles are ordered with plan dimensions which differ from those of figure 1, each plan dimension shall conform to the ordered size with a tolerance of plus or minus (\pm) 0.0625 inch (0.16 cm) (see 4 5 1).

3.5 Weight. The weight of the class 1 tile shall be 5.0 ± 0.2 pounds per square foot (lb/ft²) (24.4 ± 1.0 kilograms per square meter (kg/m²)). The weight of the class 2 tile shall be 4.4 ± 0.2 lb/ft² (21.5 ± 1.0 kg/m²) (see 4 5 2).

3.6 Flame retardance. Tiles shall be self-extinguishing (see 4 6 5).

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3.7 Vibration damping characteristics. Tiles shall conform to the vibration damping characteristics specified in table II or III, as appropriate (see 4.6.8)

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.

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4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order (see 6.2), the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

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

- a. First article inspection (see 4.3)
- b. Quality conformance inspection (see 4.4)

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

4.3 First article inspection. First article inspection shall consist of the examination and tests specified in table IV (see 6.3).

4.3.1 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 quality conformance inspections (see 4.6.2.1 and 4.6.3.1). These tiles shall have no major or minor defects (see 4.5).

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TABLE IV. *First article inspection.*

Examinations, measurements, and tests	Specimens required	Requirements	Test
<i>Performed on tiles</i>			
Hardness	5 tiles	3 2	4 6 3
Specific gravity	5 tiles	3 2	4 6 2
Adhesion	1 tile	3 2	4 6 7
Dimensions other than web thickness	5 tiles	3 4	4 5 1
Web thickness	1 tile	3 4	4 5 1 6
Weight	5 tiles	3 5	4 5 2
Flame retardance	1 tile	3 6	4 6 5
Vibration damping	3 tiles	3 7	4 6 8
Identification	5 tiles	3 8	4 5
<i>Performed on rubber sheets</i>			
Initial tensile strength and ultimate elongation	1 rubber sheet	3 2	4 6 4
Tensile strength and ultimate elongation after oven aging	1 rubber sheet	3 2	4 6 4
Volume change after water immersion	1 rubber sheet	3 2	4 6 6

4.4 Quality conformance inspection. Quality conformance inspection shall consist of the examination and test specified in table V (see 6 3).

TABLE V. *Quality conformance inspection.*

Examinations, measurements, and tests	Specimen selection	Requirement	Test
<i>Performed on tiles</i>			
Hardness	1/	3 2	4 6 3
Specific gravity	2/	3 2	4 6 2
Adhesion	2/	3 2	4 6 7
Web thickness	2/	3 4	4 5 1 6
Weight	1/	3 5	4 5 2
Identification	1/	3 8	4 5
Workmanship	1/	3 9	4 5
<i>Performed on rubber sheets</i>			
Initial tensile strength and ultimate elongation	1 rubber sheet	3 2	4 6 4
Tensile strength and ultimate elongation after oven aging	1 rubber sheet	3 2	4 6 4
Volume change after water immersion	1 rubber sheet	3 2	4 6 6

¹All tiles selected at random from the lot as specified in table VI shall be used for this inspection

²One tile selected at random from the sampling specified in table VI shall be used for this inspection

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4.4.1 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.

4.4.2 Sampling for non-destructive inspection. Random samples of tiles shall be selected in accordance with table VI from each lot for non-destructive inspection (see 6.9)

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

4.4.3 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 4.5

- a. One tile taken at random from those selected in accordance with 4.4.2
- 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.

4.5 Non-destructive inspection. Each of the tiles furnished in accordance with 4.3.1 or selected in accordance with 4.4.2 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 4.5.1, 4.5.2, and 4.6.3, 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.

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TABLE VII. *Classification of defects*

Category	Defects
<i>Critical</i>	None defined
<i>Major</i>	
101	Deviation from weight and dimensions specified in 3.4 and 3.5 (see 4.5.1 and 4.5.2)
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
<i>Minor</i>	
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)

4.5.1 Dimensions. Prior to measuring dimensions, the sample tile shall be conditioned at 80 ± 9 degrees Fahrenheit ($^{\circ}\text{F}$) (27 ± 5 degrees Celsius ($^{\circ}\text{C}$)) for at least 15 hours. The plan size of the entire tile, the groove width between the bosses, the plan size of the surface of the bosses, the average spacing between grooves, and the overall thickness of the tile shall be measured without cutting the tile. The thickness of the web shall be measured on the strips cut to prepare adhesion specimens after the tile is cut along the grooves.

4.5.1.1 Tile plan size. The plan size of the entire tile shall be measured on the web face of the tile to determine conformance to 3.4.

4.5.1.2 Boss plan size. The plan size of six randomly-selected bosses shall be measured in two perpendicular directions on two randomly-selected tiles to determine conformance to 3.4.

4.5.1.3 Groove width. The groove width at 10 randomly-selected locations on the two tiles measured in 4.5.1.2 shall be measured to determine conformance to 3.4.

4.5.1.4 Average spacing of grooves. The average spacing of grooves in two perpendicular directions on the tile shall be measured to determine conformance to 3.4. The measurement shall be made across at least 10 bosses. The average groove spacing shall be calculated by dividing the total dimension by the number of bosses included.

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4.5.1.5 Tile thickness. The thickness of the tiles shall be measured with a dial micrometer having 0.001 inch (0.0025 cm) divisions and accurate to 0.001 inch 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.

4.5.1.6 Web thickness. The web thickness shall be measured on the tile provided in 4.4.3 using method 2031 of FED-STD-601 to determine conformance to 3.4. The tile shall be cut at the grooves into six randomly-selected 1-inch (2.5 cm) wide strips which may later be used for the adhesion test. The edges of the tile shall be avoided. A total of 12 measurements shall be made, two per strip, at locations approximately 7 inches (18 cm) apart on a particular strip. Each measurement shall conform to 3.4.

4.5.2 Weight. Sample tiles shall each be weighed 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.

4.6 Test methods.

4.6.1 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.

4.6.2 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.

4.6.2.1 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 quality conformance inspection.

4.6.2.2 Conformance. The specific gravity shall be determined on specimens cut from the tile which was randomly-selected for destructive quality conformance tests. The value obtained shall be compared to the average obtained in 4.6.2.1 and shall conform to the requirement in 3.2.

4.6.3 Hardness. The hardness of the tiles shall be determined in accordance with ASTM D 2240 using a Shore A durometer.

4.6.3.1 Reference value. Hardness shall be determined on each of the five tiles furnished for first article inspection and the results shall be averaged to a tolerance of plus or minus 0.02 unit. This average value shall be recorded as a requirement for quality conformance tests of tiles submitted for delivery by the same contractor.

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4.6.3.2 Conformance. For quality 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 4.6.3.1 and shall conform to the requirement in 3.2.

4.6.4 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 initially and 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 Die C specimens shall be used. The specimens shall conform to 3.2.

4.6.5 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.

4.6.6 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 4.4.3 shall be immersed in distilled water in accordance with method 6001 of FED-STD-601 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 method 6211 of FED-STD-601 and the results shall be averaged. The volume change shall conform to the requirement in 3.2.

4.6.7 Adhesion of tile to painted steel surface.

4.6.7.1 Specimen preparation. Three specimens, each 1 by 11.875 inches (2.5 by 30.2 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 strips shall be cleaned on the grooved side with a rag wetted with 1,1,1 trichloroethane (methyl chloroform) and then allowed to dry for at least 30 minutes. Each strip specimen shall be adhered to a Devran 202/215 painted steel plate, approximately 2 by 14 by 0.125 inches (5.1 by 36 by 0.32 cm), using an 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 spread with a serrated tool having approximately 8 teeth to the inch. One end of the strip shall be aligned on the steel plate. The opposite end of the strip shall be held up and a hand roller shall be used to draw the strip against the steel surface. The surface of the strip 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.

4.6.7.2 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 strip on the bottom side. One end of the strip shall be peeled loose from the steel far enough to permit the fastening of a clamp with weight equal to 25

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pounds (11.3 kg) (corrected for buoyancy of the salt water). The specimens shall be tested for a period of 6 hours. The adhesion shall be recorded as inches of separation per hour. The values for the three specimens shall be averaged. Adhesion shall conform to the requirement in 3.2.

4.6.8 Vibration damping characteristics. Conformance to 3.7 shall be determined by the procedure described in 4.6.8.1 through 4.6.8.4

4.6.8.1 Test specimens.

4.6.8.1.1 Test specimens for class 1 tile vibration damping. The test specimens for determining class 1 tile vibration damping characteristics shall be the following:

- a. Three flat steel bars, each 0.5 by 3 by 26 inches (1.3 by 7.6 by 66 cm)
- b. Three flat steel bars, as above, with strips of tile completely covering one 3 by 26 inch (2.6 by 66 cm) face on each bar (bars from (a.) may be used after measurement of bare-bar damping characteristics).

The tile strips cut from class 1 tiles shall be bonded to the sandblasted faces of the steel bars using the bonding procedure detailed in 4.6.8.1.3. 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.

4.6.8.1.2 Test specimens for class 2 tile vibration damping. The test specimens for determining class 2 tile vibration damping characteristics shall be the following.

- a. Three flat steel bars, each 0.625 by 3 by 29 inches (1.6 by 7.6 by 73.7 cm)
- b. Three flat steel bars, as above, with strips of class 2 tile completely covering one 3 by 29 inch (7.6 by 73.7 cm) face on each bar (bars from (a) may be used after measurement of bare-bar damping characteristics). An aluminum constraining layer made of 5052 alloy conforming to QQ-A-250 and QQ-A-250/8, 0.125 by 3 by 29 inches (0.3 by 7.6 by 73.7 cm) shall completely cover the tile strips

The strips cut from class 2 tiles shall be bonded to the sandblasted faces of the steel bars using the bonding procedure detailed in 4.6.8.1.3. The aluminum constraining layer shall be bonded to the tile strips in accordance with 4.6.8.1.3. 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.

4.6.8.1.3 Bonding procedure. The grooved face of each tile shall be bonded with adhesive conforming to MIL-A-24456 to a steel bar which has been cleaned by sandblasting. The adhesive shall be evenly applied to the steel bar and the tile pressed firmly down onto the prepared bar surface. The aluminum constraining layer shall be bonded to the smooth face of the class 2 tiles

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which have previously been 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 tile surface and to the aluminum constraining layer. The constraining layer shall then be pressed firmly down onto the tile surface.

4.6.8.2 Testing. The equipment and procedure for determining the vibration damping characteristics of the test specimens listed in 4.6.8.1.1 and 4.6.8.1.2 are given in 4.6.8.2.2 and 4.6.8.2.3. The bare bars shall be conditioned at 50 ± 2 °F (10 ± 1.1 °C) for at least 24 hours and tested at this temperature. The covered bars shall be conditioned for at least 16 hours at 50 ± 2 °F (10 ± 1.1 °C) and tested at this temperature.

4.6.8.2.1 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 4.6.8.2).

4.6.8.2.2 Equipment. Arrangements of instruments that have been used and found satisfactory for this test are shown on figures 2 and 3. Other arrangements of similar instruments which meet the requirements of 4.6.8.2.3 may also be satisfactory.

4.6.8.2.3 Procedure.

4.6.8.2.3.1 Methods. 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. A force at a single resonant frequency shall be applied, and the vibration of the specimen allowed to stabilize. The force shall then be removed, and the vibration measured while decaying freely. The rate of decay of the test bar vibration shall be 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 (hertz)
- R = decay rate of vibration (decibels/second)
- Q = "quality factor" at the resonant mode.

4.6.8.2.3.2 Excitation. The bar shall be excited using an electrodynamic vibration exciter. The exciter shall be securely attached to the flat face of the bar at the intersection of the longitudinal centerline and the vertical centerline on the side not covered by damping material. A sinusoidal signal source shall be used to drive the vibration exciter. The excitation shall be adequate to provide an accelerometer signal at least 40 decibels greater than the combined ambient vibration and instrument noise at each frequency. The frequency of the signal source shall be monitored using an electronic frequency counter.

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4.6.8.2.3.3 Accelerometer. An accelerometer weighing not more than 1 ounce and having a resonant frequency of 20 kilohertz (kHz) or greater shall be used to sense the vibration decay. The accelerometer shall be attached opposite to the attachment of the vibration exciter. It is permissible to remove sufficient damping tile as required to permit necessary attachment.

4.6.8.2.3.4 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 percent of critical damping. This value shall be verified by electrical impulse applied to the input of the measuring system. In figure 2, the output of the accelerometer is passed successively through a preamplifier, an amplifier, and a logarithmic amplifier to an oscilloscope adapted by design or supplemental attachment to measure the decay rate. Insertion of an octave band filter between the amplifier and logarithmic amplifier is desirable provided it does not affect the limiting decay rate. Figure 3 shows alternative instrumentation using a spectrum analyzer. In this case, the analyzer is configured to capture a time record and display the log magnitude of that record. Filtering is desirable in this case as well, and may be accomplished by translation "zoom" analysis if the limiting decay criteria is met.

4.6.8.2.3.5 Testing. Each test bar shall be suspended edgewise from two lightweight nylon or cotton cords at least 24 inches (61 cm) long. These 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 bar for class 1 vibration damping material, approximately 6.50 inches (16.5 cm) from each end of the 29 inch bar for class 2 vibration damping material). The free bar shall be excited at each of the 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. The alignment of the vibration exciter shall be such that the direction of excitation is normal to the face of the test bar to which the vibration exciter is attached. After connecting the instrumentation as shown on figures 2 or 3, but prior to measuring the damping properties, it will be helpful to measure the resonant frequency response of the test specimen. In addition to determining the modal frequencies, this process is useful in determining misalignment and overload problems in the exciter and measurement systems.

4.6.8.3 Calculation. The percents of critical damping at each mode found for the three bare bars at 75 °F (24 °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 75 °F (24 °C)

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4.6.8.4 Results. The percents of critical damping of the three bars shall be averaged at each mode and compared with requirements of tables II or III, as applicable. No correction for bare bar damping is required.

4.7 Inspection of packaging. Sample packs, and the inspection of the preservation, packing, and marking for shipment, stowage, and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition.)

5.1 Preservation. Preservation shall be level A, C, or commercial as specified (see 6.2).

5.1.1 Dusting material. When applied to the tiles as talc and talcum, dusting material shall be asbestos-free (see 6.3).

5.1.2 Level A. Tiles shall be unit protected to meet the requirement of MIL-P-116, method III, and as follows: a quantity of tiles weighing not more than 100 pounds (45.4 kg) net, interleaved with a soft, neutral, non-abrasive paper or film shall be placed flat in a snug-fitting container for the level of packing specified (see 5.2).

5.1.3 Level C. A quantity of tiles weighing not more than 100 pounds (45.4 kg) net shall be protected against deterioration and physical damage from the supply source to the first receiving activity for immediate use.

5.1.4 Commercial. Preservation shall be in accordance with ASTM D 3951

5.2 Packing. Packing shall be level A, B, C, or commercial, as specified (see 6.2).

5.2.1 General requirements for levels A, B, and C.

5.2.1.1 Containers. Containers selected (see 5.2.2) shall be of minimum weight and cube to be consistent with the protection required, of uniform size, and contain identical quantities of identical tiles.

5.2.1.1.1 Navy fire-retardant requirements.

5.2.1.1.1.1 Lumber and plywood. Unless otherwise specified (see 6.2), all lumber and plywood including laminated veneer material used in shipping container and pallet construction, members, blocking, bracing, and reinforcing shall be fire-retardant treated material conforming to MIL-L-19140 as follows:

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- Levels A and B - Type II - weather resistant
Category 1 - general use
- Level C - Type I - non-weather resistant
Category 1 - general use

5.2.1.1.2 Fiberboard. Fiberboard used in the construction of class-domestic, non-weather resistant fiberboard, and cleated fiberboard boxes shall meet the flammability and smoke requirements of PPP-F-320 and amendments thereto.

5.2.2 Levels A, B, and C containers. Tiles preserved as specified (see 5.1) shall be packed in shipping containers for the level of packing specified, in accordance with MIL-STD-2073-1, table VII of appendix C, and herein. Unless otherwise specified (see 6.2), container selection shall be at the contractor's option.

5.2.2.1 Caseliners, closure, and gross weight.

5.2.2.1.1 Caseliners. Unless otherwise specified (see 6.2), level A, and when specified (see 6.2), level D, shipping containers shall be provided with waterproof caseliners in accordance with MIL-STD-1186.

5.2.2.1.2 Closure. Container closure, reinforcing, or banding shall be in accordance with the applicable container specification except that weather-resistant fiberboard boxes shall be closed in accordance with method V and reinforced with non-metallic or tape banding and domestic fiberboard boxes shall be closed in accordance with method I using pressure sensitive tape

5.2.2.1.3 Weight. Wood, plywood, and cleated type containers exceeding 200 pounds gross weight shall be modified by the addition of skids in accordance with MIL-STD-2073-1, appendix F, and the applicable container specification

5.2.3 Commercial. Tiles preserved as specified (see 5.1) shall be packed for shipment in accordance with ASTM D 3951 and herein

5.2.3.1 Container modification. Shipping containers exceeding 200 pounds gross weight shall be provided with a minimum of two 3- by 4-inch nominal wood skids laid flat, or a skid- or sill-type base which will support the material and facilitate handling by mechanical handling equipment during shipment, storage, and stowage.

5.3 Palletized unit loads. When specified (see 6.2), shipping containers shall be palletized in accordance with MIL-STD-2073-1, appendix F

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5.4 Marking.

5.4.1 Levels A, B, and C. In addition to any special marking required (see 6.2), interior packs and shipping containers shall be marked, including bar coding, in accordance with MIL-STD-2073-1, appendix F.

5.4.2 Commercial. In addition to any special marking required (see 6.2), interior packs and shipping containers shall be marked in accordance with ASTM D 3951. In addition, bar coding shall be applied in accordance with MIL-STD-2073-1, appendix F.

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 damp vibrations in steel plates 0.5 inch 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, steel studs, nuts, and washers, in accordance with MIL-STD-2148.

6.1.2 Class 2 tile. Class 2 tile is intended to damp 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 must specify the following:

- a. Title, number, and date of this specification
- b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1 and 2.2)
- c. Class of tile required (see 1.2)
- d. First article inspection, when required (see 3.1)
- e. Plan size of tile, if other than specified (see 3.4)
- f. Inspection conditions, if other than specified (see 4.2.1)

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- g. Number of specimens to first article (see 4.3.1 (a.))
- h. Level of preservation and packing required (see 5.1 and 5.2)
 - i. When fire-retardant treatment is not required (see 5.2.1 1.1.1)
- j. Container selection if other than contractor's option (see 5.2.2)
- k. When caseliners are not required (see 5.2.2 1.1)
- l. Palletized load when required (see 5.3)
- m. Special marking required (see 5.4).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DIDs) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DIDs are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DOD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
4.3	DI-T-4901	First Article Inspection Procedure	—
4.3	DI-T-4902	First Article Inspection Report	—
4.4	DI-T-5329	Inspection and Test Reports	—
5.1.1	DI-E-2121	Certificate of Compliance	—

The above DIDs were those cleared as of the date of this specification. The current issue of DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDDL), must be researched to ensure that only current, cleared DIDs are cited on the DD Form 1423

6.4 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a preproduction sample, a first article sample, a first production item, a sample selected from the first production items, a standard production item from the contractor's current inventory (see 3.1), and the number of items to be tested as specified in 4.3. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering

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a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.5 Suggested formulations for tiles. Tiles 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

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

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

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6.6 Manufacturing instructions. Instructions for producing tiles which have been found to conform to this specification may be obtained from the Rubber Laboratory, Naval Ship Research and Development Center, Annapolis, MD 21402. The Government does not guarantee, however, that the use of these instructions 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 instructions.

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

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

<u>M</u>	<u>24487-</u>	<u>X</u>
Prefix to indicate military specification	Specification number	Class number (see 1.2)

6.9 Acceptance criteria for non-destructive inspection. Acceptance and rejection numbers for non-destructive inspection (see 4 4.2) are given in table IX.

TABLE IX *Acceptance and rejection numbers for non-destructive inspection*

Lot size number of tiles	Sample size number of tiles	Number of non-conforming or defective tiles			
		Major defect		Total defects (major plus minor)	
		Acceptance number	Rejection number	Acceptance number	Rejection number
1 to 4	All	0	1	1	2
5 to 9	5	0	1	1	2
10 to 25	8	0	1	1	2
26 to 62	13	0	1	1	2
63 to 160	20	1	2	2	3
161 to 410	32	1	2	3	4
411 to 1,000	50	2	3	4	5
1,001 to 2,600	80	3	4	6	7

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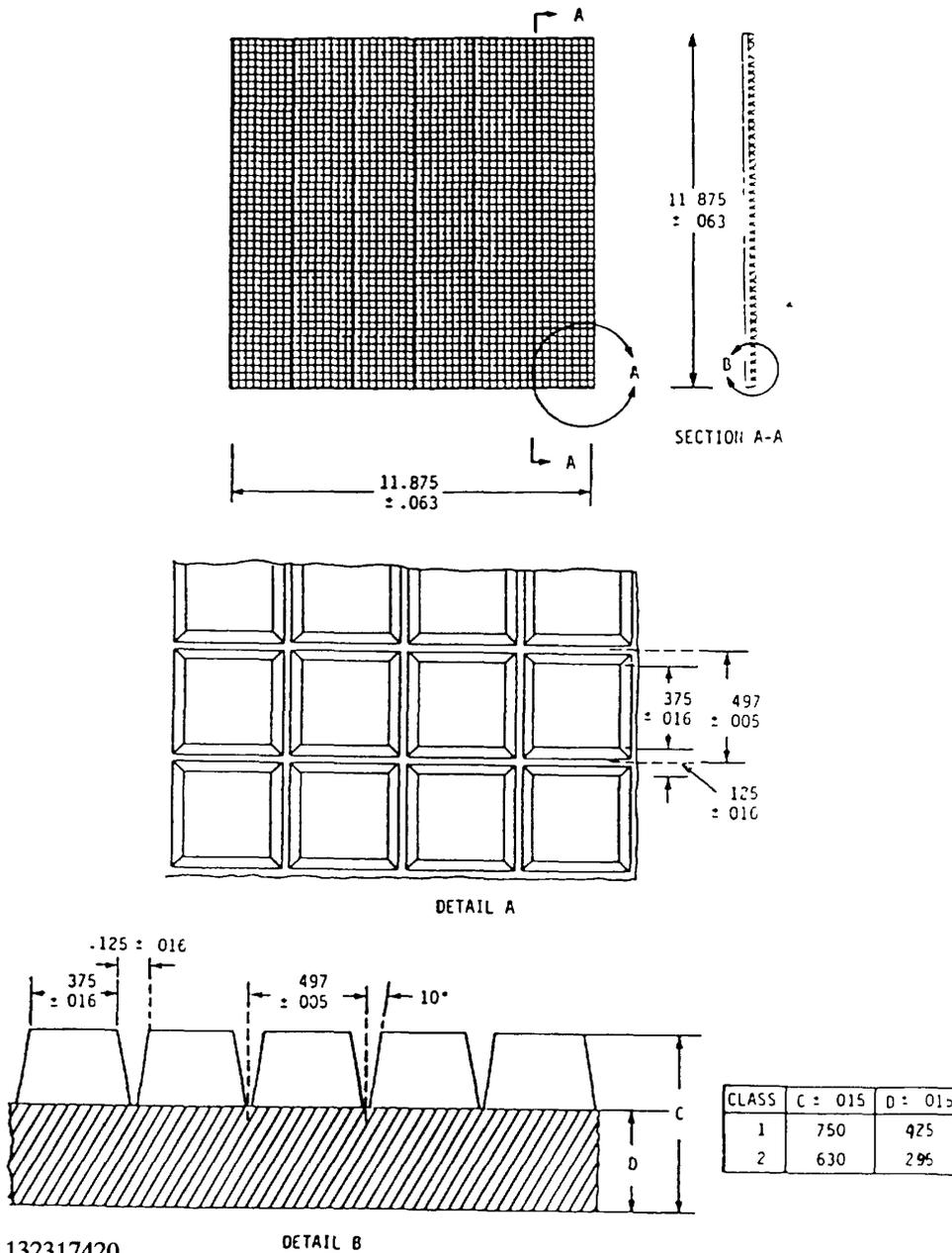
6.10 Subject term (key word) listing.

Steel plate vibration
Steel structure vibration
Vibration damping

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

Preparing activity:
Navy – SH
(Project 9320-N003)

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DETAIL B

FIGURE 1. Dimensions of type V tile (in inches)

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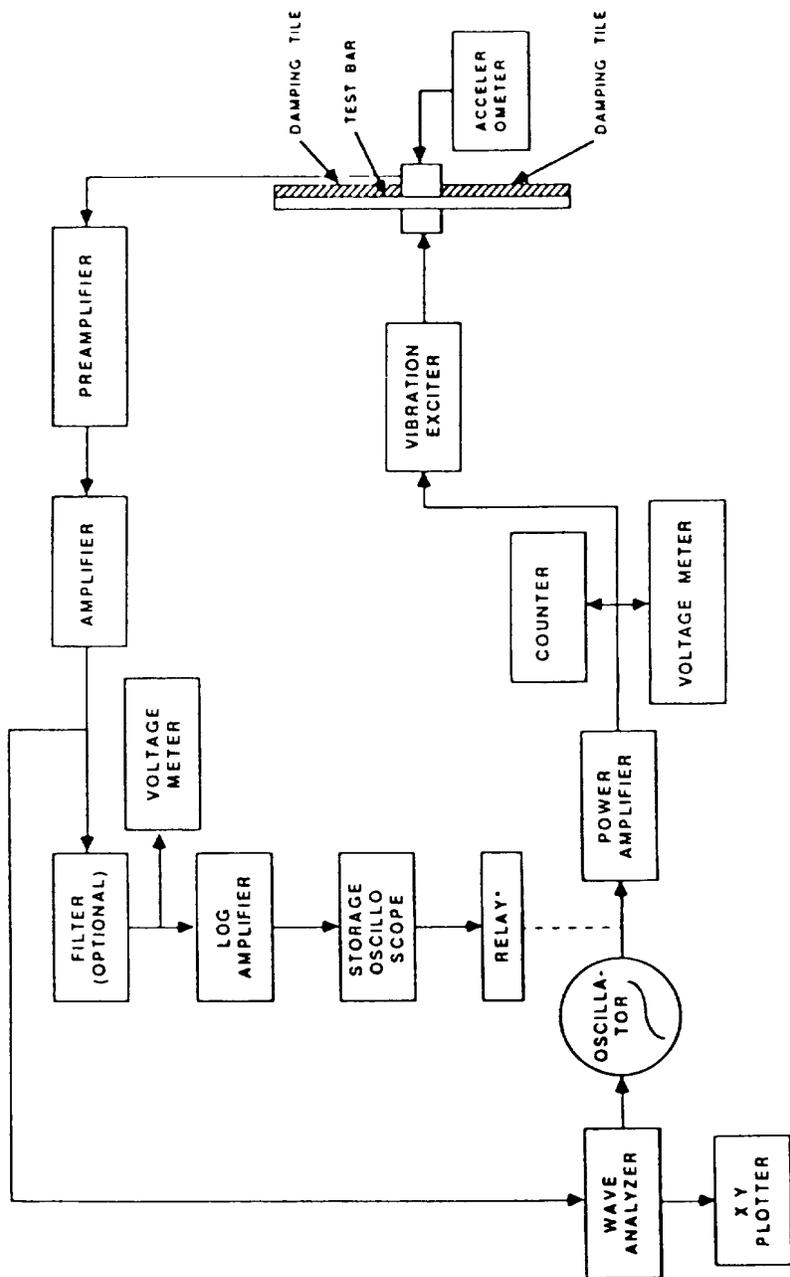


FIGURE 2. Schematic layout of instrument used to evaluate vibration damping.

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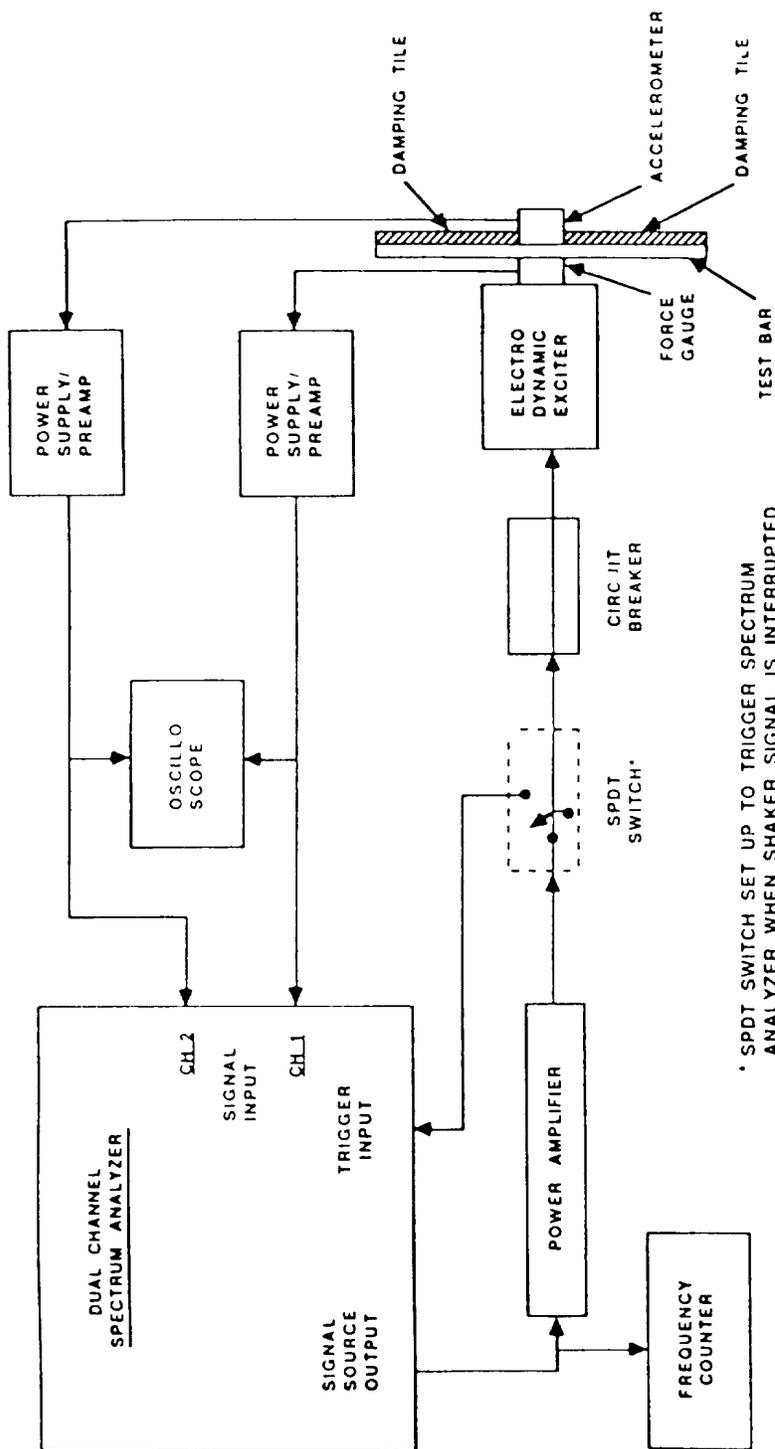


FIGURE 3 Schematic layout of alternate instrumentation used to evaluate vibration damping

SH 132317422

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

- 1 The preparing activity must complete blocks 1, 2, 3, and 8 In block 1, both the document number and revision letter should be given
- 2 The submitter of this form must complete blocks 4, 5, 6, and 7
- 3 The preparing activity must provide a reply within 30 days from receipt of the form

NOTE This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements

I RECOMMEND A CHANGE:	1 DOCUMENT NUMBER MIL-T-24487A(SH)	2 DOCUMENT DATE (YYMMDD)
3 DOCUMENT TITLE TILE RUBBER VIBRATION DAMPING TYPE V		
4 NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible Attach extra sheets as needed)		
5. REASON FOR RECOMMENDATION		
6. SUBMITTER		
a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (if applicable)	7. DATE SUBMITTED (YYMMDD)
B PREPARING ACTIVITY		
a. NAME Technical Point of Contact (TPOC); Mr. Robert Corbitt (SEA 05M3) PLEASE ADDRESS ALL CORRESPONDENCE AS FOLLOWS: ADDRESS (Include Zip Code) Commander, Naval Sea Systems Command Department of the Navy (SEA 55Z3) Washington, DC 20362-5101	b. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON TPOC: 703-602-0145 332-0145	(2) AUTOVON
IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340		