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PERFORMANCE SPECIFICATION

MOUNTS, RESILIENT (SURFACE SHIP APPLICATION)

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

1. SCOPE

1.1 Scope. This specification covers resilient mounts (see 6.4.8) used to support mechanical or electrical equipment for use in surface ship applications internal to the hull. Mounts in accordance with this specification are considered only when mounts contained in S9073-A2-HBK-010, Installation and Inspection Information; Resilient Mount Handbook, cannot meet the requirements of a particular application. This specification is not approved for resilient mounts used on submarines. For submarine applications, see 6.3.

1.2 Classification. The mounts covered by this specification are of the following types, as specified (see 6.2.b):

a. Type I - This mount type has an elastomeric resilient element (see 6.4.11) designed primarily to support shipboard equipment and isolate vibration. Snubbers (see 6.4.12) are supplied as part of the mount to limit excursion of the resilient element due to shock or ship motion. Type I mounts rely on elastomers (see 6.4.4) in compression against metal to provide the strength necessary to restrain supported equipment. The resilient element and snubber encounter very little (if any) tension during shock or ship motion. The 5B5000H and EES series mounts are examples of Type I mounts; refer to S9073-A2-HBK-010.

b. Type II - This mount type has a metallic resilient element and is primarily designed to support shipboard equipment and isolate shock. Type II mounts rely on the strength of a metallic resilient element to restrain mounted equipment during shock or ship motion. Elastomers are sometimes bonded to the metal of this mount type to fine-tune stiffness and provide damping. A high-performance cable mount is an example of a Type II mount.

c. Type III - This mount type integrates a Type I in series with a Type II mount to form a single Type III mount. Typically, the Type I mount provides vibration isolation which snubs during shock, allowing the Type II mount to provide shock isolation. Type III mounts incorporate all the inherent restraining features of Type I and II mounts.

d. Type IV - This mount type has an elastomeric resilient element that is designed to support mounted equipment and primarily isolate shock and sometimes vibration. This mount type relies on the strength of the elastomeric resilient element to restrain mounted equipment during shock and ship motion. Typically, the resilient element experiences a considerable amount of stress due to tension during shock. Type IV mounts are commonly referred to as elastomeric shock mounts. An arch mount and other buckling type mounts are examples of Type IV mounts.

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

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 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 and 4 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-S-901 - Shock Tests, H. I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for

MIL-DTL-1222 - Studs, Bolts, Screws and Nuts for Applications Where a High Degree of Reliability is Required; General Specification for

MIL-S-22698 - Steel Plate, Shapes and Bars, Weldable Ordinary Strength and Higher Strength: Structural

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I – Environmental and Type II – Internally Excited)

MIL-STD-407 - Visual Inspection Guide for Rubber Molded Items

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

AEROSPACE INDUSTRIES ASSOCIATION (AIA)

NASM17828 - Nut, Self-Locking, Hexagon Regular-Height, (Non-Metallic Insert) 250 °F or 450 °F, Nickel-Copper Alloy

NASM17829 - Nut, Self-Locking, Hexagon, Regular Height, 250 °F, Non-Metallic Insert, Non-CRES Steel

NASM25027 - Nut, Self-Locking, 250 °F, 450 °F, and 800 °F

(Copies of these documents are available online at www.aia-aerospace.org.)

ASTM INTERNATIONAL

ASTM A36/A36M - Standard Specification for Carbon Structural Steel

ASTM A105/A105M - Standard Specification for Carbon Steel Forgings for Piping Applications

ASTM A515/A515M - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

ASTM A516/A516M - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service

ASTM A675/A675M	-	Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
ASTM B117	-	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B138/B138M	-	Standard Specification for Manganese Bronze Rod, Bar, and Shapes
ASTM D395	-	Standard Test Methods for Rubber Property – Compression Set
ASTM D412	-	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
ASTM D429	-	Standard Test Methods for Rubber Property – Adhesion to Rigid Substrates
ASTM D471	-	Standard Test Method for Rubber Property – Effect of Liquids
ASTM D573	-	Standard Test Method for Rubber – Deterioration in an Air Oven
ASTM D792	-	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1005	-	Standard Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers
ASTM D1141	-	Standard Practice for the Preparation of Substitute Ocean Water
ASTM D1149	-	Standard Test Methods for Rubber Deterioration – Cracking in an Ozone Controlled Environment
ASTM D2240	-	Standard Test Method for Rubber Property – Durometer Hardness
ASTM D2632	-	Standard Test Method for Rubber Property – Resilience by Vertical Rebound
ASTM D5992	-	Standard Guide for Dynamic Testing of Vulcanized Rubber and Rubber-Like Materials Using Vibratory Methods
ASTM D7091	-	Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

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

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 10846-1	-	Acoustics and Vibration – Laboratory Measurement of Vibro-Acoustic Transfer Properties of Resilient Elements – Part 1: Principles and Guidelines
ISO 10846-2	-	Acoustics and Vibration – Laboratory Measurement of Vibro-Acoustic Transfer Properties of Resilient Elements – Part 2: Direct Method for Determination of the Dynamic Stiffness of Resilient Supports for Translatory Motion
ISO 10846-3	-	Acoustics and Vibration – Laboratory Measurement of Vibro-Acoustic Transfer Properties of Resilient Elements – Part 3: Indirect Method for Determination of the Dynamic Stiffness of Resilient Supports for Translatory Motion

(Copies of these documents are available online at www.iso.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 First article. When specified (see 6.2.c), a sample shall be subjected to first article inspection in accordance with 4.2.

3.2 General design requirements.

3.2.1 Service life. Unless otherwise specified (see 6.2.d), mounts shall be designed to provide a minimum service life of 18 years for mount Types I, II, and III and 12 years for mount Type IV. Mount service life shall be determined from the time the mount is installed and loaded onboard ship and shall include any effects from a prior minimum storage of 7 years for mount Types I, II, and III and 5 years for mount Type IV. In-service environment and age-related changes in the physical properties of mount materials shall be considered. Worst-case manufacturing tolerance (dimensions and performance) shall be taken into consideration when determining service life. In addition to manufacturer analysis of in-house design data, such as fatigue life of the resilient element, results from first article tests shall be used to support a service life determination. Failure to meet any of the following criteria denotes end-of-service life:

a. For all mount types required to isolate vibration (see 6.2.b), dynamic stiffness (see 6.4.2) shall not increase by more than two times the initial stiffness while in-service or by more than 30 percent during the first 5 years of service. Compliance shall be determined by evaluating changes in elastomer properties and mount geometry with time. An assessment of the change in dynamic stiffness due to mount drift shall be included (see 3.2.5, 3.4.5.4, and 6.4.1).

b. Mount Types II, III, and IV shall provide sufficient shock isolation during their service life, allowing no more than the maximum acceleration specified (see 3.4.8.1) to be experienced on mounted equipment during shock. If a maximum acceleration is not specified, no more than a nominal 20-percent increase in acceleration levels is permitted on mounted equipment during shock. Compliance shall be determined by evaluating the time required for an unacceptable decrease in shock isolation capability due to changes in material properties and mount height with time. An evaluation of available shock excursion in the compressive normal (see 6.4.10) direction due to mount drift shall be included (see 3.2.5 and 3.4.8).

c. Snubber gaps for mount Types I and III shall remain within their required clearance throughout the mount service life. Compliance shall be determined by evaluating the time required for snubber gaps to drift outside their required clearance. An assessment of in-service snubber gap clearance using extrapolated drift data shall be included (see 3.2.5 and 3.2.6).

d. There shall be no age-related deterioration on any mount type that may permit damage leading to failure during shock or ship motion during their service life. In addition, mounts shall not have a loss of stiffness that permits the maximum design excursion (see 6.4.7) or maximum permissible mount deflection (when specified, see 3.4.7.2 and 3.4.8.1) to be exceeded during shock or ship motion. Compliance shall be determined by evaluating changes in the resilient element properties over time with regard to endurance and shock requirements (see 3.4.7 and 3.4.8).

e. For mount Types II, III, and IV, the maximum permissible drift (when specified, see 3.2.5) shall not be exceeded during the mount's service life. Compliance shall be determined by evaluating drift data (see 3.2.5).

3.2.2 Captive feature requirements. Shipboard mounting systems shall have captive features that limit the excursion of mounted equipment and prevent the equipment from becoming adrift in any direction, should the elastomeric resilient element of the mount fail during normal operation or non-routine event.

3.2.2.1 Type I mounts. Type I mounts shall incorporate in their design captive features in accordance with 3.2.2. The captive feature can include auxiliary snubbers supplied as part of the mount. Captive feature components shall be constructed of metal and only use elastomeric elements in compression to cushion impact due to shock and ship motion. The required strength of the captive feature shall be dictated by the static strength, endurance, fatigue, and shock requirements contained in this specification (see 3.4.3, 3.4.7, and 3.4.8).

3.2.2.2 Type II mounts. Type II mounts are inherently captive since they utilize a metallic resilient element to support shipboard equipment. The required strength of the mount shall be dictated by the static strength, endurance, fatigue, and shock requirements contained in this specification (see 3.4.3, 3.4.7, and 3.4.8).

3.2.2.3 Type III mounts. Type III mounts shall incorporate all the captive features of a Type I mount integrated with the inherently captive Type II mount. The required strength of the mount's captive feature shall be dictated by the static strength, endurance, fatigue, and shock requirements contained in this specification (see 3.4.3, 3.4.7, and 3.4.8).

3.2.2.4 Type IV mounts. These mounts typically do not have captive features as part of their design. It is the responsibility of the mounting system designer to incorporate captive features that are in accordance with 3.2.2 as part of the shipboard mounting system (see 6.6). Requirements allowing for mounts to interface with captive feature components shall be as specified [see 6.2.e(1)].

3.2.3 Component parts. Mounts shall be serviceable and designed for easy inspection. The use of internal load bearing elements, such as pins or dowels, should be avoided in mount construction. Mounts should be designed so they do not collect liquids or debris (as practical). Compliance shall be verified by inspection (see 4.3.3.1).

3.2.4 Metal-to-metal contact. Mounts shall be designed so there is no rigid metal-to-metal contact between components when captive features are engaged. Compliance shall be verified by inspection (see 4.3.3.1) and to the satisfaction of examination requirements (3.4.1.4.1) when testing finished mounts.

3.2.5 Drift. The mount design and materials chosen shall minimize drift. Mounts shall be subjected to a drift test in accordance with 4.4.2.6, and the data acquired shall be extrapolated to determine compliance with drift related end-of-service life criteria (see 3.2.1). Drift may be nonlinear; data shall be extrapolated using an appropriate mathematical function or graph. Many elastomeric mounts have been successfully extrapolated with a logarithmic or power function. To maintain general alignment or clearance with surrounding structure, the amount of drift beginning from 1 week after loading the mount to the end of the mount's service life shall not exceed the maximum permissible drift [when specified, see 6.2.e(2)]. Mount drift may need to be much lower than the specified value to meet all drift related end-of-service-life criteria.

3.2.6 Snubber clearance. Snubbers, when used, shall be capable of providing clearance within the required range specified [see 6.2.e(3)] during the mount's service life. Unless otherwise specified [see 6.2.e(3)], snubbers shall be adjustable to account for installation and manufacturing dimensional tolerances, permissible tolerance in mount load-deflection performance, mount load range, and variability in predicted drift rate. Nonadjustable snubbers shall only be considered if the required clearance is large and opens with drift. Unless otherwise specified [see 6.2.e(3)], when snubbers are adjustable, they shall be capable of providing a clearance within the required range from 1 week after mount loading and initial adjustment to the end of the mount service life without further adjustment. The snubber design shall allow for easy inspection, adjustment, and measurement of clearance. As a minimum, the clearance requirement shall be verified by evaluating extrapolated drift data (see 3.2.5) with respect to worst-case manufacturing tolerance for mount dimensions and load-deflection performance.

3.3 Material requirements.

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

3.3.2 In-service environment. In addition to meeting requirements for endurance and shock (see 3.4.7 and 3.4.8), chosen mount materials shall meet the following requirements:

a. Immunity to environmental agents: Mount materials shall be resistant to the following detrimental environmental agents: seawater, oil and hydraulic fluid, ozone, radiation, sub-zero storage, and any additional agents, as specified [see 6.2.e(4)]. Elastomers shall be resistant to fungus growth; formulations containing ingredients which promote fungus growth, such as organic additives, should be avoided. Mount materials shall have high ignition temperatures. Elastomers should have low burn rates; self-extinguishing is desirable. Metal components shall be protected from galvanic corrosion resulting from contact with dissimilar metals. Except for tests cited in this specification, technical literature, reliable experience with similar material, historical in-service evidence, or results from tests not included in this specification shall be used to ensure compliance with this requirement.

b. Temperature range: Unless otherwise specified [see 6.2.e(5)], mounts shall be capable of operating over a minimum temperature range of 50 to 125 °F. Mount materials shall have stable properties and performance over this temperature range. Technical literature, reliable experience, historical evidence, or results from testing not included in this specification, such as dynamic stiffness, damping, and load-deflection data at the temperature extremes, shall be used to ensure compliance with this requirement. The nominal ambient in-service temperature specified [see 6.2.e(6)] shall be used to evaluate material aging for service life determination.

3.3.3 Hazardous materials. Materials and products utilized in this specification shall avoid chemicals listed on the Naval Sea Systems Command (NAVSEA) List of Targeted Chemicals (N-LTC). These chemicals pose significant risk to the user, the environment, or both, and are deemed both undesirable and unsustainable by NAVSEA Technical Authority (TA) (see 6.4.13). NAVSEA is minimizing the use of hazardous materials in the design and development of its assets. It is recommended that alternative materials be considered for associated applications, so as to minimize the integration of targeted chemicals in assets called out in this specification. Contact NAVSEA at CommandStandards@navy.mil to receive the most recent hazardous materials list.

3.3.4 Metal components. Unless otherwise specified [see 6.2.e(7)], metal components shall be constructed from steel. Steel shall be manufactured in accordance with military or industry standard specifications. Coatings containing cadmium or hexavalent chromium are prohibited. When specified [see 6.2.e(7)], metal components shall be constructed from non-magnetic (see 6.4.9) metals manufactured in accordance with military or industry standard specifications. Non-magnetic metal components shall be resistant to environmental agents cited in 3.3.2 without painting. Additional requirements for metals and fasteners are provided in 3.3.4.1 through 3.3.4.4 along with examples of metals used successfully in Navy mount construction. While not limited to example metals, it has been found from experience that when mounts are suitably designed and constructed from these metals, they generally have acceptable performance. Compliance shall be verified by inspection (see 4.3.3.1).

3.3.4.1 Steel materials. Electroplated zinc coatings are prohibited on steel with a yield strength of 140 kilo-pounds per square inch (ksi) or higher. Electroplated zinc coatings are prohibited on metal used in mounts designed for operation at 300 °F or higher. The carbon content of steel (plates, bars, rods, and channels) used in mount construction should have a carbon content limited to 0.35 percent maximum and have an elongation of not less than 15 percent. Steel manufactured using the Bessemer process shall not be used. Materials produced from the following specifications have been used successfully in Navy mounts: MIL-S-22698, ASTM A36/A36M, ASTM A105/A105M Grade 2, ASTM A675/A675M Grade 70, ASTM A515/A515M Grade 70, and ASTM A516/A516M Grade 70.

3.3.4.2 Steel fasteners. Fasteners to secure the mount to equipment and foundation shall be manufactured in accordance with NAVSEA approved military or industry standard specifications. Nuts shall be self-locking. Electroplated zinc coatings are prohibited on fasteners with a tensile strength of 150 ksi or higher. Electroplated zinc coatings are prohibited on fasteners used in mounts designed for operation at 300 °F or higher. Grade 5 MIL-DTL-1222 bolts and NASM17829 (NASM25027) self-locking nuts have been used successfully in Navy mounts.

3.3.4.3 Non-magnetic metals. Non-magnetic metals should have an elongation of not less than 15 percent. The following materials have been used successfully in non-magnetic Navy mounts: manganese bronze in accordance with ASTM B138/B138M; Alloy C67000, half hard, hot finish (15 percent minimum elongation); and Alloy C67500, half hard.

3.3.4.4 Non-magnetic fasteners. Fasteners to secure the mount to equipment and foundation shall be non-magnetic and in accordance with NAVSEA approved military or industry standard specifications. Nuts shall be self-locking. MIL-DTL-1222, Grade 500 bolts and NASM17828 (NASM25027) self-locking nuts have been used successfully in Navy mounts constructed of manganese bronze.

3.3.5 Paint. For metal components needing paint, a black marine epoxy paint that resists the environmental agents cited in 3.3.2 shall be used. Metal components of non-magnetic mounts shall not be painted. These requirements shall be verified by inspection (see 4.3.3.1).

3.3.6 Elastomeric materials and coatings. Elastomers and coatings shall meet all requirements of this section or as specified [see 6.2.e(8)]. This section contains general requirements for elastomeric materials and coatings used in all resilient mount types. Formulations can contain natural or manmade materials. Natural rubber (with oil and ozone resistant protective coating) or polymerized chloroprene as the basic material have been used successfully in Navy mount construction. While not limited to these materials, it has been found from experience that when mounts are suitably designed and constructed from these materials, they generally have acceptable performance. The purpose of this section is to provide minimum acceptable requirements and to document properties of the elastomeric compounds used in mount construction.

3.3.6.1 Elastomer protective coatings. A coating may be used to protect elastomeric components from environmental damage (typically from oil and ozone). The coating shall be completely attached to the elastomer and be dry, tack-free, and have no blisters, cracks, breaks, peeling, flaking, or other defects. An oil-ozone resistant coating is required on all parts manufactured from natural rubber. The coating shall cover the metal-to-elastomer bond line and overlap onto the metal component. Refer to 3.3.6.4.1 for physical requirements of the elastomer protective coating.

3.3.6.2 Porosity and delamination mount types I, III, and IV. The elastomeric components of the mount, when tested and examined in accordance with 4.4.2.13, shall not show evidence of porosity in the elastomer or separation of the elastomers into distinct layers or laminations. This requirement does not apply to elastomers used primarily as damping treatments that are not intended to support in-service loads (equipment weight, shock, etc.). The examination requirements of 3.4.1.4.1 do not apply to the porosity and delamination test.

3.3.6.3 Surface condition. There shall be no backrinding, blisters, tears, cracks, or other defects on the outer surfaces of the elastomeric components of the finished mount. If a coating is used, it shall be dry, tack-free, fully attached to the rubber, and not exhibit cracks, breaks, tears, blisters, or flaking.

3.3.6.4 Elastomer physical properties. Unless otherwise specified [see 6.2.e(8)], the physical properties of cured elastomer compounds used in the finished mount shall meet all requirements cited in table I. All tests to measure elastomer properties required by table I are to be conducted on uncoated specimens regardless of whether a coating is used on the finished product. For elastomers that will have a coating on the finished mount, table I does not require ozone resistance and volume change in oil to be measured on uncoated specimens.

TABLE I. Physical requirements for each elastomer compound.

Property	Requirement	Verification method
1. Tensile strength – before aging	Each specimen shall be not less than 80% of the average value measured during first article testing.	4.4.1.1
2. Tensile strength – after aging at 194 °F	Each specimen shall be not less than 85% of the average pre-aged value.	4.4.1.1 4.4.1.3
3. Ultimate elongation – before aging	Each specimen shall be not less than 80% of the average value measured during first article testing.	4.4.1.1
4. Ultimate elongation – after aging at 194 °F	Each specimen shall be not less than 85% of the average pre-aged value.	4.4.1.1 4.4.1.3
5. Compression set (max.) – after oven aging at 194 °F [1/]	35% (max.) for each specimen.	4.4.1.2 4.4.1.3
6. Resilience	Each specimen shall be within 5 points of the average value measured during first article testing.	4.4.1.10
7. Ozone resistance [2/] – after 168 hours at 104 °F with ozone partial pressure of 100 mPa	No cracks.	4.4.1.7
8. Volume change in oil – after immersion in oil at 73 °F for 46 hours [2/]	15% (max.).	4.4.1.4
9. Adhesion of rubber-to-metal	Each specimen shall be not less than 80% of the value measured during first article testing. The specimen shall fail 100% cohesively.	4.4.1.5
10. Hardness	Each specimen shall be within 5 points of the average value measured during first article testing.	4.4.1.8
11. Specific gravity	Each specimen shall be within 0.02 of the average specific gravity value (a dimensionless unit) measured during first article testing.	4.4.1.9

NOTES:

1/ Not required for the snubber elastomer.

2/ Not required for elastomers that will have an environment-resistant coating. These property requirements are addressed in table II for coated elastomers.

3.3.6.4.1 Physical properties for the elastomer protective coating, if used. If an environment-resistant coating is used, the physical properties of the cured elastomer and coating shall meet all requirements cited in table II.

TABLE II. Physical requirements for each elastomer coating.

Properties of coated elastomer specimens		
Property	**Requirement**	**Verification method**
1. Volume change in oil – after immersion in oil at 158 °F for 70 hours 1/	5% (max.).	4.4.1.4
2. Adhesion of coating – before immersion in oil 1/	No failures in both cases; the coated specimens shall not exhibit cracks, debonding, breaks, tears, or peeling either before or after immersion in oil when flexed by hand.	4.4.1.6
3. Adhesion of coating – after immersion in oil at 158 °F 1/		
4. Ozone resistance – after 1 week at 104 °F in air containing ozone 1/	No cracks.	4.4.1.7
Dried film coating properties		
Property	**Requirement**	**Verification method**
5. Tensile strength 2/	Not less than 75% of the average value measured during first article testing.	4.4.1.1
6. Elongation at break 2/	Not less than 75% of the average value measured during first article testing.	4.4.1.1
Properties of the coated mount		
Property	**Requirement**	**Verification method**
7. Appearance 3/	Shall be dry, tack-free, and free from cracks, breaks, tears, blisters, flaking, and other imperfections.	4.3.3.1 [table XIII (106)]
8. Film thickness (min.) – on elastomeric elements as measured on coated metal 3/	Not less than the thickness measured during first article testing.	4.4.2.12

NOTES:
1/ Pertain to elastomer specimens with their coating applied.
2/ Applicable to specimens of the coating only.
3/ Pertain to the coating when applied to the finished mount.

3.4 Performance, visual inspection, and dimensional requirements for finished mounts.

3.4.1 Visual inspection and dimensional compliance.

3.4.1.1 Geometry and interface. The mount shall not occupy more volume (length, height, and width) than identified [see 6.2.e(9)]. Interface requirements, such as bolt pattern, shall be as indicated [see 6.2.e(9)].

3.4.1.2 Drawing compliance. All components of the resilient mount shall be formed into shape and finished according to dimensions, tolerances, and materials specified in the applicable manufacturer drawing(s). All mount materials shall be manufactured in accordance with the appropriate specification. The drawing shall reference manufacturer specifications for elastomer formulations and include industry or military specifications for metals and other standard mount materials.

3.4.1.3 Identification. Each mount, including non-integral components such as auxiliary snubbers, shall be permanently marked with the following information:

a. Mount type and this specification (example: Type I, MIL-PRF-32407).

b. Manufacturer's name or identification code.

c. Manufacturer's unique model or part number.

d. The elastomer mold date (quarter, year) and lot number (example: 3Q10#1). For mounts containing only metallic resilient elements, manufacture date (quarter, year) and lot number shall be permanently marked.

e. If mount parts are fabricated from non-magnetic materials, "NM" shall directly precede the mount type. If a component is too small to mark, a separate label shall be provided.

3.4.1.4 Visual examination of mounts. Mounts shall not exhibit defects when inspected in accordance with 4.3.3.1.

3.4.1.4.1 General examination requirements for mount tests. In addition to specific performance requirements for each verification test, the mount shall also meet the inspection criteria in this section during and after each test listed in 4.4.2, except as noted in the porosity requirements section (see 3.3.6.2).

a. The elastomer and any environment-resistant coating applied shall exhibit no damage, such as cracks, breaks, tears, splits, gouges, delamination, or blisters. In addition, if a protective coating is used, it shall remain attached to the elastomer and not exhibit defects, such as peeling or flaking. Minor localized imperfections may be permitted during resistance to oil and strength tests.

b. Mount parts, metal or otherwise, shall show no evidence of damage or deterioration, such as corrosion, breaks, yielding, fractures, or cracks. Minor yielding of metal components may be permitted during shock tests. There shall be no evidence of metal-to-metal contact.

c. There shall be no debonding or separation between parts.

d. There shall be no visual damage that would indicate a possible loss in mount performance. Mounts shall recover to their original shape and shall be without distortion after completion of each test. Minor deviation in dimensions may be permitted after shock and endurance tests. Snubbers shall be within their specified clearance (see 3.2.6).

3.4.2 Load-deflection characteristics. Requirements in this section address mount load criteria including uniformity with respect to an acceptable variation in load-deflection characteristics. The mount shall be designed to support intended loads (see 6.4.5) within the range specified [see 6.2.f(1)(a)]. Unless otherwise specified [see 6.2.f(1)(b)], the acceptable variation in load-deflection characteristics for a mount shall be as cited in 3.4.2.1 and 3.4.2.2. Unless otherwise specified [see 6.2.f(1)(c)], the following criteria pertains to load-deflection measured during first article inspection directly subsequent to each endurance test (see 4.2.2.1 and 4.2.2.5); the load at each deflection shall be within 15 percent of the value measured during the initial characterization test for that same mount when tested at equivalent conditions. All other changes in load-deflection performance between first article initial characterization and subsequent tests (see 4.2.2.2 through 4.2.2.4) for a particular mount shall be negligible (within 5 percent).

3.4.2.1 Low load-deflection. Unless otherwise specified [see 6.2.f(1)(b)], when the mount is tested in a particular direction in accordance with 4.4.2.1, the load at each deflection shall be within 15 percent for mount Type I and 10 percent for mount Types II, III, and IV of the characteristic load-deflection curve . If characteristic load-deflection curves are not provided, then they shall be developed by averaging first article initial characterization tests (see 4.2.2.1 through 4.2.2.5) in the following manner. For each direction, a characteristic low load-deflection curve shall be developed by averaging the load measured at each deflection from all first article initial characterization tests. If a maximum deflection at the maximum intended load is specified [see 6.2.f(1)(d)], this deflection shall not be exceeded at that load when a mount is tested in accordance with 4.4.2.1.2.

3.4.2.2 High load-deflection, mount types II, III, and IV. Unless otherwise specified [see 6.2.f(1)(b)], when tested in accordance with 4.4.2.2, the load at each deflection for the fourth loading cycle shall be within 10 percent of the characteristic load-deflection curve . If characteristic load-deflection curves are not provided, then they shall be developed by averaging first article initial characterization tests (see 4.2.2.1 through 4.2.2.5) in the following manner. For each direction, a characteristic high load-deflection curve shall be developed by averaging the load measured at each deflection from all first article initial characterization tests. If a maximum deflection at the maximum intended load is specified [see 6.2.f(1)(d)], this deflection shall not be exceeded at that load when a mount is tested in accordance with 4.4.2.2.2.a.

3.4.3 Static strength.

3.4.3.1 Static strength, mount type I. When tested in accordance with 4.4.2.3.1, the mount shall meet the visual inspection requirements of 3.4.1.4.1. Unless otherwise specified [see 6.2.f(1)(e)], "Level A" and "Level B" loads referenced in 4.4.2.3.1 shall be in accordance with figure 3. Unless otherwise specified [see 6.2.f(1)(f)], when tested in accordance with 4.4.2.3.1, the load at each deflection for fourth cycle data shall be within 15 percent of the average load measured during first article initial characterization tests (see 4.2.2.1 through 4.2.2.5).

3.4.3.2 Static strength, mount types II, III, and IV. When tested in accordance with 4.4.2.3.2, the mount shall meet the visual inspection requirements of 3.4.1.4.1. All load-deflection data acquired shall generate smooth curves free from sudden drops in load or other anomalies indicative of the onset of failure.

3.4.4 Quality of metal-to-elastomer bond.

3.4.4.1 Quality of metal-to-elastomer bond, mount type I. When tested in accordance with 4.4.2.4.1, the mount shall meet the requirements of 3.4.1.4.1. Special attention shall be given to the elastomer-to-metal interface; there shall be no evidence of breaks, cracks, tears, or delamination at the bond interface.

3.4.4.2 Quality of metal-to-elastomer bond, mount types II, III, and IV. When tested in accordance with 4.4.2.4.2, the mount shall meet the requirements of 3.4.1.4.1. Special attention shall be given to bonded elastomer-to-metal interfaces; there shall be no evidence of breaks, cracks, tears, bulges, or delamination at the bond interface. This test is not required for Type II mounts that do not contain elastomeric material bonded to metal components.

3.4.5 Vibration isolation. Requirements in this section do not apply to Type II and IV mounts that are needed to only isolate shock and not vibration (see 6.2.b).

3.4.5.1 Dynamic stiffness. Dynamic stiffness (see 6.4.2) of each mount in the compressive normal and transverse (see 6.4.14) directions shall be within the range specified [see 6.2.f(2)(a)] when tested in accordance with 4.4.2.5. Unless otherwise specified [see 6.2.f(2)(b)], the following exceptions are applicable to subsequent tests conducted during first article testing. Dynamic stiffness measured during first article inspection subsequent to each endurance test (see 4.2.2.1 and 4.2.2.5) shall be within 15 percent of the value measured during initial characterization tests for that same mount when tested at equivalent conditions. All other changes in dynamic stiffness between first article initial characterization and subsequent tests for a particular mount shall be negligible (within 5 percent). Unless otherwise specified [see 6.2.f(2)(c)], test conditions shall be in accordance with 4.4.2.5. Dynamic stiffness measured during initial characterization tests shall be within the range specified [see 6.2.f(2)(a)].

3.4.5.2 Damping. Loss factor (see 6.4.6) in the compressive normal and transverse directions of each mount shall be within the range specified [see 6.2.f(2)(a)] when tested in accordance with 4.4.2.5. Unless otherwise specified [see 6.2.f(2)(b)], the following exceptions are applicable to subsequent tests conducted during first article testing. Loss factor measured during first article inspection subsequent to each endurance test (see 4.2.2.1 and 4.2.2.5) shall be within 25 percent of the value measured during initial characterization tests for that same mount when tested at equivalent conditions. All other changes in loss factor between first article initial characterization and subsequent tests for a particular mount shall be negligible (within 10 percent). Unless otherwise specified [see 6.2.f(2)(c)], test conditions shall be in accordance with 4.4.2.5. Loss factor measured during initial characterization tests shall be within the range specified [see 6.2.f(2)(a)].

3.4.5.3 High-frequency complex dynamic stiffness. When required [see 6.2.f(2)(d)], the complex dynamic stiffness (see 6.4.3) shall be measured in accordance with 4.4.2.5.2 within the frequency range specified [see 6.2.f(2)(e)]. When tested at the maximum and minimum intended load [see 6.2.f(1)(a)], the complex dynamic stiffness shall meet the criteria provided [see 6.2.f(2)(f)]. Unless otherwise specified [see 6.2.f(2)(g)], complex dynamic stiffness (both real and imaginary components) shall be measured and recorded in the normal direction only.

3.4.5.4 Dynamic stiffness vs. mount height. After completion of the drift test, dynamic stiffness and damping shall be measured as a function of mount height in accordance with 4.4.2.6.1 to aid in determining the vibration isolation service life of the mount (see 3.2.1.a). Extrapolated drift data shall be used to project mount height as a function of time (see 3.2.5). Measured dynamic stiffness at various mount heights that simulate drift shall be used to determine the increase in dynamic stiffness due to change in mount geometry over time.

3.4.6 Cold storage. Mounts shall be capable of being stored in less than 0 °F temperatures while awaiting installation without damage or loss of in-service performance. After mounts are subjected to a cold storage test in accordance with 4.4.2.11, they shall meet visual inspection requirements of 3.4.1.4.1 and requirements associated with subsequent tests of 4.2.2.3, test suite three.

3.4.7 Endurance. In addition to meeting the requirements of 3.4.7.1 and 3.4.7.2, which may simulate extreme conditions, the mount shall be designed to operate while exposed to routine in-service cyclical loads for the annual durations specified [see 6.2.f(3)(a)] while supporting their intended (static) load. These loads and durations shall not adversely affect performance of the mount during its service life (see 3.2.1). This requirement shall be complied with by analysis of fatigue data. This may include evaluating the fatigue resistance of the elastomeric resilient element by conducting fatigue tests on bonded specimens or reduced scale mounts. For some materials, such as metal, information to demonstrate fatigue life may be readily available in technical literature.

3.4.7.1 Vibration endurance. Mounts shall meet visual inspection requirements of 3.4.1.4.1 and requirements associated with subsequent tests contained in test suite five (see 4.2.2.5), after being tested in accordance with 4.4.2.7.1. Unless otherwise specified [see 6.2.f(3)(b)], the test method for mount Types II, III, and IV shall be resonant in accordance with 4.4.2.7.1.1, and the test method for mount Type I shall be non-resonant in accordance with 4.4.2.7.1.2. The following additional requirement is relevant to the resonance test method.

a. Resonance test. Mounts shall have sufficient damping at each translational resonance to provide an amplification not greater than specified [see 6.2.f(3)(c)] when tested in accordance with 4.4.2.7.1.1. Unless otherwise specified in the test plan [see 6.2.f(3)(d)], mounts shall be tested with their intended equipment.

3.4.7.2 Ship motion endurance. Mounts shall meet visual inspection requirements of 3.4.1.4.1 and requirements associated with subsequent tests contained in test suite one (see 4.2.2.1), after being tested in accordance with 4.4.2.7.2 at the loads, period, and number of cycles specified in each test case [see 6.2.f(3)(e)]. Unless otherwise specified [see 6.2.f(3)(f)], the loading method shall be in accordance with 4.4.2.7.2.1. For mount Types II, III, and IV, when the mount is subjected to loads associated with any cycles in any test case, the resulting deflections shall not exceed the mount's maximum design excursion. If a maximum mount deflection is specified [see 6.2.f(3)(g)] in a particular direction, it shall not be exceeded as a result of loading the mount in accordance with 4.4.2.7.2.1. If the maximum deflection permitted by a shipboard captive feature is specified [see 6.2.f(3)(g)] in a particular direction, it is not required to exceed the deflection in that direction when tested in accordance with 4.4.2.7.2.1.

3.4.8 High impact shock. Mounts shall meet the visual inspection requirements of 3.4.1.4.1 and the requirements associated with subsequent tests specified in test suite four (see 4.2.2.4) after being tested in accordance with the specified shock test procedure [see 6.2.f.(4)(a)]. If MIL-S-901 or similar shock test procedure is specified, supplementary requirements are provided in 3.4.8.1.

3.4.8.1 MIL-S-901 or similar shock test procedure. Testing shall be in accordance with the specified MIL-S-901 classifications [see 6.2.f(4)(b)]. When the maximum acceleration on the equipment side of the mount is specified [see 6.2.f(4)(c)], it shall not be exceeded when the mounts are tested in accordance with the specified shock test procedure. For mount Types II, III, and IV, the maximum design deflection of the mount shall not be exceeded when tested in accordance with the specified procedure. In addition, if a maximum permissible mount deflection is specified [see 6.2.f(4)(d)] in a particular direction, that deflection shall not be exceeded when tested in accordance with the specified procedure. Supplementary measurement requirements are provided in 4.4.2.8.

3.4.9 Resistance to salt spray. After mounts are subjected to a salt spray test in accordance with 4.4.2.9, they shall meet visual inspection requirements of 3.4.1.4.1 and requirements associated with subsequent tests of 4.2.2.2, test suite two.

3.4.10 Resistance to oil. Mounts shall be resistant to damage by oil. After mounts are subjected to an oil immersion test in accordance with 4.4.2.10, they shall meet visual inspection requirements of 3.4.1.4.1 and requirements associated with subsequent tests of 4.2.2.2, test suite two.

3.4.11 Tension until failure, mount type IV. When tested in accordance with 4.4.2.14, the failure mode shall be 100 percent elastomer. Inconsistent failure mode between production lots and first article testing shall be investigated. The load on the mount prior to any sign of damage shall exceed 1.5 times the load corresponding to the maximum design deflection in tension.

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).

4.2 First article inspection. Unless otherwise specified (see 3.1), first article inspection shall be performed on elastomer specimens and finished mounts when a first article sample is required. This inspection shall be in accordance with the test plan specified (see 6.2.c). Unless otherwise indicated in the test plan, inspection shall include the tests in 4.2.1 through 4.2.2.5. Mounts subjected to first article inspection shall not be offered in accordance with this specification.

4.2.1 First article inspection of mount elastomers. For mounts containing elastomers, specimens described in table III shall be produced from each batch of elastomer stock (and coating, if used) that is mixed for the manufacture of all first article test mounts. The manufacturer shall certify that the specimens are of the same material and equivalent cure as the corresponding first article test mounts. These specimens shall be tested in accordance with 4.2.1.1 and 4.2.1.2.

TABLE III. Elastomer and protective coating specimens for first article tests.

Quantity per compound	Component containing compound	Specimen description	Size of specimen (inches)	Property to be measured
6	Resilient element, snubber	ASTM D412, Die C specimen cut from an uncoated sheet	0.08±0.01 x 6 x 6	Tensile strength and ultimate elongation (initial & aged), specific gravity
3	Resilient element, snubber	1/	0.08±0.01 x 1 x 2	Resistance to oil (volume change) and for coated specimens, adhesion to elastomer
2	Resilient element, snubber	1/	0.08±0.01 x 1 x 6	Ozone resistance
3	Resilient element, snubber	ASTM D429, Method A specimen, uncoated	-------	Elastomer-metal adhesion
3	Resilient element	Cylinder, uncoated	0.50±0.02 height x 1.14±0.02 diameter	Compression set
3	Resilient element, snubber	Cylinder, uncoated	0.50±0.02 height x 1.14±0.02 diameter	Hardness then resilience
1	Resilient element, snubber (protective coating)	ASTM D412, Die C specimen cut from sheet of dried film coating	t±0.3t x 6 x 6 2/	Tensile strength and ultimate elongation

NOTES:

1/ If an environment-resistant coating is used on the elastomeric component of the finished mount, then these test specimens shall be coated with that protective coating. Coating thickness shall be equivalent to that used on the finished product. If a protective coating is not used, then these test specimens shall remain uncoated.

2/ Where "t" is the coating thickness of the finished elastomeric mount component.

4.2.1.1 First article verification tests on elastomer specimens. The uncoated elastomer specimens described in table III shall be subjected to the tests specified in table IV. If any specimens tested fail to meet any requirement, all mounts manufactured for first article tests from elastomer batches represented by that specimen shall be rejected.

TABLE IV. First article tests on elastomer specimens.

Property	Verification method	Requirement
1. Initial tensile strength	4.4.1.1	3.3.6.4 (table I, no. 1)
2. Initial ultimate elongation	4.4.1.1	3.3.6.4 (table I, no. 3)
3. Tensile strength after oven aging	4.4.1.1, 4.4.1.3	3.3.6.4 (table I, no. 2)
4. Ultimate elongation after oven aging	4.4.1.1, 4.4.1.3	3.3.6.4 (table I, no. 4)
5. Compression set after oven aging 1/	4.4.1.2, 4.4.1.3	3.3.6.4 (table I, no. 5)
6. Hardness	4.4.1.8	3.3.6.4 (table I, no. 10)
7. Resistance to oil 2/	4.4.1.4	3.3.6.4 (table I, no. 8)

TABLE IV. First article tests on elastomer specimens – Continued.

Property	Verification method	Requirement
8. Ozone resistance 2/	4.4.1.7	3.3.6.4 (table I, no. 7)
9. Adhesion to metal	4.4.1.5	3.3.6.4 (table I, no. 9)
10. Specific gravity	4.4.1.9	3.3.6.4 (table I, no. 11)
11. Resilience	4.4.1.10	3.3.6.4 (table I, no. 6)

NOTES:

1/ This test is not required for the snubber elastomer.

2/ This test is replaced by the corresponding test in table V when a protective coating is used.

4.2.1.2 First article verification tests on elastomer protective coating (if used). If an environment-resistant coating is used, the dried film and coated specimens specified in table III shall be subjected to the verification tests specified in table V. If any specimens tested fail to meet any requirements, all mounts manufactured for first article tests that utilize the protective coating shall be rejected.

TABLE V. First article tests on elastomer protective coating.

Properties of dried film		
Property	**Verification method**	**Requirement**
1. Tensile strength of dried film	4.4.1.1	3.3.6.4.1 (table II, no. 5)
2. Ultimate elongation of dried film	4.4.1.1	3.3.6.4.1 (table II, no. 6)
Properties of coated specimens		
Property	**Verification method**	**Requirement**
3. Oil resistance of coated elastomer specimen	4.4.1.4	3.3.6.4.1 (table II, no. 1)
4. Adhesion of coating	4.4.1.6	3.3.6.4.1 (table II, no. 2, 3)
5. Ozone resistance of coated elastomer specimen	4.4.1.7	3.3.6.4.1 (table II, no. 4)

4.2.2 First article inspection and tests on finished mounts. If elastomer specimens meet all requirements associated with first article tests in 4.2.1 (or mounts are Type II and do not contain elastomeric material), finished mounts shall be subjected to first article testing to determine compliance with this specification. Unless otherwise specified (see 6.2.c), mounts shall be subjected to first article tests comprised of five test suites (see 4.2.2.1 through 4.2.2.5). Approximately 15 finished mounts are required for first article testing; this number is an estimate based on test suite one requiring one mount, test suite three requiring two mounts, and test suites two, four, and five each requiring four mounts. Quantities may differ depending on changes to first article test requirements (see 6.2.c) and the number of mounts required for shock and vibration endurance testing [see 6.2.f(4)(a) and 6.2.f(3)(d)]. Also, at the discretion of the manufacturer, mounts may be subjected to multiple test suites. For example, mounts that have undergone test suite five may also undergo test suite four in its entirety.

a. When specified [see 6.2.f(3)(d) and 6.2.f(4)(a)], high-impact shock (test 5, table IX) and vibration endurance (test 5, table X) tests shall be conducted with mounts supporting their intended equipment. This shall be specified when it is beneficial to combine the same tests required for mounts and equipment. Combining tests does not eliminate the need to conduct all tests in each test suite or to meet all requirements in this specification.

b. Refer to 4.4.2 for general guidance and requirements for testing finished mounts. Detailed requirements with corresponding verification tests are referenced in each test suite. If any finished mount fails to meet any requirement, it shall constitute cause for rejection. Offering any of the specific mounts that have been subjected to first article testing in accordance with this specification shall be prohibited.

c. In addition to conducting first article tests, it shall be demonstrated via analytical evidence that the following requirements have been met (see 6.7): service life (see 3.2.1), fatigue (see 3.4.7), in-service environment (see 3.3.2), and hazardous materials (see 3.3.3).

4.2.2.1 Mount test suite one. One mount shall be subjected to the tests in table VI in the sequential order indicated. Unless otherwise indicated in the table, each test shall be conducted on all mount types.

TABLE VI. Test suite one.

Initial characterization tests	**Requirement**	**Verification method**
1. Examination	3.4.1	4.3.3.1
2. Protective coating thickness and condition Perform on mounts with elastomers that have a coating	3.3.6.4.1 (table II, no. 7 & no. 8)	4.3.3.1 [table XIII (106)] & 4.4.2.12
3. Low load-deflection, dynamic stiffness, and damping at the maximum intended load, in the normal direction 1/	3.4.2 (3.4.2.1) & 3.4.5 (3.4.5.1 & 3.4.5.2)	4.4.2.1 (4.4.2.1.2) & 4.4.2.5 (table XVI, LF-3)
4. High load-deflection, along the normal axis Perform on mount Types II, III, & IV	3.4.2 (3.4.2.2)	4.4.2.2 (4.4.2.2.2)
5. Strength test, along the normal axis, all cycles to Level A Perform on mount Type I	3.4.3.1	4.4.2.3.1 (4.4.2.3.1.1)
Ship motion test	**Requirement**	**Verification method**
6. Ship motion endurance	3.4.7.2	4.4.2.7.2
Subsequent tests	**Requirement**	**Verification method**
7. Low load-deflection, dynamic stiffness, and damping at the maximum intended load, in the normal direction 1/	3.4.2 (3.4.2.1) & 3.4.5 (3.4.5.1 & 3.4.5.2)	4.4.2.1 (4.4.2.1.2) & 4.4.2.5 (table XVI, LF-3)
8. High load-deflection, along the normal axis Perform on mount Types II, III, & IV	3.4.2 (3.4.2.2)	4.4.2.2 (4.4.2.2.2)
9. Strength test, along the normal axis	3.4.3	4.4.2.3

NOTE:
1/ This test is not required for Type II and IV mounts intended to only isolate shock and not vibration (see 6.2.b).

4.2.2.2 Mount test suite two. Four mounts shall be subjected to the tests in table VII in the sequential order indicated. The two mounts undergoing the resistance to oil test shall be paired for all tests requiring two mounts. Similarly, the two mounts undergoing the salt spray test shall be paired for all tests requiring two mounts. Unless otherwise indicated in the table, each test is to be conducted on all mount types and all four mounts.

TABLE VII. Test suite two.

Initial characterization tests	**Requirement**	**Verification method**
1. Examination	3.4.1	4.3.3.1
2. High-frequency complex dynamic stiffness If required [see 6.2.f(2)(d)], perform on any one mount or one pair if transverse testing is specified [see 6.2.f(2)(g)] 1/	3.4.5.3	4.4.2.5.2
3. Low load-deflection, dynamic stiffness, and damping, in all directions 1/	3.4.2 (3.4.2.1) & 3.4.5 (3.4.5.1 & 3.4.5.2)	4.4.2.1 & 4.4.2.5 (table XVI, LF-1 through LF-4)
4. High load-deflection, in all directions Perform on mount Types II, III, & IV	3.4.2 (3.4.2.2)	4.4.2.2
5. Strength test, in all directions, all cycles to Level A Perform on mount Type I	3.4.3.1	4.4.2.3.1
Salt spray and oil tests	**Requirement**	**Verification method**
6a. Salt spray (two mounts)	3.4.9	4.4.2.9
6b. Resistance to oil (two mounts)	3.4.10	4.4.2.10
Subsequent tests	**Requirement**	**Verification method**
7. Low load-deflection, dynamic stiffness, and damping at the maximum intended load, in all directions 1/	3.4.2 (3.4.2.1) & 3.4.5 (3.4.5.1 & 3.4.5.2)	4.4.2.1 & 4.4.2.5 (table XVI, LF-1 through LF-4)
8. High load-deflection, in all directions Perform on mount Types II, III, & IV	3.4.2 (3.4.2.2)	4.4.2.2
9. Strength test, in all directions	3.4.3	4.4.2.3

NOTE:
1/ This test is not required for Type II and IV mounts intended to only isolate shock and not vibration (see 6.2.b).

4.2.2.3 Mount test suite three. Two of the mounts provided for first article inspection shall be subjected to the tests in table VIII in the sequential order indicated. Unless otherwise indicated in the table, each test is to be conducted on all mount types and both mounts.

TABLE VIII. Test suite three.

Initial characterization tests	**Requirement**	**Verification method**
1. Examination	3.4.1	4.3.3.1
2. Low load-deflection, dynamic stiffness, and damping at the maximum intended load, in the normal direction 1/	3.4.2 (3.4.2.1) & 3.4.5 (3.4.5.1 & 3.4.5.2)	4.4.2.1 (4.4.2.1.2) & 4.4.2.5 (table XVI, LF-3)
3. High load-deflection, along the normal axis Perform on mount Types II, III, & IV	3.4.2 (3.4.2.2)	4.4.2.2 (4.4.2.2.2)
4. Strength test, along the normal axis, all cycles to Level A Perform on mount Type I	3.4.3.1	4.4.2.3.1 (4.4.2.3.1.1)
Drift and cold storage tests	**Requirement**	**Verification method**
5a. Drift and dynamic stiffness vs. height (mount one of the two)	3.2.5 & 3.4.5.4	4.4.2.6 & 4.4.2.6.1
5b. Cold storage (mount two of the two)	3.4.6	4.4.2.11
Subsequent tests	**Requirement**	**Verification method**
6. Low load-deflection, dynamic stiffness, and damping at the maximum intended load, in the normal direction 1/	3.4.2 (3.4.2.1) & 3.4.5 (3.4.5.1 & 3.4.5.2)	4.4.2.1 (4.4.2.1.2) & 4.4.2.5 (table XVI, LF-3)
7. High load-deflection, along the normal axis Perform on mount Types II, III, & IV	3.4.2 (3.4.2.2)	4.4.2.2 (4.4.2.2.2)
8. Strength test, along the normal axis (mount two of two)	3.4.3	4.4.2.3
9. Porosity and delamination Perform on mount Types I, III, & IV (mount one of the two)	3.3.6.2	4.4.2.13
10. Tension until failure (mount two of two)	3.4.11	4.4.2.14
NOTE: 1/ This test is not required for Type II and IV mounts intended to only isolate shock and not vibration (see 6.2.b).		

4.2.2.4 Mount test suite four. Mounts shall be subjected to shock (test 5, table IX) and associated initial and subsequent tests as indicated in test suite four. Mount quantities required for testing shall be as specified in the shock test procedure [see 3.4.8 and 6.2.f(4)(a)]. Unless otherwise indicated in the table, each test is to be conducted on all mount types.

TABLE IX. Test suite four.

Initial characterization tests	**Requirement**	**Verification method**
1. Examination	3.4.1	4.3.3.1
2. High load-deflection, in all directions Perform on mount Types II, III, & IV 1/	3.4.2 (3.4.2.2)	4.4.2.2
3. Low load-deflection, dynamic stiffness, and damping, in all directions 1/ 2/	3.4.2 (3.4.2.1) & 3.4.5 (3.4.5.1 & 3.4.5.2)	4.4.2.1 & 4.4.2.5 (table XVI, LF-1 through LF-5)
4. Strength test, in all directions, all cycles to Level A Perform on mount Type I 1/	3.4.3.1	4.4.2.3.1
Shock test	**Requirement**	**Verification method**
5. Shock test	3.4.8 (& 3.4.8.1, when applicable)	6.2.f(4)(a) (& 4.4.2.8, when applicable)
6. Examination, all mounts that underwent shock test	3.4.1(3.4.1.4.1)	visual examination
Subsequent tests	**Requirement**	**Verification method**
7. High load-deflection, in all directions 1/ Perform on mount Types II, III, & IV	3.4.2 (3.4.2.2)	4.4.2.2
8. Low load-deflection, dynamic stiffness, and damping, in all directions 1/ 2/	3.4.2 (3.4.2.1) & 3.4.5 (3.4.5.1 & 3.4.5.2)	4.4.2.1 & 4.4.2.5 (table XVI, LF-1 through LF-4)
9. Strength test, in all directions 1/	3.4.3	4.4.2.3

NOTES:

1/ Perform on a minimum of two mounts, as specified in the shock test procedure [see 3.4.8 and 6.2.f(4)(a)].

2/ Not required for Type II and IV mounts intended to only isolate shock and not vibration (see 6.2.b).

4.2.2.5 Mount test suite five. Mounts shall be subjected to vibration endurance (test 5, table X) and associated initial and subsequent tests as indicated in test suite five. Mount quantities shall be as specified by the vibration endurance test procedure [see 4.4.2.7.1 and 6.2.f(3)(d)]. Unless otherwise indicated in the table, each test is to be conducted on all mount types.

TABLE X. Test suite five.

Initial characterization tests	**Requirement**	**Verification method**
1. Examination	3.4.1	4.3.3.1
2. Low load-deflection, dynamic stiffness, and damping, in all directions 1/ 2/	3.4.2 (3.4.2.1) & 3.4.5 (3.4.5.1 & 3.4.5.2)	4.4.2.1 & 4.4.2.5 (table XVI, LF-1 through LF-5)
3. High load-deflection, in all directions Perform on mount Types II, III, & IV 2/	3.4.2 (3.4.2.2)	4.4.2.2
4. Strength test, in all directions, all cycles to Level A Perform on mount Type I 2/	3.4.3.1	4.4.2.3.1
Vibration endurance test	**Requirement**	**Verification method**
5. Vibration endurance	3.4.7.1	4.4.2.7.1
6. Examination, all mounts that underwent vibration endurance test	3.4.1 (3.4.1.4.1)	visual examination
Subsequent tests	**Requirement**	**Verification method**
7. Low load-deflection, dynamic stiffness, and damping, in all directions 1/ 2/	3.4.2 (3.4.2.1) & 3.4.5 (3.4.5.1 & 3.4.5.2)	4.4.2.1 & 4.4.2.5 (table XVI, LF-1 through LF-4)
8. High load-deflection, in all directions 2/ Perform on mount Types II, III, & IV	3.4.2 (3.4.2.2)	4.4.2.2
9. Strength test, in all directions 2/	3.4.3	4.4.2.3

NOTES:

1/ This test is not required for Type II and IV mounts intended to only isolate shock and not vibration (see 6.2.b).

2/ Perform on a minimum of two mounts as specified in the vibration endurance test procedure [see 4.4.2.7.1 and 6.2.f(3)(d)].

4.3 Conformance inspection. A conformance inspection shall be performed on each production lot for mount designs that have received a letter of first article compliance from NAVSEA (see 6.7) and are being offered in accordance with this specification. This inspection shall be in accordance with the test plan specified (see 6.2.g). Unless otherwise indicated in the test plan, inspection shall include the tests contained herein. Tests and examinations specified are intended to supplement and not replace production and process inspections normally conducted by the manufacturer. For example, strength and elongation requirements in table I are in addition to minimum values for these properties imposed by the mount manufacturer to meet performance requirements of the finished mount.

4.3.1 Lot. For the purpose of sampling for conformance inspection, a lot shall contain all mounts produced at the same time in the same facility under the same conditions with the same batch of elastomer (if used). All mounts shall be manufactured using the exact same materials, elastomer formulations, and manufacturing processes as those produced for first article testing. A lot serial number shall be assigned to the mounts and shall not be repeated in any one quarter. The lot serial number with elastomer cure date (quarter, year) or manufacture date (for metallic mounts) shall be traceable to the elastomer batch number(s), manufacturing/process control records, and conformance documentation. The lot serial number along with cure or manufacture date shall be permanently marked on each mount (see 3.4.1.3) and be included on all shipping documents, packages, and shipping containers.

4.3.2 Conformance inspection of mount elastomers. The specimens identified in table XI shall be prepared from each elastomer batch for each mount lot produced and tested as indicated in table XI and table XII. While only these tests are specified, it does not dismiss the manufacturer from meeting all requirements of 3.3.6. The elastomer test specimens shall be made with the same material and equivalent cure as used in the lot of finished mounts. All mounts in the lot fabricated from the same batch of elastomer shall be rejected if any test specimen from that batch does not meet the requirements.

TABLE XI. Elastomer specimens for conformance tests.

Quantity per compound	Compound in component	Specimen description	Size of specimen (inches)	Property to be measured
3	Resilient element, snubber	ASTM D412, Die C specimen cut from an uncoated sheet	0.08±0.01 x 6 x 6	Tensile strength and ultimate elongation, specific gravity
3	Resilient element, snubber	Cylinder, uncoated	0.50±0.02 height x 1.14±0.02 diameter	Hardness and resilience
3	Resilient element, snubber (mount Type IV)	ASTM D429, Method A specimen	-------	Elastomer metal adhesion

4.3.2.1 Conformance verification tests on elastomer specimens. Unless otherwise specified (see 6.2.g), the specimens as described in table XI shall be subjected to the tests in table XII. The adhesion to metal test is not required for elastomers on Type I, II, and III mounts.

TABLE XII. Conformance tests on elastomer specimens.

Property	Requirement	Verification method
Tensile strength	3.3.6.4 (table I, no. 1)	4.4.1.1
Ultimate elongation	3.3.6.4 (table I, no. 3)	4.4.1.1
Specific gravity	3.3.6.4 (table I, no. 11)	4.4.1.9
Hardness	3.3.6.4 (table I, no. 10)	4.4.1.8
Resilience	3.3.6.4 (table I, no. 6)	4.4.1.10
Adhesion to metal Perform on mount Type IV	3.3.6.4 (table I, no. 9)	4.4.1.5

4.3.2.2 Rejection. If any specimens tested in accordance with 4.3.2.1 fail to meet the requirements, all mounts in the lot represented by the specimens shall be rejected. Offering future mounts in accordance with this specification manufactured from the rejected elastomer batch shall be prohibited.

4.3.3 Conformance inspection of mounts.

4.3.3.1 Visual inspection. All mounts in every lot shall be inspected in accordance with this section to determine compliance with 3.4.1. Classifications of defects are shown in table XIII. If one or more major defect is found in any sample, the entire lot shall be rejected. Minor defects discovered on each mount shall be corrected or the particular mount containing the defect shall be rejected. MIL-STD-407 may be used to determine and evaluate defects during visual examination.

TABLE XIII. Classification of defects.

Category	Defect
Major:	
101	Evidence of use of unauthorized materials, including lack of documentation demonstrating components were produced in accordance with material specifications or elastomer formulations listed in the drawing
102	Elastomeric components not molded to specified form on drawing
103	Evidence of delamination or air pockets in elastomeric components of finished product
104	Elastomeric components not bonded to metal components in accordance with drawing
105	Evidence of backrinding, blisters, cracks, debonding, breaks, gouges, tears, voids, blisters, or other imperfections on the surface of elastomeric components
106	Absence of environmental coating, when required, or evidence of tackiness and non-drying, peeling, or non-adherence of the environment-resistant coating, or evidence of cracks, breaks, tears, blisters, peeling, flaking, or other imperfections (coated elastomers)
107	Components not protected from corrosion by seawater, oil, or other environmental conditions encountered in-service. Absence of paint or protective coating when required by the drawing
108	Mount dimensions, materials, and configuration not in accordance with drawing and acquisition requirements
109	Any other defect that would affect performance or serviceability of the mount
110	Mounts with cure dates more than 2 years old shall not be offered
111	Metal-to-metal contact when captive feature is engaged
112	Insufficient snubber clearance or evidence of a sound short
113	Lack of evidence demonstrating non-magnetic mounts have a relative magnetic permeability not greater than 2.0
Minor:	
201	Identification marking not in accordance with drawing/specification
202	Burrs, rough edges, and sharp corners not removed
203	Any other defect that would affect performance or serviceability of the mount

4.3.3.2 Conformance tests on finished mounts. Conformance inspection shall be in accordance with the test plan (see 6.2.g). Unless otherwise specified in the test plan, conformance inspection shall include the tests herein. Prior to sampling, all Type IV mounts in the lot shall be subjected to test 2 then test 3 in table XIV. From each lot, a sample of mounts shall be selected in accordance with the sampling procedure in the test plan. Mount samples shall be subjected to tests specified in table XIV, as indicated in the test plan. Unless otherwise specified in the test plan, a minimum of one mount from the sample shall also undergo tests in table XV in the sequence indicated.

4.3.3.3 Rejection. If the mount sample fails to meet the acceptance criteria specified in the test plan, the entire lot shall be rejected. The entire lot shall be rejected if any of the mounts fail to meet any of the requirements of table XV. If any mounts were damaged as a result of any test other than the "tension until failure test", the entire lot shall be rejected.

TABLE XIV. Conformance tests, non-destructive.

Test	Requirement	Verification method
1. Protective coating condition and thickness Perform on mounts with elastomers that have a coating	3.3.6.4.1 (table II, no. 7 & no. 8)	4.3.3.1 [table XIII (106)] & 4.4.2.12
2. Low load-deflection, dynamic stiffness, and damping, in the normal direction 1/	3.4.2 (3.4.2.1) & 3.4.5 (3.4.5.1 & 3.4.5.2)	4.4.2.1 (4.4.2.1.2) & 4.4.2.5 (table XVI, LF-1 and LF-3)
3. High load-deflection, along the normal axis Perform on mount Types II, III, & IV 2/	3.4.2 (3.4.2.2)	4.4.2.2 (4.4.2.2.2)
4. Quality of metal-to-elastomer bond. Perform on mount Type I	3.4.4.1	4.4.2.4.1

NOTES:

1/ Not required for Type II and IV mounts intended to only isolate shock and not vibration (see 6.2.b).

2/ Refer to 6.2.g for high load-deflection procedure modifications specified in the test plan.

TABLE XV. Conformance tests, destructive

Test	Requirement	Verification method
1. High load-deflection, along the normal axis Perform on mount Types II, III, & IV 1/	3.4.2 (3.4.2.2)	4.4.2.2 (4.4.2.2.2)
2. Strength test, along the normal axis	3.4.3	4.4.2.3
3. Tension until failure 2/	3.4.11	4.4.2.14

NOTES:

1/ Tension and compression to the maximum design deflection for all four cycles.

2/ Perform on Type IV mounts only when specified in the test plan (see 6.2.g).

4.4 Verification tests.

4.4.1 Elastomer specimen, test methods. Unless otherwise specified in a particular test procedure, all tests shall be conducted at 80±10 °F and, within this range, the temperature from the beginning to the end of any one test shall not vary more than ±5 °F.

4.4.1.1 Tensile strength and ultimate elongation tests. The tensile strength and ultimate elongation shall be measured on three test specimens fabricated from each elastomer and one specimen of the protective coating (if a coating is used). The tests shall be conducted in accordance with ASTM D412, Method A, using Die C test specimens. Refer to table III or table XI for specimen size.

4.4.1.2 Compression set after oven aging. Compression set shall be determined on three test specimens fabricated from each elastomer in accordance with ASTM D395, Method B, except oven aging conditions shall be as specified in 4.4.1.3. Refer to table III for specimen size.

4.4.1.3 Oven aging test. Specimens for tensile, ultimate elongation, compression set, and adhesion of rubber-to-metal tests shall be oven aged in accordance with ASTM D573 at a temperature of 194±2 °F for 46±¼ hours. Final determination of aged tensile strengths and ultimate elongations shall be made not less than 16 hours, or more than 48 hours, after removal from the oven. Tensile strength and ultimate elongation tests on un-aged specimens shall be made immediately prior to, and on the same machine as, oven aged specimens.

4.4.1.4 Volume change in oil. Volume change in oil shall be determined in accordance with ASTM D471, except three uncoated specimens shall be immersed in reference oil IRM 903 for a period of 46±¼ hours at 73±2 °F. Otherwise, if a protective coating is used on the finished elastomeric mount component, then three coated specimens shall be immersed for a period of 70±¼ hours at 158±2 °F. The coating shall be of the same thickness and undergo the same application procedure as the finished mount component. Refer to table III for specimen size.

4.4.1.5 Adhesion to metal tests. The adhesion tests shall be in accordance with Method A of ASTM D429. Three specimens of the elastomer compound bonded to metal shall be tested. Specimens shall be prepared with the same metal, surface preparation, adhesive system, and bonding method as used in the finished mount component. Refer to table III for specimen size.

4.4.1.6 Adhesion of coating. Adhesion of the protective coating to three specimens of coated elastomer shall be determined before and after immersion in oil in accordance with 4.4.1.4. Refer to table III for specimen size. Each coated specimen shall be flexed, elongated by hand, and then visually examined for adhesion failure. The coated specimens shall not exhibit cracks, breaks, tears, debonding, blisters, or any other type of damage. The coating shall remain intact and not be conducive to peeling or blistering by hand either before or after immersion in oil.

4.4.1.7 Ozone resistance. The ozone resistance shall be determined on two specimens of the elastomer. Refer to table III for specimen size. If a protective coating is used on the finished elastomeric mount component, then the two specimens shall be coated for this test. The coating shall be of the same thickness and undergo the same application procedure as the finished mount component. The specimens shall be elongated to 20 percent extension. To protect the clamped ends of the specimen from ozone exposure, a thin layer of melted paraffin wax shall be applied to each end of the stretched specimens not exceeding ¼ inch from the clamps. The stretched specimens shall be conditioned for 16±2 hours at 104±2 °F before being exposed, in accordance with ASTM D1149. The standard ozone partial pressure shall be 100 millipascals (mPa) ±10 percent, the temperature shall be 104±2 °F, and the period of exposure shall be 168 hours. Observation magnification shall be 7X. The specimens shall be visually examined and shall exhibit no cracks, breaks, tears, or blisters.

4.4.1.8 Hardness. The hardness of the 0.50-inch thick elastomer specimens shall be determined in accordance with ASTM D2240 with a Type A shore durometer. A 3-second reading shall be taken to determine hardness. Refer to table III or table XI for specimen dimensions.

4.4.1.9 Specific gravity. The specific gravity shall be determined in accordance with ASTM D792 on samples cut from the specimen sheets. Refer to table III or table XI for elastomer specimen sheets. The average of three measurements shall be used to determine compliance (see 3.3.6.4).

4.4.1.10 Resilience. The resilience of the 0.50-inch thick specimens fabricated from the elastomer shall be measured in accordance with ASTM D2632. Refer to table III for specimen dimensions.

4.4.2 Mount test methods. Test procedures in this section are applicable to finished mounts. Unless otherwise specified in a particular test procedure, all tests shall be conducted at 80±10 °F and within this range. The temperature from the beginning to the end of any one test shall not vary more than ±5 °F. Unless otherwise specified in a particular test procedure, all tests conducted on finished Type I and III mounts shall be with snubber clearance within the required range [see 6.2.e(3)]. It is the intent of load-deflection and vibration isolation tests (see 4.4.2.1, 4.4.2.2, 4.4.2.3, and 4.4.2.5) to measure mount translational properties along each orthogonal mount axis. If rotation is coupled with translation along a particular mount axis, translational motion shall be isolated by testing mounts as pairs arranged to cancel rotation or by other means.

4.4.2.1 Low load-deflection test. Mounts shall be subjected to four loading and unloading cycles at a constant deflection rate in the normal compression direction and each orthogonal transverse direction as indicated in 4.4.2.1.2 and 4.4.2.1.3. Unless otherwise specified [see 6.2.f(1)(g)], the deflection rate shall permit the maximum load to be attained from the unloaded condition in approximately 2 minutes. It is not necessary to test in both transverse directions when the mount's resilient element is symmetrical about the normal axis. In this case, measurements are only required in one transverse direction.

4.4.2.1.1 Test system. A suitable test system capable of loading the mounts at a constant rate of deflection while measuring the load at each deflection shall be used. A commonly used type of equipment for measuring load-deflection is a servo-hydraulic machine (see figure 1). Sampling rate of measured load and deflection shall provide a sufficient number of samples to furnish smooth load-deflection plots without discontinuities. Deflection shall be measured to the nearest 0.001 inch. Data shall be corrected to account for flexibility of the test system (load frame, force gauge, fixtures, etc.). A test system which is at least 100 times stiffer than the static stiffness of the mounts being tested shall not require a flexibility correction. To avoid over-correction, the stiffness of the test system shall be at least 25 times greater than the stiffness of the mounts being tested. All sensors used for measurement (force and motion transducer) shall be calibrated at regular intervals.

4.4.2.1.2 Low load-deflection test in normal direction, compression. Each mount shall be subjected to four compressive loading and unloading cycles at a constant rate of deflection in the normal direction to a peak force of 125 percent of the maximum intended load [see 6.2.f(1)(a)]. Load-deflection data with deflection rate shall be recorded during the fourth loading cycle to determine conformance with 3.4.2 (see 3.4.2.1).

4.4.2.1.3 Low load-deflection test in the transverse directions. Mounts shall be tested in each transverse direction as a pair while installed back-to-back on a fixture similar to that shown on figure 2. Mounts shall be compressed in the normal direction via the threaded rods to their maximum intended load [see 6.2.f(1)(a)] while load-deflection is measured in the transverse directions. The mount assembly shall be subjected to four loading and unloading cycles in each transverse direction to a peak force equal to twice the load specified in 6.2.f(2)(h). Deflection for each cycle shall be at a constant rate. Load-deflection data with deflection rate shall be recorded during the fourth loading cycle to determine conformance with 3.4.2 (see 3.4.2.1). Criterion is for a single mount; to yield per-mount average load-deflection data, load at each displacement shall be divided by two.

4.4.2.2 High load-deflection test, mount types II, III, and IV. Mounts shall be subjected to four loading and unloading cycles at a constant deflection rate in each direction along the normal axis (see 4.4.2.2.2, compression and tension), then in each orthogonal transverse direction (see 4.4.2.2.1). All load-deflection data for all cycles shall generate smooth similar curves free from sudden drops in load or other anomalies indicative of damage. All data shall be recorded. Unless otherwise specified [see 6.2.f(1)(g)], the deflection rate shall permit the maximum deflection to be reached from the unloaded condition in a time span of approximately 3 minutes. Measured data shall be corrected to account for flexibility of the test system (load frame, force gauge, fixtures, etc.). The test apparatus shall be in accordance with 4.4.2.1.1. The mount shall be carefully inspected during and after each test to determine compliance with 3.4.1.4.1.

4.4.2.2.1 High load-deflection test in the transverse directions, mount types II, III, and IV. Upon completion of testing in the normal direction, mounts shall be tested in each transverse direction as a pair and installed symmetrically back-to-back in a fixture similar to that shown on figure 2. Mounts shall be subjected to four loading and unloading cycles while compressed statically in the normal direction at the maximum intended load [see 6.2.f(1)(a)]. For all cycles, peak deflection shall be to the maximum design excursion of the mount in this direction. Unless otherwise specified [see 6.2.f(1)(b)], load-deflection data during the fourth loading cycle shall be used to determine conformance with 3.4.2 (see 3.4.2.2); deflection rate shall be noted. Criterion is for a single mount; to yield per-mount average high load-deflection data, load at each displacement shall be divided by two. When specified, repeat this test with mounts at zero load or compressed statically in the normal direction at the load(s) indicated [see 6.2.f(1)(h)].

4.4.2.2.2 High load-deflection test along the normal axis, mount types II, III, and IV. Each mount shall be tested along their normal axis in the test sequence given ("a" then "b"). After testing, mounts that contain elastomeric material bonded to metal shall be subjected to the quality-of-bond test in accordance with 4.4.2.4.2.

a. Normal direction, compression. Each mount shall be subjected to four compressive loading and unloading cycles at a constant rate of deflection in the normal direction. All cycles shall be to the maximum design excursion of the mount. Unless otherwise specified [see 6.2.f(1)(b)], load-deflection data during the fourth loading cycle shall be used to determine conformance with 3.4.2 (see 3.4.2.2); deflection rate shall be noted.

b. Normal direction, tension. Each mount shall be subjected to four loading and unloading cycles at a constant rate of deflection in tension along the normal axis of the mount. Deflection shall be to the maximum design excursion of the mount in this direction for all four cycles. Unless otherwise specified [see 6.2.f(1)(b)], load-deflection data during the fourth loading cycle shall be used to determine conformance with 3.4.2 (see 3.4.2.2); deflection rate shall be noted.

4.4.2.3 Strength test.

4.4.2.3.1 Strength test, mount type I. Mounts shall be subjected to four loading and unloading cycles at a constant deflection rate in each of the following directions: both orthogonal transverse directions and both directions along the normal axis (compressive and tensile). Unless otherwise specified [see 6.2.f(1)(g)], the rate of loading shall be at a constant rate such that the maximum load is attained in approximately 3 minutes. All load-deflection data for all cycles shall generate smooth similar curves free from sudden drops in load or other anomalies indicative of damage. All data shall be recorded. Flexibility of the test system (load frame, force gauge, fixtures, etc.) shall be accounted for via correction of measured mount data. Unless otherwise specified [see 6.2.f(1)(e)], "Level A" and "Level B" shall be in accordance with figure 3. Mounts shall be carefully inspected during and after each test to determine compliance with 3.4.1.4.1.

4.4.2.3.1.1 Strength test along the normal axis, mount type I. Mounts shall be tested in both directions along their normal axis in the test sequence given ("a" then "b"). Upon completion of testing, mounts shall be subjected to the quality-of-bond test in accordance with 4.4.2.4.1.

a. Normal direction, compression. Each mount shall be subjected to four compressive loading and unloading cycles at a constant rate of deflection in the normal direction. The peak load obtained shall be "Level A" for the first three loading cycles and to "Level B" for the fourth loading cycle. Load-deflection data during the fourth loading cycle shall be used to determine conformance with this specification; deflection rate shall be noted.

b. Normal direction, tension. Each mount shall be subjected to four loading and unloading cycles at a constant rate of deflection in the tensile direction along the normal axis of the mount. The peak load obtained shall be "Level A" for the first three loading cycles and to "Level B" for the fourth loading cycle (see figure 3). Load-deflection data during the fourth loading cycle shall be used to determine conformance with this specification; deflection rate shall be noted.

4.4.2.3.1.2 Strength test in the transverse directions, mount type I. Upon completion of testing along the normal axis, mounts shall be tested in each transverse direction as a pair while installed symmetrically back-to-back on a fixture similar to that shown on figure 2. Mounts shall be subjected to four loading and unloading cycles while compressed statically in the normal direction at their maximum intended load [see 6.2.f(1)(a)]. The peak load obtained on the fixture shall be “Level A” for the first three loading cycles, and to “Level B” for the fourth loading cycle (see figure 3). Load-deflection data during the fourth loading cycle shall be used to determine conformance with this specification; deflection rate shall be noted. Flexibility of the test system (load frame, force gauge, fixtures, etc.) shall be accounted for via correction of measured mount data. A per-mount average load-deflection plot shall be determined by dividing the load at each displacement by two. Upon completion of testing, mounts shall be subjected to the quality-of-bond test in accordance with 4.4.2.4.1.

4.4.2.3.2 Strength test, mount types II, III, and IV. Mounts shall be subjected to an overload test in each of the following directions: both orthogonal transverse directions and both directions along the normal axis (compression and tension). The rate of deflection (inches per minute) shall be equal to the deflection rate used to conduct high load-deflection measurements [see 4.4.2.2]. The test shall be conducted in accordance with 4.4.2.3.2.1 and 4.4.2.3.2.2. All load-deflection data for all cycles shall generate smooth similar curves free from sudden drops in load or other anomalies indicative of damage. Measured data shall be corrected to account for flexibility of the test system (load frame, force gauge, fixtures, etc.). Mounts shall be carefully inspected during and after testing in each direction to determine compliance with 3.4.1.4.1.

4.4.2.3.2.1 Strength test along the normal axis, mount types II, III, and IV. Each mount shall be subjected to a single load-deflection ramp in the normal compression then the tension direction. The peak ramp load in each direction shall be equal to 1.5 times the load corresponding to the maximum design excursion in that direction. Load-deflection data shall be recorded. Upon completion of testing, mounts shall be subjected to the quality-of-bond test in accordance with 4.4.2.4.2.

4.4.2.3.2.2 Strength test in the transverse directions, mount types II, III, and IV. Upon completion of testing along the normal axis, mounts shall be tested in each orthogonal transverse direction as a pair while installed symmetrically back-to-back on a fixture similar to that shown on figure 2. The mounts shall be tested while compressed statically in the normal direction at their maximum intended load [see 6.2.f(1)(a)] via the threaded rods. The mount pair shall be subjected to a single load-deflection ramp equal to three times the load corresponding to the maximum design excursion in the direction being tested. Load-deflection data shall be recorded. A per-mount average load-deflection plot shall be determined by dividing the load at each displacement by two. Upon completion of testing, mounts shall be subjected to the quality-of-bond test in accordance with 4.4.2.4.2.

4.4.2.4 Quality of the elastomer-to-metal bond test.

4.4.2.4.1 Quality of the elastomer-to-metal bond test, mount type I. The elastomer-to-metal bond of the resilient element shall be inspected while compressed to twice the maximum intended load of the mount [see 6.2.f(1)(a)]. A suitable test apparatus capable of loading the mount in compression to the required load shall be used. If the mount has adjustable snubbers, they shall either be removed or set to their maximum clearance to allow the mount resilient element to be compressed to the required load. The resilient element shall be slowly compressed and held to twice its maximum intended load for approximately 1 minute while the appearance of the resilient element and rubber-to-metal bond are examined to determine conformance with 3.4.4.1. After unloading the resilient element, the rubber-to-metal bond shall be further examined to determine conformance with 3.4.4.1.

4.4.2.4.2 Quality of the elastomer-to-metal bond test, mount types II, III, and IV. This test is not required for mounts not containing elastomers bonded to metal. Bond quality tests along the normal axis of the mount in both tension and compression shall be conducted in accordance with 4.4.2.4.2.1 and 4.4.2.4.2.2. The rate of deflection shall be constant and equal to the deflection rate (inches per minute) used to conduct high load-deflection measurements (see 4.4.2.2).

4.4.2.4.2.1 Compression. The mount shall be slowly compressed to half its maximum design deflection in the normal compressive direction. The mount shall be held at this deflection while the appearance of the resilient element and rubber-to-metal bonds are examined to determine conformance with 3.4.4.2.

4.4.2.4.2.2 Tension. The mount shall be slowly stretched to half its maximum design deflection in tension and held at this deflection while the appearance of the resilient element and rubber-to-metal bonds are examined to determine conformance with 3.4.4.2.

4.4.2.5 Vibration isolation tests. These tests are not required for Type II and IV mounts needed to only isolate shock and not vibration (see 6.2.b). Unless otherwise specified [see 6.2.f(2)(c)], all test conditions shall be in accordance with this test procedure. General guidelines and considerations for dynamic testing are given in ASTM D5992 and ISO 10846.

4.4.2.5.1 Method for measuring dynamic stiffness and damping.

4.4.2.5.1.1 Test system for measuring dynamic stiffness and damping. The test system shall be capable of superimposing cyclical vibration while statically loading the mount. Refer to ASTM D5992 and ISO 10846 for examples of non-resonant forced vibration test systems and guidance in addressing mechanical and instrumentation factors that influence dynamic measurements. Commonly used types of equipment for non-resonant testing are vibration shaker with load frame or a closed-loop servo-hydraulic machine (see figure 1). Transducers shall be arranged to measure force at the blocked output or foundation side of the mount and displacement at the equipment or input side of the mount. The stiffness of the test apparatus (machine, load-frame, force transducer, etc.) in series with the mount under test shall be determined experimentally or via calculation. A test apparatus that is at least 100 times stiffer than the dynamic stiffness of the mount being tested shall not require measurement adjustment to account for the flexibility of the test apparatus. If the test apparatus fails to meet this relative stiffness requirement, the test apparatus compliance shall be subtracted from the measurement to obtain the dynamic stiffness (spring constant) of the mount (K_{mount}). The dynamic stiffness of the mount can be calculated using the classic equation governing the summation of springs in series:

$$(1/K_{measured}) = (1/K_{mount}) + (1/K_{apparatus}) \qquad \text{yielding} \qquad K_{mount} = \frac{(K_{apparatus})(K_{measured})}{(K_{apparatus}) - (K_{measured})}$$

To avoid over-correction, the stiffness of the test apparatus shall be greater than 30 times the stiffness of the mount.

4.4.2.5.1.2 Confirmation of the measurement system. Refer to ASTM D5992 for mechanical and instrumentation factors influencing dynamic measurement and selection and use of springs to assess the capability of the test apparatus to measure dynamic stiffness. Prior to conducting dynamic stiffness measurements on mounts, the dynamic calibration of the complete system shall be confirmed using steel springs of known spring constants, having negligible damping. Springs shall be free of hysteresis and their dynamic and static stiffness (tangent to the slope of the load-deflection curve) equivalent. This procedure is not intended to replace the periodic calibration of transducers, signal conditioners, and other measuring instruments. Springs shall be selected on the basis of their linear force-deflection properties and ability to produce a spring constant comparable to the stiffness of the mount to be tested. Refer to ASTM D5992 for factors influencing the selection of springs. Spring constant values shall be verified by NAVSEA prior to first article testing and when requested by the mount manufacturer. System confirmation shall be performed using springs of known spring constants at the excitation amplitudes and frequencies at which the mount is to be tested. System confirmation shall be performed at loads that produce spring constant measurements that bracket the expected dynamic stiffness range of the mount to be tested. This shall be accomplished by adding or removing springs within the stiffness range of intended mount measurements. Care shall be taken to ensure measurements are conducted within the linear load range of the springs. All spring dynamic stiffness measurements (corrected for test apparatus stiffness) shall be within 2 percent of the known spring constants. If this is not the case, the error shall be investigated and corrected. A system scaling factor may only be applied to measured dynamic stiffness with NAVSEA approval.

4.4.2.5.1.3 Measuring mount dynamic stiffness and damping. The dynamic stiffness (K_{mount}) and loss factor (η) shall be measured in the normal and two orthogonal transverse directions of the mount at the test conditions listed in LF-1 through LF-5 of table XVI. Excitation displacement amplitude shall be approximately 0.020 inch peak-to-peak. Dynamic stiffness measurements shall be acquired at the excitation frequency by using a Fast Fourier Transform (FFT) or equivalent method. This requires measurement of the sinusoidal displacement at the input of the mount and transmitted dynamic force at the blocked output of the mount, as well as the phase relationship between them. Damping loss factor is the tangent of the phase between the displacement and force. The loss factor and dynamic stiffness is calculated from the measurements as follows:

$$K_{measured} = (F/X)(\cos(\theta)) \quad \text{and} \quad \eta = \tan(\theta)$$

Where (F) and (X) are the amplitudes of force and displacement, respectively, and (θ) is the phase between them.

In order to obtain mount stiffness (K_{mount}), the measured stiffness ($K_{measured}$) may likely require adjustment to account for test apparatus flexibility (see 4.4.2.5.1.1).

$$K_{mount} = \frac{(K_{apparatus})(K_{measured})}{(K_{apparatus}) - (K_{measured})}$$

A system phase adjustment or scaling factor applied to the measurements is assumed to be unnecessary and not shown in any of equations above. Refer to 4.4.2.5.1.2 and ASTM D5992.

Unless otherwise specified [see 6.2f.(2)(c)], dynamic stiffness and damping in the normal and transverse directions shall be measured in accordance with table XVI. Refer to tests LF-1 through LF-3 of table XVI for measurement conditions in the normal direction. Refer to tests LF-4 and LF-5 of table XVI for the per-mount transverse measurement test conditions. It is not necessary to take measurements in both transverse directions when the mount's resilient element is symmetrical about the normal axis. In this case, measurements are only required in one transverse direction. In the transverse directions, mounts shall be compressed in the normal direction, while dynamic stiffness and damping in the transverse directions are measured. Figure 2 provides a diagram of a test fixture which permits static loads to be applied in the normal and transverse directions while dynamic stiffness is measured in the transverse direction. This fixture yields twice the transverse dynamic stiffness that shall be halved to obtain the per-mount average for a particular mount direction. This fixture is similar to the double shear fixture in ASTM D5992.

TABLE XVI. Vibration test matrix.

Test	**Measurement**	**Transverse load 1/ (static)**	**Normal load 1/ (static)**
LF-1	Low-frequency dynamic stiffness and damping Normal compressive direction	0	2/
LF-2	Low-frequency dynamic stiffness and damping Normal compressive direction	0	3/
LF-3	Low-frequency dynamic stiffness and damping Normal compressive direction	0	G 4/ 5/
LF-4	Low-frequency dynamic stiffness and damping Each transverse direction	0	G 5/

TABLE XVI. Vibration test matrix – Continued.

Test	Measurement	Transverse load 1/ (static)	Normal load 1/ (static)
LF-5	Low-frequency dynamic stiffness and damping Each transverse direction	see 6.2.f(2)(h)	G

FOOTNOTES:

1/ All loads in the normal and transverse directions are per-mount loads.

2/ Compress to "0.80G" or the minimum mount load [see 6.2.f(1)(a)] supporting the weight of the intended equipment (smaller load of the two).

3/ If the minimum intended mount load [see 6.2.f(1)(a)] is less than "0.80G", compress to a load midway between "G" and that minimum load; otherwise, disregard test LF-2.

4/ "G" is the maximum intended mount load for the application [see 6.2.f(1)(a)].

5/ When specified, repeat tests LF-3 and test LF-4 with a zero static normal load or as instructed [see 6.2.f(2)(c)].

NOTE:

1. Unless otherwise specified [see 6.2.f(2)(c)], the excitation amplitude in all directions for LF-1 through LF-5 shall be 0.020 inch pk-to-pk. Unless otherwise specified [see 6.2.f(2)(c)], the excitation frequency in all directions for LF-1 through LF-5 shall be equal to the nominal natural frequency in the normal direction of the mount supporting its maximum intended load [see 6.2.f(1)(a)].

4.4.2.5.2 High-frequency complex dynamic stiffness measurements. When required (see 3.4.5.3), high-frequency complex dynamic stiffness shall be measured in accordance with ISO 10846-1, ISO 10846-2, ISO 10846-3, or other NAVSEA-approved document. The test apparatus shall meet the requirements cited in these documents.

4.4.2.6 Drift test. A drift test shall be conducted at the nominal in-service temperature specified [see 6.2.e(6)]. Unloaded mount height shall be measured at the ambient room temperature prior to the start of the drift test. The mount shall then be conditioned at the nominal in-service operating temperature at a tolerance of ±2 °F for a minimum of 48 hours, until all parts of the mount have reached test temperature. This mount temperature and tolerance shall be maintained until the drift test is complete. The unloaded mount height shall be measured. A static weight equal to the maximum intended load of the mount [see 6.2.f(1)(a)] shall then be applied, and after 2 minutes, the height of the mount shall be measured. Thereafter, the mount height shall be measured every 15 minutes for the first hour, followed by measurements every 2 hours for 12 hours. Then, starting with a measurement 24 hours after applying the load, mount height shall be measured three times per day (as evenly spaced as practical) for the first week, then once a day for the second week, and twice a week for subsequent weeks. The measurement intervals cited are minimum requirements. The drift test shall continue for at least 30 days and until data can easily be extrapolated to estimate future mount height. Upon completion of the drift test, the mount shall be conditioned while unloaded at ambient room temperature for 48 hours. A final height shall then be measured before subjecting the mount to the dynamic stiffness verses mount height test (see 4.4.2.6.1).

NOTE: The change in mount height due to drift shall be measured to the nearest 0.001 inch. It is usually convenient to measure the amount of drift from an arbitrary datum from which mount height can be determined.

NOTE: For Type III mounts, the heights of both mount components (Type I and II) shall be measured and individually recorded during the test.

4.4.2.6.1 Dynamic stiffness vs. mount height. This test is not required for Type II and IV mounts needed to only isolate shock and not vibration (see 6.2.b). After the drift test, mount dynamic stiffness and damping shall be measured in accordance with 4.4.2.5 at test condition LF-3 of table XVI, with the following major exceptions. Measurements shall be at various mount heights that correspond to in-service heights due to drift, in lieu of the normal load specified in the table. Measurements shall be at a minimum of five evenly incremented mount heights down to a height that corresponds to the service life of the mount.

4.4.2.7 Endurance tests.

4.4.2.7.1 Vibration endurance test. Unless otherwise specified [see 6.2.f(3)(b)], mount Types II, III, and IV shall be tested in accordance with 4.4.2.7.1.1, and mount Type I shall be tested in accordance with 4.4.2.7.1.2.

4.4.2.7.1.1 Vibration endurance, resonance test. Mounts shall undergo environmental vibration testing in accordance with MIL-STD-167-1 while supporting their intended equipment or loaded with dummy masses to simulate the shipboard configuration [see 6.2.f(3)(d)]. Testing the mounts while supporting their intended equipment is the preferred method. Mounts shall not be removed during any part of the MIL-STD-167-1 test. Acceleration in the direction of excitation shall be measured and recorded across the mounts at 15-minute intervals (minimum). Amplification or maximum transmissibility shall be calculated at each resonance to determine compliance with 3.4.7.1.a.

Amplification = A(equipment)/A(base)

Where:

A(equipment) is the acceleration magnitude measured on the equipment side of the mount

A(base) is the acceleration magnitude measured on the shaker table side of the mount

4.4.2.7.1.2 Vibration endurance, non-resonant test. Two mounts shall be tested in three orthogonal directions in accordance with 4.4.2.7.1.2.1 and 4.4.2.7.1.2.2. A servo-hydraulic machine operating in displacement control or equivalent apparatus capable of providing the required loading shall be used to conduct this test.

4.4.2.7.1.2.1 Normal direction. The mounts can be tested individually or as a pair. Each mount shall be compressed to its maximum intended load [see 6.2.f(1)(a)] and subjected to one-half million cycles of sinusoidal vibration in the normal direction at the dynamic deflection and frequency below.

Deflection (inches, pk-to-pk) equal to $(0.01/\eta)$ but not less than 0.10

and:

Frequency (Hz) equal to or greater than $3.1(K/W)^{0.5}$

where:

η is the loss factor, measured from test LF-3 at the maximum intended load (table XVI)

K (pounds per inch) is the dynamic stiffness, measured from test LF-3 at the maximum intended load (table XVI)

W (pounds) is the maximum intended load

4.4.2.7.1.2.2 Transverse direction. Mounts shall be tested as a pair while installed symmetrically back-to-back on a fixture similar to that shown on figure 2. Each orthogonal transverse direction shall be tested independently. Mounts shall be compressed in the normal direction to their maximum intended load while being subjected to one-half million sinusoidal vibration cycles in each transverse direction at the dynamic deflection and frequency below.

Deflection (inches, pk-to-pk) equal to $(0.01/\eta)$ but not less than 0.10

and:

Frequency (Hz) equal to or greater than $3.1(K/W)^{0.5}$

where:

η is the loss factor, measured from test LF-4 at the maximum intended load (table XVI)

K (pounds per inch) is the dynamic stiffness, measured from test LF-4 at the maximum intended load (table XVI)

W (pounds) is the maximum intended load

4.4.2.7.2 Ship motion endurance test. Mounts shall be loaded statically and subjected to the cyclical loads indicated for each test case specified [see 6.2f(3)(e)]. Load testing shall be in accordance with 4.4.2.7.2.1 or as specified [see 6.2.f(3)(f)] for each test case. The cyclical loads specified in the procedure shall be superimposed over the static load. A servo-hydraulic machine operating in load control or equivalent apparatus capable of providing the required loading shall be used to conduct this test. Top and bottom surfaces of the mount shall remain parallel and not rotate during testing. Load and deflection shall be monitored to determine compliance with 3.4.7.2 and to document changes in load-deflection characteristics during the test. Mounts shall be inspected during and after testing to determine conformance with 3.4.1.4.1.

4.4.2.7.2.1 Loading method (three-axis). This method applies to a test apparatus capable of applying forces along all three orthogonal mount axes simultaneously. The mount shall be statically loaded in the normal direction and subjected to three superimposed cyclical force components ($\pm F_N$, $\pm F_{T1}$, $\pm F_{T2}$) applied simultaneously in-phase for the period and cycles specified [see 6.2.f(3)(e)]. One cycle is defined as the loading from the initial position at the static mount load, to the superimposed load ($+F_N$, $+F_{T1}$, $+F_{T2}$), then to superimposed load ($-F_N$, $-F_{T1}$, $-F_{T2}$), finishing back at the static load.

NOTE: Where (F_N), (F_{T1}), and (F_{T2}) are the specified magnitudes [see 6.2.f(3)(e)] of the orthogonal cyclical per-mount force components along the normal and both transverse axes of the mount, respectively, a shorter test period may be used provided the load-deflection relationship is the same as with the specified period. If the maximum deflection permitted by a shipboard captive feature is specified [see 6.2.f(3)(g)] in a particular direction, it is not required to exceed the specified deflection in that direction during the test. The force component in the specified direction can be adjusted to allow a deflection equal to the maximum permitted by the captive feature.

4.4.2.8 MIL-S-901 or similar shock test procedure. This procedure is applicable when MIL-S-901 or similar shock test procedure is specified [see 6.2.f(4)(a), 3.4.8, and 3.4.8.1]. Mounts shall undergo shock testing while supporting their intended equipment or loaded with dummy masses to simulate the shipboard configuration as specified in the test procedure [see 6.2.f(4)(a)]. Testing the mounts while supporting their intended equipment is the preferred method when it is technically justifiable. Testing shall be in accordance with the specified MIL-S-901 or similar shock test procedure classifications [see 6.2.f(4)(b)]. Measurements required on mounts when conducting a MIL-S-901 or similar shock test procedure are specified in 4.4.2.8.1 and 4.4.2.8.2.

4.4.2.8.1 Deflection measurements. Deflection shall be measured during the shock test to determine conformance with 3.4.8.1 mount deflection requirements and to acquire data for calculating the excursion envelope of the equipment. Deflection shall be measured along each orthogonal mount axis.

4.4.2.8.2 Acceleration measurements. Acceleration time histories above and below the mounts shall be measured during the shock test to assess mount performance. Acceleration shall be measured in the normal and transverse directions to determine compliance with 3.4.8.1.

4.4.2.9 Salt spray test. Salt spray tests shall be conducted in accordance with ASTM B117 using substitute ocean water in accordance with ASTM D1141 (without heavy metals). The mounts shall be compressed to their maximum intended load for the application [see 6.2.f(1)(a)] and installed in the salt spray chamber. The mounts shall be exposed to the salt spray test for 14 days, after which the mount shall be soaked and washed thoroughly in fresh water and examined for corrosion, cracks, swelling, or other deterioration in accordance with 3.4.1.4.1.

4.4.2.10 Resistance to oil test. The mounts shall be compressed to their maximum intended load for the application [see 6.2.f(1)(a)] and immersed in 158±2 °F oil IRM 903 in accordance with ASTM D471 for a period of 70±¼ hours. After this, the mount shall be removed and immersed in fresh oil at room temperature for 30 minutes. After the cooling period, the mounts shall be removed from the ambient oil and inspected for cracks, bubbles, swelling, or other deterioration in accordance with 3.4.1.4.1.

4.4.2.11 Cold storage test. The mount shall be exposed to a temperature of -30±2 °F for 3 days. After this, the mount shall be removed from cold storage and allowed to thaw at a temperature of 80±10 °F for at least 48 hours. The mount shall be examined for conformance with 3.4.1.4.1.

4.4.2.12 Film thickness of the elastomer protective coating. A flat metal test coupon shall be temporarily attached to the mount during the coating application. The coupon shall be attached in such a way that one side of it is exposed to receive the coating. The film thickness of the coating shall be measured at various locations on the test coupon using a micrometer in accordance with ASTM D1005. The thickness of the test coupon shall be determined before and after the coating has been applied to the mount. The difference in the two thickness measurements shall be the thickness of the environment-resistant coating. In lieu of the above procedure, the film thickness may also be measured in accordance with ASTM D7091. The coating shall meet the requirements of 3.3.6.4.1 and table II, no. 8.

4.4.2.13 Porosity and delamination. Each elastomeric component of the mount (resilient element and snubber) shall be cut into two parts along a plane through the center of the component. The cut surfaces shall be carefully examined for porosity. Each cut part shall be immersed in toluene for approximately 24 hours. After removal from the toluene, the parts shall be examined for evidence of separation into distinct layers or laminations.

4.4.2.14 Tension until failure. The mount shall be loaded in tension until failure to determine compliance with 3.4.11. The mount shall be subjected to a single load-deflection ramp in tension along the normal axis until failure. The rate of deflection shall be constant and equal to the deflection rate used to conduct high load-deflection measurements [see 4.4.2.2]. Load-deflection measurements shall be recorded and corrected to account for flexibility of the test system (load frame, force gauge, fixtures, etc.).

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging and storage requirements shall be as specified in the contract or order (see 6.2.h and 6.7.c). 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. The mounts covered by this specification are used to improve at least one of the following performance attributes on surface ships: vibration, shock, ambient noise, or radiated noise. These functions make the mounts military unique. Mounts covered by this specification are intended to be used when Navy standard mounts cannot meet the requirements for a particular application. This specification is intended to be tailored, where permitted, to each specific application by specifying the required mount attributes and verification tests in the acquisition documents (see 1.2 and 6.2).

6.2 Acquisition requirements. Acquisition documents should specify the following:

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

b. Provide the classification of the required mount type. Also for Type II and IV mounts, indicate if mounts are only required to isolate shock and not vibration by specifying "shock only" (see 1.2, 3.4.5, 4.4.2.5, 4.4.2.6.1, table VI through table X, and table XIV).

c. Identify when first article testing is required; either for initial procurement, or based on change in application, design, materials, or manufacturer. Specify the NAVSEA-approved first article test procedure along with any modifications (additions, deletions, deviations, etc.) to this specification (see 3.1, 4.2, and 6.7.a).

d. If necessary, provide modifications to the service life requirement (see 3.2.1).

e. Mount construction and materials.

(1) If necessary, provide requirements to interface with captive features (see 3.2.2.4). If necessary, specify requirements for captive feature components (see 3.2.2.4).

(2) If necessary, specify the maximum allowable drift to maintain an acceptable equipment excursion envelope for clearance with surrounding structure or alignment with flexible connections (see 3.2.5). Note: Specify sufficient margin to account for variability in drift rate. Flexible hose and cabling should be installed with enough slack to not invoke this requirement.

(3) Specify snubber clearance range for mount Types I and III along with any required adjustable features (see 3.2.6 and 4.4.2). If necessary, specify if snubber adjustability is not required (see 3.2.6). If necessary, for adjustable snubbers, specify the number of adjustments permitted during the mount service life (see 3.2.6). Note: Snubbers should be adjustable if the required clearance is small and closes with drift.

(4) If necessary, provide additional in-service environmental agents (see 3.3.2.a).

(5) If necessary, provide modifications to the required temperature range (see 3.3.2.b).

(6) Provide the nominal ambient temperature the mount is expected to experience while in-service (see 3.3.2.b, and 4.4.2.6).

(7) If necessary, specify metal preference used in mount construction. If necessary, specify that non-magnetic metal should be used in mount construction (see 3.3.4 and 6.4.9).

(8) If necessary, specify modifications to elastomer or coating requirements (see 3.3.6 and 3.3.6.4).

(9) Provide geometry and interface requirements, including bolt pattern, maximum height, or area the mount is to occupy (see 3.4.1.1).

f. Performance.

(1) Load-deflection.

(a) Provide the minimum, maximum, and average intended loads for mounts supporting the weight of intended equipment (see 3.4.2, 3.4.5.3, 4.4.2.1.2, 4.4.2.1.3, 4.4.2.2.1, 4.4.2.3.1.2, 4.4.2.3.2.2, 4.4.2.4.1, 4.4.2.6, 4.4.2.7.1.2.1, 4.4.2.9, 4.4.2.10, and table XVI).

(b) If necessary, specify a modification to the acceptable variation in the characteristic low and high load-deflection curves in each direction (see 3.4.2, 3.4.2.1, and 3.4.2.2). If necessary, provide a characteristic low and high load-deflection curve for each direction (3.4.2.1 and 3.4.2.2). If necessary, specify if a loading cycle other than the fourth is to be used to determine conformance with high load-deflection criteria (see 3.4.2.2, 4.4.2.2.1, and 4.4.2.2.2).

(c) If necessary, provide an acceptable percentage change in low and high load-deflection data between first article initial characterization and subsequent tests for a particular mount (see 3.4.2).

(d) If necessary, specify a maximum static deflection at the maximum intended load (see 3.4.2.1 and 3.4.2.2).

(e) If necessary, for Type I mounts, specify peak test loads “Level A” and “Level B” for the strength tests if different from loads obtained using figure 3 (see 3.4.3.1 and 4.4.2.3.1).

(f) If necessary, for Type I mounts, specify modifications to the acceptable variation in strength load-deflection properties (see 3.4.3.1).

(g) If necessary, specify deflection rates for the low and high load-deflection tests (see 4.4.2.1 and 4.4.2.2). If necessary, for Type I mounts, specify deflection rate for strength test (see 4.4.2.3.1).

(h) If necessary, specify if the high load-deflection test is to be repeated and provide the static normal load conditions (see 4.4.2.2.1). (Specify zero load or nominal static normal load(s) when mounts are used at a lightly loaded condition, such as for lateral supports).

(2) Vibration isolation.

(a) Provide the range of acceptable dynamic stiffness and loss factors for tests LF-1 through LF-5 of table XVI for mounts required to isolate vibration (see 3.4.5.1 and 3.4.5.2). Include a sketch relating values to each mount axis.

(b) If necessary, provide an acceptable percentage change in dynamic stiffness and loss factor between first article initial characterization and subsequent tests for a particular mount (see 3.4.5.1 and 3.4.5.2).

(c) If necessary, provide modifications to excitation amplitude, frequency, loads, and test conditions for measuring dynamic stiffness and damping (see 3.4.5.1, 3.4.5.2, 4.4.2.5, and table XVI). If necessary, specify if tests LF-3 or LF-4 are to be repeated at other loads and provide the static normal load conditions (see table XVI). (Specify zero load or nominal static normal load(s) when mounts are used in a lightly loaded condition, such as for lateral supports).

(d) Indicate if high-frequency complex dynamic stiffness is to be measured (see 3.4.5.3 and table VII).

(e) Provide frequency range for high-frequency complex dynamic stiffness measurements (see 3.4.5.3).

(f) Provide criteria for acceptable performance for high-frequency complex dynamic stiffness measurements (see 3.4.5.3).

(g) Indicate if high-frequency complex dynamic stiffness measurements are required in the transverse direction (see 3.4.5.3).

(h) Provide a sketch showing the static load per mount required along each transverse axis for test LF-5 of table XVI and for the low load-deflection test in the transverse directions (see 4.4.2.1.3). The transverse static load should correspond to the worst-case ship motion that vibration isolation is required.

(3) Endurance.

(a) Provide typical dynamic loads and cycles per year that the mount is expected to experience while in-service (see 3.4.7 and 6.5).

(b) If necessary, specify the vibration endurance test method along with any modifications, such as frequency, number of cycles, or mount deflection (see 3.4.7.1 and 4.4.2.7.1).

(c) Provide the maximum amplification or transmissibility at resonance permitted during the vibration resonance test (see 3.4.7.1.a).

(d) Specify if mounts are to be tested with supported equipment or with dummy mass simulating equipment. Provide a sketch of the test configuration including number of mounts for the vibration resonance test (see 3.4.7.1.a, 4.2.2.5, and 4.4.2.7.1.1). Specify particular mounts for the vibration endurance test to be provided for initial and subsequent testing in accordance with first article test suite five in lieu of all mounts (see 4.2.2.5).

(e) For the ship motion endurance test, provide a sketch of the mount and a table summarizing the static and orthogonal dynamic load components along the normal (F_N) and each transverse (F_{T1}, F_{T2}) axis, in conjunction with the cyclical period and number of cycles for each test case (see 3.4.7.2, 4.4.2.7.2, 4.4.2.7.2.1, and 6.5).

(f) If necessary, for the ship motion endurance test, specify an alternate loading method and NAVSEA-approved procedure (see 3.4.7.2 and 4.4.2.7.2). Example: Specify an equivalent test using two-axis loading.

(g) If necessary, specify the maximum mount deflection in a particular direction due to loads associated with the ship motion endurance test (see 3.4.7.2). If contact with a shipboard captive feature is expected for the test conditions, specify the maximum mount deflection permitted along each orthogonal axis by the shipboard captive feature (see 3.4.7.2, 4.4.2.7.2.1, and 6.6).

(4) Shock isolation.

(a) Specify the applicable shock Technical Authority-approved shock test procedure (see 6.4.13). If 3.4.8.1 is applicable (see 3.4.8 and 4.4.2.8), specify if mounts are to be tested with supported equipment or with dummy loads. Include the quantity of mounts to be tested (see 4.2.2 and 4.2.2.4) along with a drawing of the test configuration. Specify particular mounts from the shock test to be provided for initial characterization and subsequent testing in accordance with first article test suite four (see 4.2.2.4 and table IX) in lieu of all mounts.

(b) If 3.4.8.1 is applicable, specify the mounting location aboard the ship, mounting plane, and mounting orientation in accordance with MIL-S-901 (see 3.4.8.1 and 4.4.2.8).

(c) If 3.4.8.1 is applicable, specify the maximum above mount acceleration during the shock test, if required (see 3.4.8.1).

(d) If 3.4.8.1 is applicable, specify the maximum permissible mount deflection in a particular direction during the shock test, if required (see 3.4.8.1).

g. Specify the NAVSEA-approved mount manufacturer conformance inspection procedure (see 6.7) with modifications (additions, deletions, deviations, etc.) to the specification (see 4.3, 4.3.2.1, 4.3.3.2, and 6.7). A sampling plan with lot acceptance criteria should be included. The sampling plan should be based on ANSI/ASQ Z1.4, Sampling Procedures and Tables for Inspection by Attributes, or similar procedure.

h. Specify packaging requirements, shipping, and storage conditions (see 5.1 and 6.7.c).

6.3 Submarine applicability. For submarine applications, contact NAVSEA at CommandStandards@navy.mil.

6.4 Definitions.

6.4.1 Drift (or creep or strain relaxation). The time-dependent increase in the deformation of the mount resilient element without any increase in the applied force. In general terms, drift results in a decrease in height and increase in girth of the resilient element.

6.4.2 Dynamic stiffness. The real part of the frequency-dependent complex ratio of force on the blocked output side of the mount to displacement on the input side during sinusoidal vibration. Also referred to as spring constant or elastic dynamic stiffness. In this document, elastic dynamic stiffness, spring constant, and dynamic stiffness are used interchangeably.

6.4.3 Dynamic stiffness, complex. The frequency-dependent complex ratio of force on the blocked output side of the mount to displacement on the input side during sinusoidal vibration.

6.4.4 Elastomer. A polymer with the property of elasticity. The term is derived from elastic polymer.

6.4.5 Intended load. The static load on the mount from supported equipment. The maximum, minimum, and average intended load quantifies the relatively small variation in loading due to differences in supported weight between equipment installations for a particular application, changes in supported weight (fluids, stowage, etc.), and inequality in mount loading [see 6.2.f(1)(a)].

6.4.6 Loss factor (damping). Tangent of the phase between the input displacement and blocked output force across the mount.

6.4.7 Maximum design deflection or excursion. For each direction, the largest deflection the mount is designed to experience with consideration given to safety and design margin requirements imposed by the manufacturer and performance requirements of this specification. These deflections are based on the mount shock excursion envelope. The manufacturer provides this information in the normal (tension and compression) and transverse directions for mount Types II, III, and IV.

6.4.8 Mount, resilient. A device designed to support and limit the motion of shipboard equipment while isolating shock or vibration, or both shock and vibration, from equipment to its foundation or from the foundation to its equipment. The term "mount" encompasses all components necessary to accomplish this task including integral and auxiliary snubbers, resilient elements, and fasteners.

6.4.9 Non-magnetic. Having a relative magnetic permeability not greater than 2.0 [see 6.2.e(7)].

6.4.10 Normal. The direction or axis of the mount designed to support the static weight of mounted equipment.

6.4.11 Resilient element. The flexible part of a mount that supports equipment and isolates shock or vibration, or both shock and vibration.

6.4.12 Snubber. Part of a mount whose primary purpose is to limit equipment excursion. A snubber may be incorporated as part of, or attached to, the resilient element component (integral), or as a separate component (auxiliary).

6.4.13 Technical authority. The Technical Authority has the authority, responsibility, and accountability to establish, monitor, and approve technical standards, tools, and processes in conformance to higher authority policy, requirements, architectures, and standards [see 6.2.f(4)(a)]. (NOTE: The Technical Authority is not authorized to approve contract deliverable data, except as authorized by the Contracting Activity).

6.4.14 Transverse. The direction or axis perpendicular to the normal axis of the mount at the mount input (equipment-side). Testing is typically required in two transverse directions, which are both perpendicular to each other and the normal mount axis (three orthogonal axes).

6.5 Guidance for specifying dynamic loads for the ship endurance test [see 6.2.f.(3)(e)]. If possible, the dynamic load, period, and number of cycles at each test-case should reflect what the mount may experience while in-service during the entire life of the mount (fatigue test). Otherwise, the dynamic load, period, and number of cycles at each test case should be based on the harshest conditions the mount may experience while in-service. The endurance test should demonstrate the ability of the mount to operate in the worst-case sea state or maneuvering for which the ship is designed. Refer to the applicable ship specification concerning ship motion in seaway requirements and MIL-STD-1399, Interface Standard for Shipboard Systems. The dynamic load for each test case should consist of components in each orthogonal mount direction (normal and both transverse directions). When specifying loads, consideration should be given to the load-deflection manufacturing tolerance of the mount. When specifying the number of cycles at the worst-case sea state, the following should be considered: mission-specific seakeeping requirements, time required to pass through this condition, and if return to port for inspection is mandatory. Consideration should be given to the design limits for ship motion. Unless otherwise specified by NAVSEA (see 6.7), it should be assumed that a ship spends 40 percent of the time at sea in the following conditions: 14.5 percent in storm condition (ss6 - ss8), 20 percent in moderate seas (ss5), 65.5 percent in calm seas (ss3 and ss4). Refer to 3.4.7 and 6.2.f(3)(a).

6.6 Guidance for the design of captive features used in conjunction with type IV mounts. It is the responsibility of the mounting system designer to ensure a captive feature is incorporated as part of the "fail-safe" shipboard mounting system. The captive feature should be designed to replace the strength of the mount and keep equipment from coming adrift in case the mount elastomer becomes torn, de-bonded, or otherwise damaged during normal operation or non-routine event. The captive feature should limit mount deflection in shock, seaway, and maneuvering to the maximum design deflection of the mount (see 6.4.7). Included in the design analysis should be the ability of the captive feature to restrain mounted equipment during shock and in the worst-case sea state or maneuvering for which the ship is designed, without contribution of the tensile restraining force of the mount elastomer. Refer to the applicable ship specification concerning ship motion in seaway requirements and MIL-STD-1399, Interface Standard for Shipboard Systems. Design loads should be dynamically applied and include possible acceleration resulting from equipment excursions within the displacement envelope of captive feature engagement. Consideration should be given to the following when designing captive features:

a. Mounts arranged horizontally and vertically, as part of the shock and vibration isolation system, in such a manner as to provide the necessary confinement.

b. Using non-contacting metallic springs, elastomeric elements (in compression when engaged), or other means to cushion impact and provide the necessary confinement. Derive its strength from metal; however, when engaged, hard metal-to-metal contact should be avoided.

c. Not adversely affect the shock isolation capabilities of the mounting system and provide the restraining force during shock when the maximum design deflection of the mount is reached.

d. Limit mount deflections during ship motion or shock to the specified maximum [see 6.2.f(3)(g) and 6.2.f(4)(d)]. Limit mount excursion to a displacement based on the allowable excursion of the mounted equipment (piping, intakes, exhausts, etc.).

e. Engage at a deflection not greater than the maximum design deflection of the mount.

f. When the mounting system is required to isolate vibration, the captive feature should not have an adverse effect on this capability.

6.7 Contractual and administrative provisions essential for acquisition. The following provisions are essential for acquisition:

a. First article testing is only to be conducted in accordance with a NAVSEA-approved first article test plan. Prior to conducting first article inspection, submit the following to NAVSEA:

(1) First article test plan with section 6.2 completed including modifications (additions, deletions, deviations, etc.) to the specification.

(2) Drawings showing mount construction, installation details including fasteners, captive feature, and nominal load-deflection graphs in each direction.

(3) Previous first article tests that may have been conducted, rationale for not using standard Navy mounts, and health hazard assessment information (see 4.2 and 6.2.c).

The purpose of these submissions is for NAVSEA to evaluate the proposed first article test plan with respect to the resilient mount being offered and approve or provide revisions to the test plan or specification, as necessary. Mounts previously offered in accordance with this specification that are being used for a different application or have undergone a change in design, materials, or manufacturer may require a retest of all or selective first article tests as determined by NAVSEA. Upon completion of first article inspection, submit a detailed test report to NAVSEA. The report contains first article test data and results along with evidence demonstrating the following requirements have been met: service life (see 3.2.1), fatigue (see 3.4.7), in-service environment (see 3.3.2), and hazardous materials (see 3.3.3). Also included in the report is a conformance inspection procedure provided by the mount manufacturer based on first article test results and 4.3. The mount manufacturer receives correspondence from NAVSEA stating first article inspection requirements have been met and approval of the conformance inspection procedure (see 4.3 and 6.2.g) prior to offering the mount for purchase in accordance with this specification. The purchaser may waive subsequent first article inspections or portions of them, if the mount manufacturer certifies that the current materials, construction, dimensions, and fabrication process are equivalent to those previously tested.

b. The mount manufacturer is to maintain a quality program containing sufficient depth to ensure that all specification requirements are met. The manufacturer is responsible for maintaining records and performing all inspection requirements (examinations and tests) as specified in this specification as part of a quality program. NAVSEA or the purchaser is allowed to inspect the manufacturing and quality assurance process, and perform or witness any of the inspections and tests set forth in the specification where such actions are deemed necessary to ensure products conform to prescribed requirements.

c. Guidance for specifying marking on packaging (refer to 6.2.h). Provide marking information on interior packages and exterior shipping containers. The information should include the identification information contained in 3.4.1.3. The container should also include information for storage and shipment environment: Example: “STORE INDOORS – AVOID EXCESSIVE HEAT.” The container also includes an expiration date to ensure old mounts are not installed. Example: “EXPIRATION DATE: FOURTH QUARTER 2017, DO NOT INSTALL AFTER THIS DATE.” Expiration from date of cure is a minimum of 7 years for mount Types I, II, and III and 5 years for mount Type IV.

6.8 Subject term (key word) listing.

Isolator

Shock

Vibration

6.9 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.

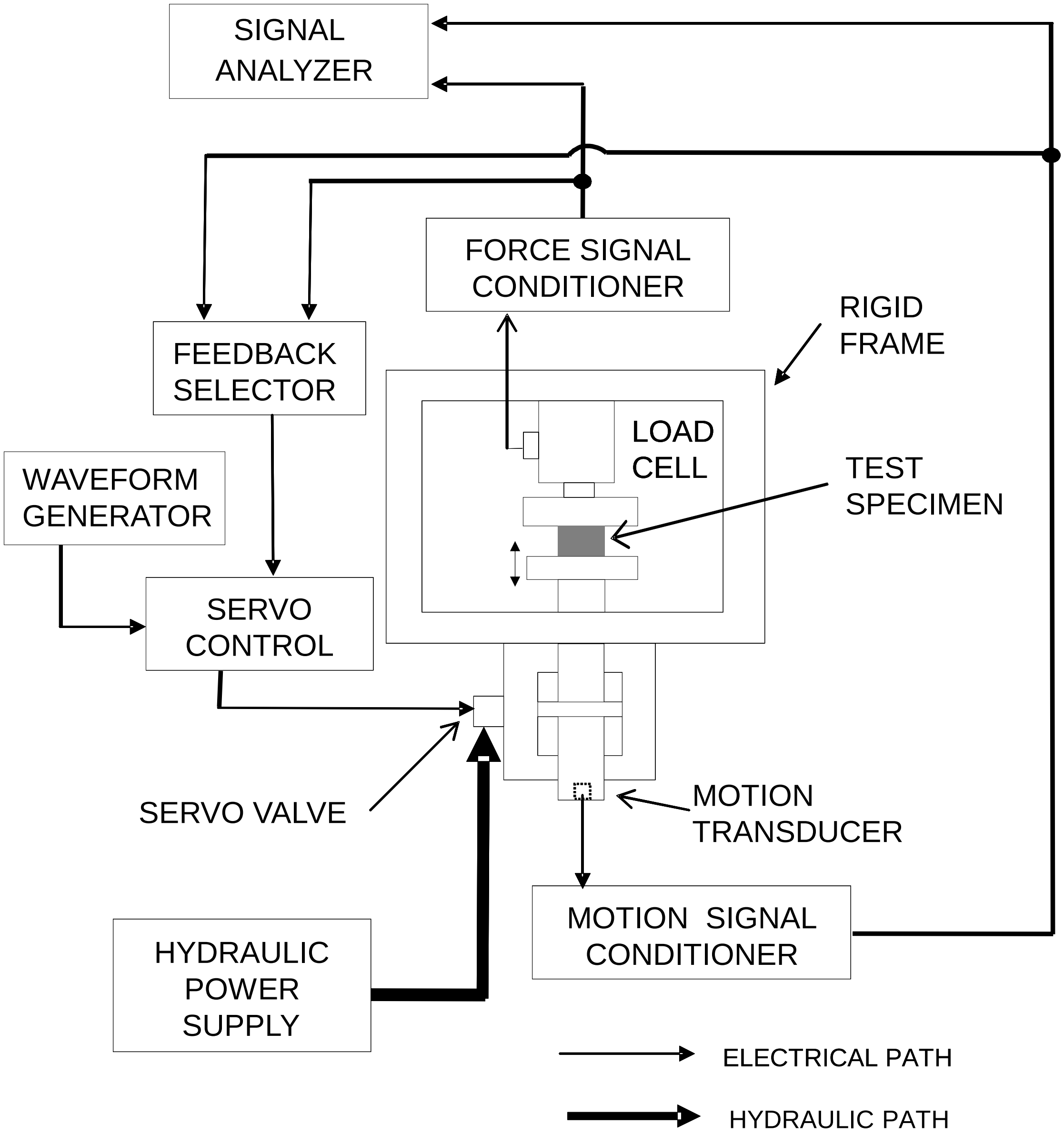

FIGURE 1. Diagram of major components of servo-hydraulic test machine.

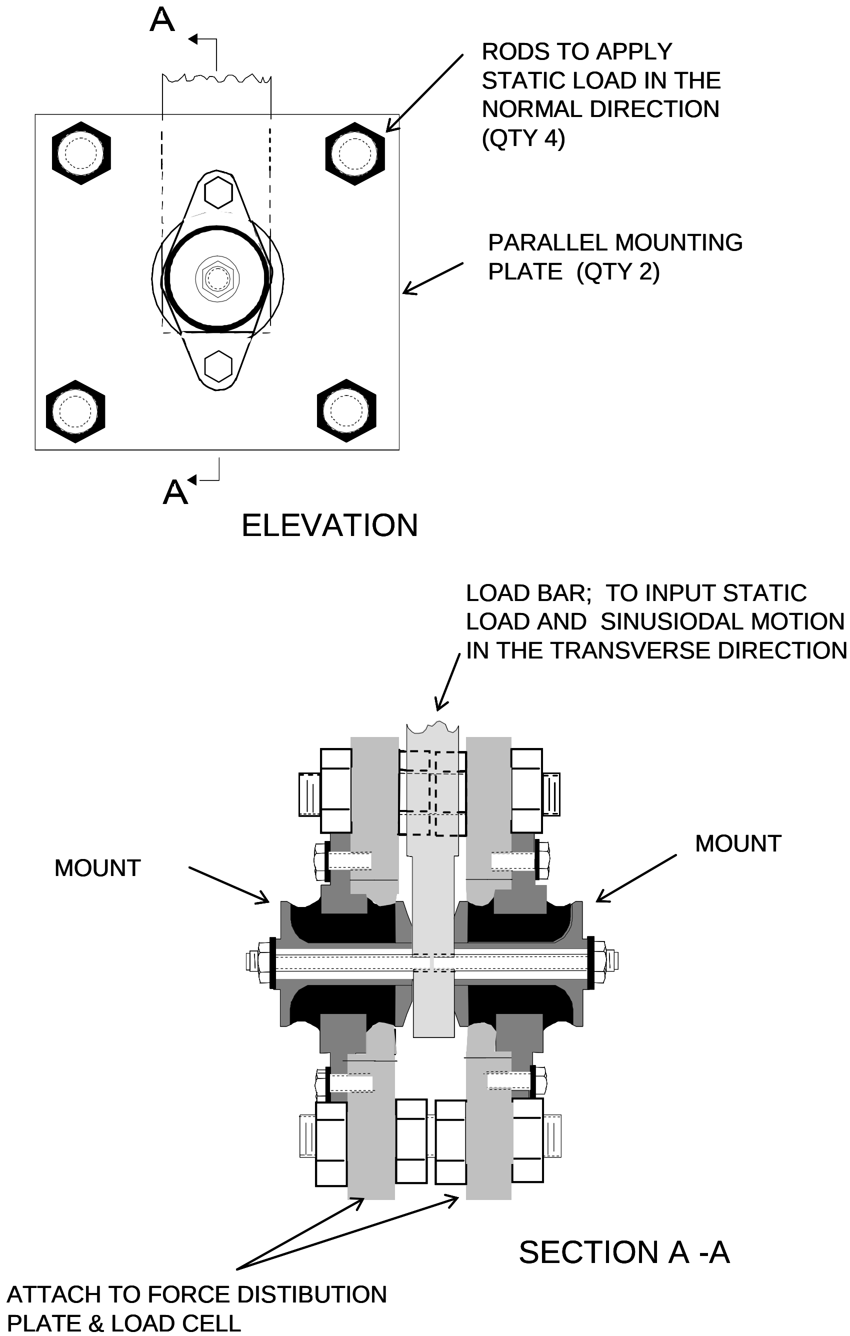

FIGURE 2. Fixture for conducting transverse tests on a pair of mounts.

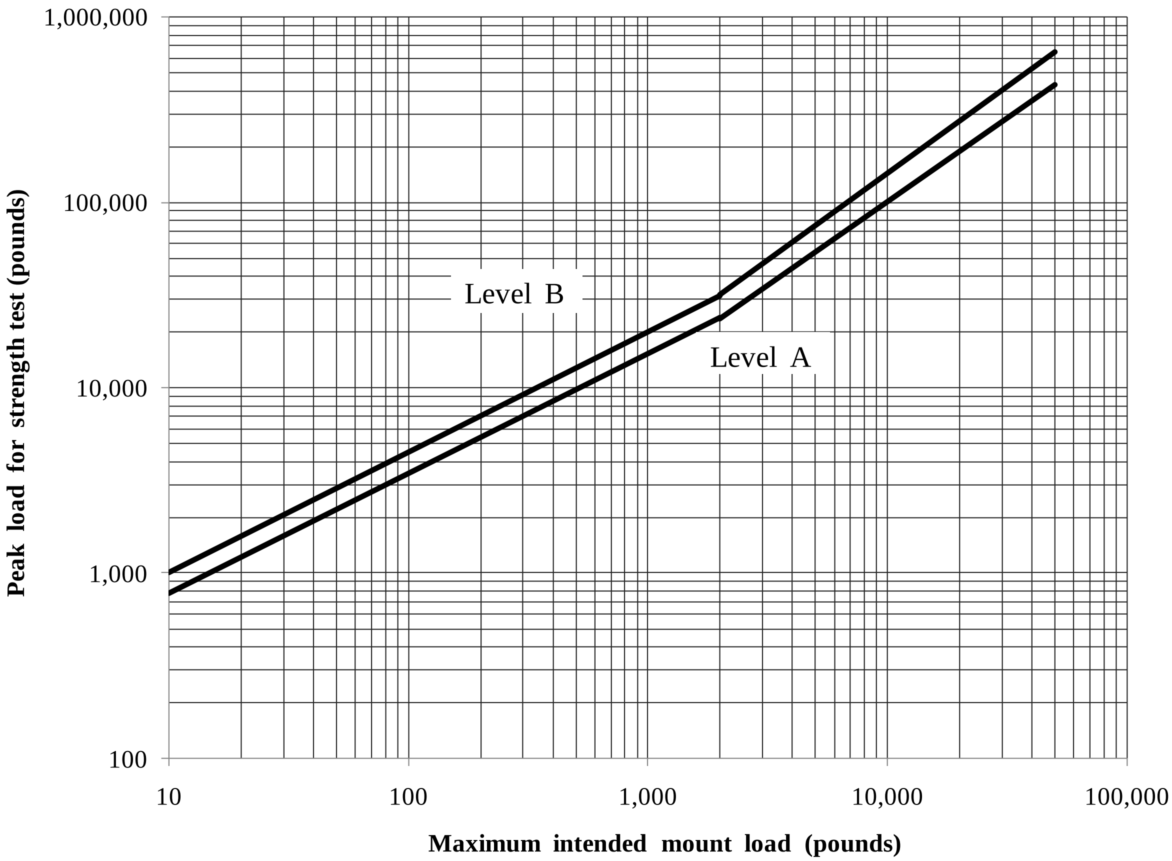

FIGURE 3. Applied loads for strength tests on type I mounts.

Custodians:
Navy – SH
Air Force – 03

Preparing activity:
Navy – SH
(Project 5340-2016-001)

Review activities:
Navy – CG,YD
Air Force – 71
DLA – IS

Civil agencies:
GSA – FAS

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