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DETAIL SPECIFICATION

SHOCK TESTS, H.I. (HIGH-IMPACT) SHIPBOARD MACHINERY, EQUIPMENT, AND SYSTEMS, REQUIREMENTS FOR

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.

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

1. SCOPE

1.1 Scope. This specification covers high-impact (H.I.) shock testing requirements for machinery, equipment, systems, and structures aboard surface ships, including carriers unless otherwise noted, and submarines, herein referred to collectively as “ships”. The purpose of these requirements is to verify the ability of shipboard installations to withstand shock loadings due to the effects of nuclear or conventional weapons or environmental mechanical shock during operation.

1.2 Classification.

1.2.1 Test categories. Tests are classified in accordance with one of the following test categories, as specified (see 3.1.2, 6.2.1, and 6.2.2):

1.2.1.1 Standard shock test methods (see 3.1.8.1 through 3.1.8.4).

Lightweight. The lightweight shock test is a test performed on the lightweight shock machine (LWSM) (see figure 1).

Medium weight. The medium weight shock test is a test performed on the medium weight shock machine (MWSM) (see figure 2).

Heavyweight. The heavyweight shock test is a test performed on a Standard Floating Shock Platform (FSP), Extended Floating Shock Platform (EFSP), Intermediate Floating Shock Platform (IFSP), or Large Floating Shock Platform (LFSP) (see 3.1.2.c and figures 3, 3a, 3b, and 4).

Medium weight deck simulating. The medium weight deck simulating shock test is a test performed on Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment on the Deck Simulating Shock Machine (DSSM) (see figure 23).

1.2.1.2 Alternate shock test vehicles/machines (see 3.1.8.5). All equipment categorized as requiring lightweight, medium weight, heavyweight, or medium weight deck simulating shock testing can, at the discretion of the Technical Authority, be tested on the Submarine Shock Test Vehicle (SSTV), Full Scale Section (FSS), A/B-1, or by other means approved by the Technical Authority (see 6.5). In some cases, the Paddle Wheel Test Vehicle (PWTV), simple drop testing, or other machines that can be used to test mast mounted equipment, subsidiary components, etc., may be used with approval by the Technical Authority.

1.2.2 Shock grades. Items to be tested are classified in accordance with one of the following grades, as specified (see 3.1.3 and 6.2.1):

Grade A. Grade A items are items that are essential to the safety and continued combat capability of the ship.

Grade B. Grade B items are items whose operation is not essential to the safety and combat capability of the ship, but which could become a hazard to personnel operating or manning Grade A equipment including personnel at battle stations, to Grade A items, or to the ship as a whole, as a result of exposure to shock.

1.2.3 Equipment types. Items to be tested are classified in accordance with one of the following types, as specified (see 3.1.4 and 6.2.1):

Principal unit

Subsidiary component

Subassembly

Note that the definitions of principal unit (see 6.6.27), subsidiary component (see 6.6.39), and subassembly (6.6.35) may be different than other common usages.

1.2.4 Equipment classes. Items to be tested are classified in accordance with one of the following classes, as specified (see 3.1.4 and 6.2.1):

Class I. Class I equipment is required to meet these shock requirements without the use of isolation devices (e.g., shock, noise, or vibration mounts, or flexible elements) installed between the equipment and the ship structure or shipboard foundation. (For clarification on submarines only, equipment mounted on a submarine conventional deck [see 6.6.36] or submarine shock mitigated deck [see 6.6.38] without isolation devices between the equipment and the deck is still considered Class I, or Class I/II [as defined below], vice Class II equipment). Examples are on figure 20.

Class II. Class II equipment is required to meet these shock requirements with the use of isolation devices (e.g., shock, noise, or vibration mounts, or flexible elements) installed between the equipment and the ship structure or shipboard foundation. Examples are on figure 20.

Class I/II. Class I/II equipment is equipment that has some part or parts that are required to meet these shock requirements without the use of isolation devices (e.g., shock, noise, or vibration mounts, or flexible elements) and some other part or parts that are required to meet these shock requirements with the use of isolation devices installed between the part(s) and ship structure or shipboard foundation. Examples are on figure 20.

Class III. Class III equipment has shipboard application both with and without the use of isolation devices (e.g., shock, noise, or vibration mounts, or flexible elements) installed between the equipment and the ship structure or shipboard foundation, and is therefore required to meet these requirements with and without the use of isolation devices.

1.2.5 Shock test types. Tests are classified in accordance with one of the following types, as specified (see 3.1.5 and 6.2.1):

Type A. A Type A test is a test of a principal unit.

Type B. A Type B test is a test of a subsidiary component.

Type C. A Type C test is a test of a subassembly.

1.2.6 Mounting locations. Items are classified in accordance with one of the following mounting locations aboard ship, as specified (see 6.2.1):

1.2.6.1 Hull mounted. Hull mounted items are those mounted on:

a. For surface ships, excluding carriers. The main structural members of the ship that have a direct load path to the wetted hull, including structural bulkheads and structural bulkhead stiffeners below the main deck, and shell plating above the waterline.

b. For carriers. The basic hull structure, including frames, structural bulkheads below the waterline (or limiting draft, as defined by the ship specification), and shell plating above the waterline.

c. For submarines. The main structural members of the ship including structural bulkheads including stiffeners, hard tanks, the haunched portion of typical frames, and deep frames, but excluding typical hull frames.

1.2.6.2 Deck mounted. Deck mounted items are those mounted on:

a. For surface ships, excluding carriers. The main deck and above, and decks, platforms, and non-structural bulkheads below the main deck, or on structural bulkheads that do not have a direct load path to the wetted hull (see 6.6.40).

b. For carriers. Decks, structural bulkheads that are above the waterline (or limiting draft, as defined by the ship specification), or non-structural bulkheads.

c. For submarines.

(1) Conventional deck mounted. A conventional deck (see 6.6.36).

(2) Mitigated deck mounted. A shock mitigated deck (see 6.6.38).

(3) Isolated deck mounted. A shock isolated deck (see 6.6.37). (Testing and extension requirements are not covered by this specification.)

1.2.6.3 Shell mounted. Shell mounted items are those mounted on:

a. For surface ships. The shell plating and longitudinal stringers below the waterline.

b. For submarines. The shell plating. (This specification does not cover underwater explosion testing of items that penetrate the submarine pressure hull [see 3.1.1.1].)

1.2.6.4 Wetted-surface mounted. Wetted-surface mounted items are those located such that the item is fluid immersed and mounted:

a. For surface ships. Below the waterline and (1) external to the hull or (2) internal within normally filled hull integral tankage.

b. For submarines. External to a pressure hull boundary or internal within a normally filled hull integral tankage.

Except that, for all ships, where the item is (1) arranged in a location not subject to explosion-induced water flow, such as ballast tanks or fairwaters, or whose compactness makes it insensitive to flow effects; (2) has no buoyant or pressure sensitive components; and (3) where specifically exempted by the Technical Authority, then the item is considered not vulnerable to wetted surface effects and is classified and qualified as appropriate to its mounting location.

1.2.6.5 Submarine frame mounted. Frame mounted items are those mounted directly on submarine hull frames, excluding frames identified as submarine hull mounted item locations (see 1.2.6.1.c.).

1.2.6.6 Submarine end closure/closure bulkhead mounted. End closure/closure bulkhead mounted items are those mounted directly on submarine pressure hull closure bulkheads, but in areas not backed by pressure hull frames or external framing.

1.2.6.7 Surface ship mast mounted. Mast mounted items are those mounted on the surface ship's masts, yard-arms, or other flexible structure above deck.

1.2.7 Mounting plane aboard ship. Items are classified in accordance with one of the following planes of mounting aboard ship, as specified (see 6.2.1 and figure 27):

Base (Bottom)

Front or face

Back

Top

Combination (such as base and back)

Other

1.2.8 Mounting orientation aboard ship. Items are classified in accordance with one of the following installed orientations aboard ship, as specified (see 6.2.1 and figures 28 through 30):

a. Unrestricted. The item is installed aboard ship in any orientation with respect to the vertical, fore-aft, and athwartship axes of the ship without limitation.

b. Vertical axis specified. The item is installed aboard ship in a particular orientation with respect to the vertical axis of the ship, but without regard to the fore-aft or athwartship axes of the ship.

c. Restricted. The item is installed aboard ship in a particular orientation with respect to the vertical, fore-aft, and athwartship axes of the ship.

Mounting orientation restrictions or limitations that are applicable to the item's installation should be recorded on block 23, "Remarks/Approval Limitations", of figure 19.

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.

DEFENSE SPECIFICATIONS

MIL-DTL-1222	-	Studs, Bolts, Screws and Nuts for Applications Where a High Degree of Reliability is Required; General Specification for
MIL-DTL-15024	-	Plates, Tags and Bands for Identification of Equipment
MIL-P-15024/5	-	Plate, Identification
MIL-W-21157	-	Weldment, Steel, Carbon and Low Alloy (Yield Strength 30,000 – 60,000 PSI)
MIL-DTL-22200/1	-	Electrodes, Welding, Mineral Covered, Iron-Powder, Low-Hydrogen, Medium and High Tensile Steel, As Welded or Stress-Relieved Weld Application

FEDERAL STANDARDS

FED-STD-H28	-	Screw-Thread Standards for Federal Services

DEFENSE STANDARDS

MIL-STD-22	-	Welded Joint Design
MIL-STD-798	-	Nondestructive Testing, Welding, Quality Control, Material Control and Identification and HI-Shock Test Requirements for Piping System Components for Naval Shipboard Use
MIL-STD-1689	-	Fabrication, Welding, and Inspection of Ships Structure
MIL-STD-31000	-	Technical Data Packages

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

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

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

BUSHIPS 10-T-2145-L	-	HI Shock Testing Machine, Lightweight
BUSHIPS 645-1973904	-	Floating Shock Platform, General Arrangement and Details
BUSHIPS N0807-655947	-	HI Shock Testing Machine, Medium Weight
NAVSEA 072-6938024	-	Ninety Degree Mounting Fixture for Testing Equipment on the Medium Weight Shock Test Machine

H-81898-SF-645-H-1644 - Large Floating Shock Platform (San Francisco Bay Naval Shipyard Drawing)

(Copies of these documents are available from the applicable repositories listed in S0005-AE-PRO-010/EDM, which can be obtained online at https://nll.ahf nmci.navy.mil, may be requested by phone at 215-697-2626, or may be requested by email at nllhelpdesk@navy.mil. Copies of these documents may also be obtained from the Naval Ships Engineering Drawing Repository (NSEDR) online at https://199.208.213.105/webjedmics/index.jsp. To request an NSEDR account for drawing access, send an email to NNSY_JEDMICS_NSEDR_HELP_DESK@navy.mil.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

S9074-AR-GIB-010/278 - Requirements for Fabrication, Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels

(Copies of this document are available online at https://nll.ahf.nmci navy mil, may be requested by phone at 215-697-2626, or may be requested by email at nllhelpdesk@navy.mil. This publication can be located by searching the Navy Publications Index for the Technical Manual Identification Number (TMIN) without the suffix.)

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.

ASME

ASME B46.1 - Surface Texture (Surface Roughness, Waviness and Lay)

ASME Y14.5 - Dimensioning and Tolerancing

ASME Y14.6 - Screw Thread Representation

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

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4 - Standard Symbols for Welding, and Nondestructive Testing, Including Brazing and Nondestructive Examination

AWS A3.0 - Standard Welding Terms and Definitions, Including Terms for Brazing, Soldering, Thermal Spraying, and Thermal Cutting

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

HUNTINGTON INGALLS INDUSTRIES, NEWPORT NEWS SHIPBUILDING

DSSM 2010-100 - Deck Simulating Shock Machine Generation II Assembly

DSSM 2010-102 - 25Hz Spring Tray Assembly

DSSM 2010-103 - 8-14Hz Spring Tray Assembly

(Copies of these documents are available from COMNAVSEASYSCOM, 1333 Isaac Hull Avenue SE, Washington Navy Yard, DC 20376.)

HI-TEST LABORATORIES DRAWINGS

HT-IFSP-1 - Intermediate Floating Shock Platform (IFSP)

HT-OH-39 - Paddle Wheel Test Vehicle (PWTV)

(Copies of these documents are available from COMNAVSEASYSCOM, 1333 Isaac Hull Avenue SE, Washington Navy Yard, DC 20376.)

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 Shock testing requirements. Shock testing requirements shall be met either by shock testing (see 3.1.1 through 3.1.15) or by extension of previously approved shock tests (see 3.2). Shock machines and FSPs shall comply with the appropriate Government drawings, unless otherwise approved by the Technical Authority.

3.1.1 Establishment of requirements. Requirements contained herein are intended to establish general shock test criteria, and to provide a basis for selection by the contracting activity or contractor of detailed shock test requirements (see 6.2.2), which must be tailored to suit the design, function, and application of the specific item to be tested.

3.1.1.1 Limitations. This specification is very general so as to cover the entire field of shipboard machinery, equipment, and systems. This specification does not cover all the detailed requirements for shock testing of any specific item. In order to apply this specification properly and avoid post-test disagreements, all features enumerated herein shall be specified, described, or defined as specified (see 6.2.1). Testing of items located on submarine shock isolated decks, testing of submarine pressure hull penetrations (see 1.2.6), and testing of wetted surface components to hull integrity levels, are not covered by this specification.

3.1.1.2 Contractor development of requirements. Where required data listed in 6.2.1 is not specified in the acquisition documents, the contractor shall develop the required information on the basis of this specification and on the basis of the contractor's knowledge of the design, function, and intended application of the item requiring tests. In cases where information required by the contractor to permit development of detailed testing requirements is not available to the contractor, such information shall be requested from the contracting activity or Technical Authority. Contractor-developed ordering data requires approval by the Technical Authority (see 6.2.2.b, 6.5.c, and 6.5.d).

3.1.1.3 Approval of detailed requirements. For heavyweight and alternate vehicle/machine shock tests, detailed test procedures and other ordering data listed in 6.2, which are independently developed by the contractor, shall require Technical Authority approval prior to installing the item for shock tests (see 6.5.c). Test fixture drawings shall be as specified (see 6.2.3) and justification shall be provided as to why the test fixture satisfactorily meets the requirements of this document (see 6.2.3). Acquisition documents may require that detailed test procedures and other information required by 6.2.1, which are independently developed by the contractor for lightweight, medium weight, and medium weight deck simulating shock tests, also be approved by the Technical Authority prior to installing the item for shock tests (see 6.5.d). Absence of specified requirements for prior approval of such information does not prohibit the contractor from submitting such information for approval prior to testing.

3.1.2 Selection of test category (see 1.2.1). Unless otherwise specified (see 1.2.6, 6.2.2, and 6.5), for surface ships, shell mounted and wetted surface mounted items shall be subject to heavyweight shock testing. Unless otherwise specified (see 1.2.6, 6.2.2, and 6.5), for submarines, shell mounted items and wetted surface mounted items shall be subject to heavyweight or alternate vehicle shock testing. Other items shall be proven acceptable by either lightweight, medium weight, heavyweight, medium weight deck simulating, or alternate vehicle/machine shock testing, provided that the following limitations are complied with:

a. Lightweight shock test. The total weight supported by the lightweight shock machine anvil plate (excluding the weight of anvil plate itself but including all structure and equipment added to the anvil plate) shall not exceed, for surface ship items and submarine shock mitigated deck mounted items, 550 pounds, and for submarine conventional deck, hull, and frame mounted items, 300 pounds. Practical size limitations shall not be exceeded. Equipment that would normally be tested on the lightweight shock machine, but is mounted on or incorporates isolation devices (e.g., shock, noise, or vibration mounts; or flexible elements) that have a deflection capability under shock loading of 1½ inches or more in any direction, shall instead be subject to medium weight, medium weight deck simulating, heavyweight, or alternate vehicle/machine shock testing.

b. Medium weight shock test. For surface ship items and submarine shock mitigated deck mounted items, the total weight supported by the medium weight shock machine anvil table shall not exceed 7,400 pounds. For submarine conventional deck mounted and hull mounted items, the total weight (item and test fixture) supported by the medium weight shock machine anvil table shall not exceed 6,000 pounds and the item weight supported by the anvil table shall not exceed 4,500 pounds (except as noted below). When the standard 90-degree fixture (figure 18a), or a previously approved non-standard 90-degree fixture, is used for testing submarine conventional deck mounted and hull mounted items, the maximum allowable total weight supported by the medium weight shock machine anvil table shall not exceed 7,400 pounds and the item weight supported by the anvil table shall not exceed 4,500 pounds. For submarine frame mounted items, the total weight supported by the medium weight shock machine anvil table shall not exceed 3,400 pounds (except as noted below). When the standard 90-degree fixture (figure 18a), or a previously approved non-standard 90-degree fixture, is used for testing submarine frame mounted items, the maximum allowable total weight supported by the medium weight shock machine anvil table shall not exceed 5,000 pounds and the item weight supported by the anvil table-shall not exceed 3,400 pounds. The use of previously approved non-standard 90-degree fixtures shall comply with the requirements of 3.1.6.4. Practical size limitations shall not be exceeded. Equipment that would normally be tested on the medium weight shock machine, but is mounted on or incorporates isolation devices (e.g., shock, noise, or vibration mounts, or flexible elements) that have a deflection capability under shock loading of 3 inches or more in any direction, shall instead be subject to medium weight deck simulating, heavyweight, or alternate vehicle/machine shock testing.

c. Heavyweight shock test. Weight, size, and center of gravity (CG) limitations applicable to Standard FSP (see figure 3) testing are shown on figure 5. Weight, size, and CG limitations for the utilization of the EFSP (see figure 3a), IFSP (see figure 3b), or LFSP (see figure 4) shall be in accordance with figures 5a, 5b, and 6, respectively. The approved payload weight limits for the FSPs are as follows:

(1) Standard FSP: 2,500 lbs * (L – 4); where L = barge length in ft
For example, the standard 28-ft FSP has a 60,000-lb limit.

(2) EFSP: 100,000 lbs.

(3) IFSP: 250,000 lbs.

(4) LFSP: 400,000 lbs.

NOTE: It may be acceptable to exceed these approved payload weight limits on a case basis subject to Technical Authority review and approval.

FSP deck simulating fixture (DSF) mass ratios may limit the maximum tested equipment weight. Mass added to satisfy the FSP DSF mass ratio requirements of 3.1.8.5.1.3 shall be included in the payload capacity calculations of heavyweight shock test procedures that include the use of the DSF.

d. Medium weight deck simulating shock test. This test is performed on Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment, subject to satisfying all criteria for use of the DSSM in 3.1.8.4. The shock excursion envelope of Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment (6.6.32) shall not interfere with the DSSM cage structure (see figure 23), which has an interior dimension of 56 inches by 56 inches by 88 inches, or the conduct of the test. The payload weight limit shall be as specified on figures 24 through 26 for the testing of all Class II isolated payloads with weights up to 1,000 pounds and some Class II isolated payloads with weights up to 4,000 pounds. Applicability for weights between 1,000 and 4,000 pounds is dependent on ship type as well as equipment, fixture, and additional weight. Greater weights may be used subject to review and approval by the Technical Authority.

e. Alternate shock test vehicles/machines. Use of alternate shock test vehicles/machines may be required when specified (see 6.2.2).

(1) Shell mounted items. The PWTV may be utilized as an alternate shock test vehicle as approved by the Technical Authority. When shock testing on the PWTV, shell mounted items shall be attached to the PWTV target plate using the same attachment method as specified in the shipboard installation. The equipment weight shall not exceed 900 pounds and its attachment points to the target plate shall not extend beyond a 15-inch diameter area on the target plate centered about the equipment's centroid. A clearance of at least 6 inches shall be maintained between an internal shell mounted item and the paddle wheel backing plate when installed in the paddle wheel.

(2) Submarine end closure/closure bulkhead mounted items not directly backed by pressure hull frames or external stiffeners. Technical Authority approval shall be obtained for the test to be performed as either shell mounted (see 1.2.6.3) or frame mounted (see 1.2.6.5).

(3) Surface ship mast mounted items. In order to meet the requirements of 3.1.6.4, non-standard testing is generally required for mast mounted items. Alternate shock testing vehicles/machines may be used to provide a technically acceptable alternative on a case basis subject to Technical Authority review and approval. Mast mounted equipment ordering data shall include shipboard location and equipment shock test requirements.

f. Separately specified limitations. Acquisition documents may specify the shock test category, or may impose additional limitations upon selection of the test category (see 6.2.2).

3.1.3 Selection of shock grade (see 1.2.2). Shock grade shall be as specified (see 6.2.1). If shock grade is not specified, acceptance of tested items shall be based upon requirements for Grade A items (see 3.1.10.1), unless otherwise approved by the Technical Authority.

3.1.4 Selection of equipment type and class (see 1.2.3 and 1.2.4). Equipment type and class shall be as specified (see 6.2.1) or, if no type or class is specified, shall be selected to suit the types or classes described in 1.2.3 or 1.2.4.

3.1.5 Selection of shock test type (see 1.2.5). Shock test type shall be as specified (see 6.2.1).

3.1.5.1 Type A. The Type A test (principal unit test) shall be required in all cases, except as indicated in 3.1.5.2 and 3.1.5.3. The fact that subsidiary components and subassemblies of a principal unit have passed the Type B or C shock test does not affect requirements for Type A testing.

3.1.5.2 Type B. The Type B test (subsidiary component test) shall be required in cases where Type A testing is not possible due to heavyweight shock test size or weight limitations (see 3.1.2.c and 6.2.1). The fact that subassemblies have passed Type C tests does not affect requirements for Type B testing. Type B testing may also be required by specifications (or may be recommended by the contractor for approval by the Technical Authority) to suit any of the following situations:

a. In cases where a subsidiary component (such as an electric motor) is associated with a wide variety of principal units, Type B testing of the item may be required by the acquisition documents for the purpose of providing reasonable assurance that the item will also pass subsequent Type A tests (when tested as a part of one or more principal units), and to support shock test extension or analysis.

b. In cases where a subsidiary component has failed during shock testing of a principal unit, repeat shock testing of the subsidiary component only (by Type B testing) may be permitted by the Technical Authority in lieu of repeat testing of the entire principal unit (see 3.1.11.5.1).

c. In cases where a subsidiary component is installed in a principal unit where the principal unit is re-qualified by shock extension, and in cases where a subsidiary component is installed in a principal unit and the principal unit is not re-qualified (e.g., controllers on the turbine generator), Type B testing may be required. The effect of the subsidiary component on the survivability of the principal unit must be evaluated in the shock extension process, regardless of whether or not the principal unit is designated for requalification. Additionally, limitations must be placed on the subsidiary component qualification based on the application and non-standard test performed to represent the principal unit installation.

3.1.5.3 Type C. The Type C test (subassembly test) shall be performed only when specified (see 6.2.1) or as approved by the Technical Authority. The Type C test may be required by specifications (or recommended by the contractor for consideration by the Technical Authority) for the same reasons as indicated in 3.1.5.2.a, 3.1.5.2.b, and 3.1.5.2.c. The contractor may also recommend performance of Type C tests in cases where subassemblies associated with a principal unit or subsidiary component are not available at the time the principal unit or subsidiary component is scheduled for shock testing (see 3.1.7.3).

3.1.6 Mounting and testing requirements. Items shall be mounted upon shock machines (see figures 1, 2, and 23), upon FSPs (see figures 3, 3a, 3b, and 4), or upon alternate shock test vehicles/machines for shock testing in the manner specified (see 6.2.1). 3.1.6.1 through 3.1.6.4 provide testing requirements, mounting requirements, and requirements applicable to selection or design of shock test mounting fixtures by the contracting activity, and provide requirements that shall be observed by the contractor in the event that the required mounting fixture design is not specified by the acquisition documents.

3.1.6.1 Mounting and testing of test items to the standard or non-standard test fixtures. Items, regardless of class, shall be mounted to the appropriate standard or non-standard fixture. The means of attachment of the item to the test fixture shall represent the means of attachment aboard ship, where possible. Where not possible, the means of attachment shall be at least as stiff, in the three orthogonal directions, as the shipboard attachment. Items that are not mounted directly to ship structure (e.g., valves suspended in pipe runs) may be attached to the appropriate standard or non-standard test fixture using additional support structure (such as block hangers for pipe hung components).

a. Class I equipment shall be shock tested mounted to the test fixture in the non-isolated mounting configuration (see 6.6.23).

b. Class II equipment shall be shock tested mounted to the test fixture in the isolated mounting configuration. Class II equipment for which all isolation devices are Limited Displacement Capability Isolation Devices (LDCIDs) (see 6.6.21), and where the equipment's shock response frequency (SRF) is greater than 37 Hz, may be tested upon the mounts to Class I equipment requirements with approval by the Technical Authority. Class II equipment utilizing external LDCIDs and any internal non-LDCIDs shall be qualified to Class I/II equipment requirements, unless otherwise approved by the Technical Authority.

c. Class I/II equipment shall be shock tested mounted to the test fixture in the shipboard mounting configuration. Class I/II equipment that only uses LDCIDs may be tested to Class I equipment requirements with approval by the Technical Authority, including approval that the corresponding SRF requirements have been met.

d. Unless otherwise specified (see 6.2.1.i, 6.2.2 f), or if approved by the Technical Authority (see 6.5.y), Class III equipment shall be shock tested mounted to the test fixture in both the isolated and non-isolated mounting configurations. Class III equipment for which all isolation devices are LDCIDs, and where the equipment's SRF is greater than 37 Hz, may be tested in the non-isolated mounting configuration to Class I equipment requirements with approval by the Technical Authority. Permission to do so is subject to the provision that the isolation devices, subbases, hold-down means, and other components unique to the isolation mounted installation are selected, designed, or shock tested to satisfy separately invoked shock requirements.

e. Medium weight shock machine test orientations and inclinations are provided in tables VI through X for surface ships and tables XI and XII for submarines. For cases where the item has application in both submarines and surface ships, test orientations and inclinations for submarine application shall be used. When an item is to be qualified on the medium weight shock machine for any mounting location excluding shell mounted equipment, it shall be tested for unrestricted orientation. When medium weight testing is required to be performed prior to knowing the actual shipboard mounting orientation, the item shall be tested for unrestricted mounting orientation, or vertical axis specified mounting orientation if appropriate (see 1.2.8). Additional criteria for selection and use of medium weight test fixtures are contained in 3.1.6.3.1 and 3.1.6.4.

f. For heavyweight or alternate vehicle/machine shock testing, consideration shall be given to the mounting orientation of the equipment aboard ship. If this equipment is to be qualified for vertical axis specified mounting orientation (see 1.2.8) or if the limiting mounting orientation is not known, testing in two test orientations may be required (see 3.1.8.3.1.b). Qualification of equipment for unrestricted mounting orientation (see 1.2.8) on the Standard FSP, EFSP, IFSP, or LFSP will generally require testing in three test orientations (see 3.1.8.3.1.a).

g. For medium weight deck simulating shock testing, test items shall be mounted in the DSSM in the isolated mounting configuration, using an approved fixture, according to the following conditions:

(1) Equipment shall be positioned in the cage so that the vertical location of the principal unit CG during the test accurately represents the vertical location of the principal unit CG in the shipboard installation.

(2) Equipment shall be positioned in the cage so that the horizontal principal unit CG is located inside the internal cage dimensions and, where practicable, along the cage side-to-side center plane as depicted on figure 23.

3.1.6.2 Lightweight test fixtures. For lightweight shock tests, items to be tested shall normally be attached to the anvil plate of the lightweight shock machine by means of standard mounting fixtures 4A, 4C, 6D-1, 6D-2, 6E, or 11-C as shown on figures 7 through 12. If the required mounting fixture is not specified, an appropriate standard fixture shall be selected by the contractor (see 3.1.6.4), or the contractor may recommend the use of a non-standard fixture that complies with 3.1.6.4 for approval by the Technical Authority. The test item shall be mounted directly to standard or non-standard fixtures. No intermediate fixtures or interface fixtures are to be used except as indicated in 3.1.6.2.1. When the item has been mounted for test upon a standard or non-standard fixture, its position upon the fixture shall not be changed to accomplish the required orthogonal blows during the course of the test (see 3.1.8.1).

3.1.6.2.1 Modifications to fixture 4C of figure 8 and fixture 11-C of figure 12. To minimize mounting plate and fixture replacement due to excessive perforation of the mounting plates, the test facility may specify installation patterns for the ½ inch bolts in the mounting plates of these fixtures to allow for universal mounting arrangements using adaptor plates, contingent upon review and approval by the Technical Authority.

3.1.6.3 Medium weight test fixtures. For medium weight shock tests, items to be tested shall normally be attached to the medium weight shock machine anvil table by means of the standard or non-standard mounting fixtures referred to in 3.1.6.3.1. If the required mounting fixtures are not specified, appropriate standard fixtures shall be selected by the contractor (see 3.1.6.4), unless use of one or more non-standard fixtures that comply with 3.1.6.4 is recommended by the contractor with substantiating technical justification and approved by the Technical Authority. Note that different test fixtures may be required for testing of a given item depending on the item's class and the number of test orientations (vertical, athwartship, fore-aft) in which the item is to be tested. When an item's applications encompass more than one mounting location, mounting orientation, or both, the item shall be tested for its most severe application.

3.1.6.3.1 Selection of test fixtures (medium weight shock test). For the portion of the shock test series that is intended to produce shock loadings in the vertical direction, items shall be attached to the anvil table by means of the standard mounting platforms (shown on figures 13 and 14 for base mounted items and figures 15 or 18a for back mounted items) or a suitable non-standard fixture. For the portion of the shock test that is intended to produce shock loadings in the athwartship directions, items shall be attached to the standard mounting platforms (shown on figures 15, 16, 17, 18, or 18a) or a suitable non-standard 30- or 90-degree fixture. Tables VI through VIII give requirements for selection of surface ship test orientations and inclinations; tables XI and XII give requirements for selection of submarine test orientations and inclinations. If practical, a back mounted item may be mounted on a vertical fixture (such as shown on figure 15), which is in turn mounted on an inclined fixture such as shown on figures 16 or 17. All non-standard fixtures shall be approved by the Technical Authority prior to testing.

3.1.6.3.2 Medium weight shock machine mounting requirements.

a. Supporting channels. Carbuilding channels, standard channels, and mixed channels are to be used in mounting the test item such that symmetry is achieved whenever possible. Mixed channels shall be used where they can eliminate the use of carbuilding channel pairs and standard channel pairs in the same mounting arrangement. When mixed channels are used, the carbuilding channel shall be oriented toward the outside of the table and the standard channel to the inboard side. Dimension "A" (see note 1 of figure 13) is centered between the shipbuilding channels and shall be measured along the supporting channel axis.

b. Spacers. Spacers shall be used at each mounting bolt between the supporting channels and the test item or any intermediate structure (plates, standard fixtures, special fixtures). Steel spacers shall be approximately 6 inches by 2 inches by 0.5 inch thick with a clearance hole for the mounting bolt. These spacers shall be installed with the longest dimension running perpendicular to the supporting channel pair.

c. Intermediate structures. The flexibility of the supporting channels is required to produce energy in the appropriate fundamental frequency band. The structures between the supporting channels and test item shall not change the frequency response of the item under test by introducing additional flexibility. For this reason, intermediate plates and fixtures used to mount the test item to the supporting channels shall be rigid enough so that they do not influence the shock environment for the item under test. Intermediate plates shall be of sufficient thickness to remain rigid, and the plates shall extend for the minimum distance necessary beyond the mounting pattern of the test item.

d. Use of bulkhead fixture on figure 15. The bulkhead fixture identified on figure 15 has a dimension “A” of 36¼ inches and a dimension “B” of 48 inches (see Bottom View, Drilling Pattern of figure 15 and note 1 of figure 13). The bulkhead fixture shall be installed in the center of the supporting channels (supporting channels defined on figure 13 are referenced as mounting channels in Front Elevation view on sheet 1 of figure 15). Ballast shall be used to balance the anvil table. It is permissible to attach ballast directly to the fixture on figure 15, in which case it shall be included in the weight of the fixture when determining the appropriate number of channels per figure 13. In addition, it is permissible to attach the equipment to either side of each face of the fixture on figure 15.

e. Use of figure 15 with figure 16. Occasionally, it is necessary to use the fixture shown on figure 15 with the fixture shown on figure 16. If it is necessary to orient the fixture shown on figure 15 with its test item mounting plane parallel to the 30 degree mounting flanges of figure 16, an intermediate mounting plate shall be used to preserve the “A” and “B” dimensions (see note 1 of figure 13), and the number of supporting channels shall be determined from this new assembly weight.

f. Use of the 30-degree fixtures on figures 16, 17, and 18. The following statements determine the proper use of figures 16, 17, and 18:

(1) Use of the 30-degree fixtures on figures 16 and 17 is dependent on dimensions “A” and “B” (see note 1 of figure 13).

(a) When dimensions “A” and “B” are equal (see note 1 of figure 13), it is acceptable to rotate the fixture on figure 16 on the supporting channels. 3.1.6.3.2.g shall be used to prescribe proper use of adaptor plates.

(b) When dimensions “A” and ”B” are not equal (see note 1 of figure 13), it is acceptable to remove the equipment and supporting channels from the fixture on figure 16 without disassembly of the equipment from the supporting channels and place them directly on the fixture on figure 17.

(2) The fixture on figure 18 shall be used on back mounted items only. The fixture on figure 18 shall be used in accordance with the vertical axis specified qualification series in table VII.

(3) The fixture on figure 17 shall only be used with the fixture on figure 15 to conduct 30-degree testing on back mounted equipment if there is no interference with the center supporting channels.

(4) Fixture balance shall be verified and corrected, if necessary, whenever test setups are changed (see 3.1.8.9).

g. Adaptor plates. The use of adaptor plates between the equipment and the supporting channels is allowed under the following guidelines:

(1) It is acceptable to use rectangular adaptor plates with the fixtures on figures 16 and 17.

(2) It is acceptable to use a square adaptor plate with bolt pattern dimension “A” equal to dimension “B” (see note 1 of figure 13) between the equipment and the supporting channels.

(3) The activity requesting use of adaptor plates and stiffened adaptor plates shall provide engineering information that identifies design and use of the adaptor plate and shall document all necessary limitations (e.g., equipment weight, CG, and equipment dimension “A” and “B” ratios) on acceptable adaptor plate use for equipment shock testing. The engineering information and documentation requires Technical Authority review and approval prior to first use.

3.1.6.4 Design and selection of test fixtures. The following requirements apply to selection of standard test fixtures in cases where none are specified, to design of non-standard fixtures for lightweight and medium weight shock tests, to design of heavyweight shock test fixtures, to design of medium weight deck simulating shock test fixtures, and to design of test fixtures for installation in alternate shock test vehicles/machines:

a. Except as indicated by 3.1.6.4.c, principal units shall be mounted for testing in a manner that simulates the most severe dynamic environment likely to be encountered in the actual shipboard installation. For Class I equipment, this is normally the stiffest mounting condition.

b. Subsidiary components and subassemblies shall be mounted in a manner that simulates the dynamic characteristics of the associated principal unit and the principal unit foundation. The flexibility of the principal unit foundation shall be considered. The flexibility of both the principal unit and foundation appropriate for the fixture design shall be as specified (see 6.2.1). If more than one installation is possible, the installation that provides the most severe dynamic environment shall be simulated.

c. Standard shock machine mounting fixtures are intended to represent hull mounted conditions, and are typically stiffer than would be required to simulate deck mounted conditions. The use of standard shock machine mounting fixtures is acceptable for tests of surface ship deck mounted (see 6.6.40), submarine conventional deck mounted, and submarine shock mitigated deck mounted Class I equipment. It is acceptable to mount Class I deck mounted equipment directly to the FSP inner bottom.

Heavyweight shock testing with a DSF, medium weight deck simulating shock testing, alternate vehicle/machine shock testing, or the use of other approved DSF shock testing methods is required for surface ship deck mounted, submarine conventional deck mounted, or submarine shock mitigated deck mounted Class II, Class I/II, or Class III equipment. Lightweight and medium weight shock machine testing of such equipment using standard fixtures is acceptable only in cases where all the isolation devices have limited displacement capability. Acquisition documents may specify additional requirements pertaining to shock machine testing of deck mounted Class II, Class I/II, or Class III equipment (see 6.2.2).

Heavyweight shock tests that are intended to simulate deck mounted conditions shall provide for the test fixture fundamental response frequencies similar to the response frequencies that the equipment will experience in its shipboard configuration. In those instances where it is impractical to determine the shipboard response frequency, the tests shall provide the following standard test fixture fundamental response frequencies (where the use of these frequencies is known to result in a deficient test, an alternate test shall be submitted for Technical Authority approval):

(1) Unless otherwise specified (see 6.2.2), for tests of Class I equipment, the fixtures shall provide a fundamental response frequency not lower than 25 hertz (Hz) in each principal shock direction.

(2) Unless otherwise specified (see 6.2.2), for tests of Class II equipment, the fixtures shall provide a fundamental response frequency in accordance with 3.1.6.5.

(3) Unless otherwise specified (see 3.1.6.5 and 6.2.2), for tests of Class I/II equipment and Class III equipment, if applicable, a fixture in accordance with (1), above, and a fixture in accordance with (2), above, are required.

d. Plastic yielding or cracking of test fixtures during shock tests, as determined by visual evidence, shall be considered unacceptable, unless otherwise specifically approved by the Technical Authority. (Acceptance of test fixture yielding or cracking by the Technical Authority is contingent upon demonstration by the contractor that such yielding or cracking did not reduce the validity of the test.)

e. Tested items shall be attached to their shock test fixtures in accordance with the manufacturer's installation drawings or the Interface Control Drawings (ICD). This method of mounting shall reflect the intended shipboard installation. Class II, Class I/II, and Class III equipment shall be mounted for tests upon the same type and arrangement of isolation devices as will be used to support the equipment aboard ship (except as allowed per 3.1.6.1.d).

f. Test fixtures for hull mounted heavyweight shock test items shall be attached directly to the Standard FSP's or EFSP's inner bottom structure (see figures 3 or 3a) or to transverse or longitudinal hull stiffeners of the IFSP or LFSP (see figure 3b and figure 4) or to the hull of the Technical Authority approved alternate shock test vehicles, and shall be designed in accordance with 3.1.6.4.a. Requests for approval shall be in accordance with 3.1.6.4.m.

g. Mounting fixtures for wetted surface mounted items shall be attached to the underside of the Standard FSP or IFSP, or to the external (wetted) surface on an alternate shock test vehicle. The mounting fixture shall be arranged such that the tested item is exposed to the direct explosion pressure wave during test. The test fixture shall be located so as to minimize (insofar as practical) the horizontal distance between the tested item and the side of the FSP that faces the explosive charge during the most severe test shot. For Standard FSP, IFSP, or Alternate Vehicle testing, test fixtures shall be designed in accordance with 3.1.6.4.a and 3.1.6.4.b and the fixture shall be designed to simulate the response of the item, including the effects of air-backed or water-backed mounting locations. The mounting fixture shall be approved in accordance with 3.1.6.4 m.

h. Unless otherwise specified (see 6.2.2), the Standard FSP shall be utilized for shock testing of wetted surface mounted transducers. The wetted portion of the transducer face shall be positioned at a horizontal standoff distance no greater than 21 feet from the explosive charge during the most severe test and no less than 3 feet below the underside of the FSP.

i. Surface ship shell mounted items shall be installed on the inner bottom plating of the FSP at a locale with a direct load path to the bottom shell plate as close to the shot as practicable. Submarine shell mounted items shall be attached directly to the FSP bottom shell or to the shell plating of submersible alternate shock test vehicles. For Standard FSP, IFSP, or Alternate Vehicle testing, test fixtures shall be designed in accordance with 3.1.6.4.a and 3.1.6.4.b and the fixture shall be designed to simulate the response of the item, including the effects of air-backed or water-backed mounting locations. The mounting fixture shall be approved in accordance with 3.1.6.4.m.

j. Acquisition documents may specify additional requirements pertaining to selection of standard test fixtures or to the required design of non-standard fixtures (see 6.2.2).

k. Where hold-down bolts for test items are specified to be torqued to specific values in the ship installation, the hold-down bolts shall be torqued to these values in the shock test installation (see 3.1.8.8 and 6.2.1). Where mounting torque is not specified, applied torque shall achieve a preload of two-thirds of the fastener yield stress.

l. Bolting materials and procedures used to secure items to the shock test fixtures or foundations shall conform to ship installation drawings, or, if not specified, shall conform to MIL-DTL-1222, Grade 5 minimum, or alternate fasteners that meet the minimum elongation, tensile strength, and yield strength requirements defined by MIL-DTL-1222 for machined specimens, or as approved by the Technical Authority.

m. Test fixtures designed in accordance with 3.1.6.4.a and 3.1.6.4.b for installation on FSPs and alternate shock test vehicles/machines shall be approved by the Technical Authority. Analyses shall demonstrate that the test configuration and fixtures will not yield or crack (see 3.1.6.4.d) and will provide a suitable dynamic representation of the shipboard installation. For the dynamic representation, the analysis, as a minimum, shall consist of a static one G comparative analysis applied in all three orthogonal directions, for both the shipboard and test vehicle/machine installations. The analysis should evaluate, as a minimum, the principal unit and any subsidiary components, subassemblies, or piping that affect the principal unit, as well as foundations. Foundations should be evaluated down to the interface of the foundation to the ship or test vehicle/machine structure (primary or secondary structure). Shock test fixture yielding shall be permitted in cases where the actual shipboard foundation is used for shock testing, subject to the analysis demonstrating the item will not come adrift during the shock test.

n. Frame mounted heavyweight shock test items shall be attached directly to the FSP inner bottom in alignment with its stiffener webs or to the hull frames of submersible alternate shock test vehicles. For FSP or alternate vehicle/machine shock testing, test fixtures shall be designed in accordance with 3.1.6.4.a and 3.1.6.4.b and approved in accordance with 3.1.6.4.m.

o. Use of non-standard test fixtures on the lightweight or medium weight shock machine requires Technical Authority approval prior to test on a case basis.

(1) Lightweight shock machine. Any shock test fixture designed to represent a specific shipboard installation that is mounted on a standard fixture or directly to the anvil plate during the shock test series is a non-standard fixture.

(2) Medium weight shock machine. Any shock test fixture designed to represent a specific shipboard installation that is mounted on a standard fixture or directly mounted to the supporting channels is a non-standard fixture.

p. Sway braces (see 6.6.13) are not required to be simulated during shock qualification testing. Upper foundations shall be simulated during shock testing. Simulation of upper foundations shall take into consideration the relative motions between the equipment upper and lower foundations.

3.1.6.5 Selection of DSF target frequencies.

3.1.6.5.1 For Class II equipment and, if applicable, Class I/II and Class III equipment. Unless otherwise specified (see 6.2) for tests of Class II equipment and, if applicable, Class I/II and Class III equipment mounted on all ships, fixtures that are intended to simulate deck mounted conditions shall possess fundamental response frequencies representative of the most severe shipboard condition with the equipment installed on the fixture. Selection of DSF target frequency is dependent upon Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment SRF ranges. Selection of SRF ranges shall be documented in the test procedure using isolator vendor information, information from previous tests of similar equipment, analytical methods, or other methods approved by the Technical Authority.

3.1.6.5.1.1 On surface ships. Specific DSF target frequencies for surface ship Class II equipment and, if applicable, Class I/II and Class III equipment, shall be as follows:

a. If the SRF of the equipment is greater than 37 Hz, standard fixtures intended to simulate hull mounting conditions for hull and deck mounted Class II equipment and, if applicable, hull and deck mounted Class I/II and Class III equipment may be used.

b. If the SRF of the equipment is greater than 18 Hz and less than or equal to 37 Hz, the DSF target frequency shall be 25 Hz (±4 Hz) in the vertical direction with the equipment installed.

c. If the SRF of the equipment is greater than or equal to 4 Hz and less than or equal to 18 Hz, the DSF target frequency shall be as follows:

(1) For surface ships excluding carriers, the DSF target frequency shall be 14 Hz (±2 Hz) in the vertical direction with the equipment installed.

(2) For carriers, the selection of DSF target frequency shall be:

(a) If the item is installed on a low-frequency carrier deck (as determined by the Technical Authority), the DSF target frequency shall be 8±1 Hz.

(b) If the item is installed on any other carrier deck, the DSF target frequency shall be 14±2 Hz.

(c) If the item is intended to be installed on all carrier decks, then both 8 Hz and 14 Hz DSF target frequencies shall be required.

d. If the SRF of the equipment is less than 4 Hz, the Technical Authority shall be notified and approval obtained to proceed with additional evaluation, analysis, or alternate testing to assure suitability of the equipment for shipboard service (see 6.2.2.h, 6.4.u, and 6.5.dd).

e. For selection of the DSF target frequency of Class I/II equipment installed on surface ships, the DSF target frequency of the Class I portion of Class I/II deck mounted equipment shall be selected in accordance with 3.1.8.3.2.1.b. For selection of the DSF target frequency of Class III equipment installed on surface ships, the DSF target frequency of the deck mounted equipment without the use of isolation devices shall be selected in accordance with 3.1.8.3.2.1.b and the target frequency of the deck mounted equipment with use of isolation devices shall be selected in accordance with 3.1.6.5.1.1.a through 3.1.6.5.1.1.d.

3.1.6.5.1.2 On submarines. Specific DSF target frequencies for Class II equipment and, if applicable, Class I/II and Class III equipment, shall be as approved by the Technical Authority in accordance with the following criteria:

a. If the submarine response frequency at the mounting location is less than or equal to 37 Hz or is unknown, the test shall be as approved by the Technical Authority.

b. If the submarine response frequency at the mounting location is greater than 37 Hz, the equipment shall be tested as a hull mounted item.

3.1.7 Simulation of items during shock tests.

3.1.7.1 Simulation of shipboard connections. In cases where piping, drive shafts, control linkages, electric cables and connectors, or similar items or structures will be connected to the shock tested item in the shipboard installation, characteristics of the connection that could significantly influence shock damage potential shall be represented during the shock test. Specific requirements for simulation of shipboard connections during shock tests shall be as specified (see 6.2.1) or, if not specified, shall be developed by the contractor on the basis of the following and for approval by the Technical Authority.

a. Rigid dummy masses may be used in place of the actual components to simulate inertial effects of the connected item (i.e., dummy masses used for simulating shipboard connections shall normally provide the same weight, CG, and means of attachment as the actual connected item). Dummy masses shall not be fabricated from brittle materials such as cast iron.

(1) When simulation of extended and relatively flexible connected items such as piping is considered conservative, dummy masses equal to the weight, including any contained fluid, of the first 5 feet or first 10 diameters (whichever is greater in weight) of the connected item shall be represented and oriented in a prototypical fashion. Dummy masses used for simulating flexible connected items shall provide the same means of attachment as the actual flexible connected item.

(2) Components supported by piping or other flexible connections where simulation of the flexibility is not considered conservative shall be tested by mounting between rigid support structure such as block hangers or bookends.

(3) When simulation of the shipboard connection in a prototypical manner is not practical, or when the prototypical configuration is not available at the time of testing, or if multiple applications exist, dummy masses may be placed in alternate locations for testing purposes, subject to approval by the Technical Authority.

(4) Acquisition documents may invoke specific requirements for the weight or design of dummy masses to be used during tests (see 6.2.2).

b. In cases where tested items will derive a substantial degree of support from relatively rigid shipboard connections (such that the connections effectively serve as secondary foundations), the restraining effects of these connections shall be simulated during the shock test.

c. For shock tests of resiliently mounted items, connections between the resiliently mounted item and other (separately mounted) items shall be represented during the shock test if shock-induced relative motion between the resiliently mounted item and the connected item could result in damage to the tested item or to the connection.

d. Lightweight, highly flexible items, such as cabling that bridges two structures, are a special concern. The relative motion of the elastic structures may generate large forces in such an item. To simulate this, consideration shall be given to this relative motion in the design of the test fixture.

e. Cable connections to the item under test shall be representative of the shipboard installation, and simulation of one or more (but not all) of a group of identical cable connections shall be in accordance with 3.1.7.2. It is noted that military standard connectors are not exempted from this requirement.

f. Cabling used during high-impact testing shall represent actual shipboard cabling, unless it can be demonstrated that the entire shipboard cable array is not needed to demonstrate functionality of the item and the added mass effects are not detrimental during high-impact testing (i.e., the differences are considered negligible); otherwise, appropriately sized dummy mass(es) and connectors shall be used in order to properly simulate the inertial effects on the unit under test.

g. In some cases ship structure or adjacent equipment can interfere with the shock excursion envelope of Class II equipment. For shock tests of such equipment, the adjacent ship structure or equipment shall be represented during the shock test if shock-induced relative motion between the Class II equipment and the adjacent ship structure or equipment could result in damage to either the tested Class II equipment or to the adjacent ship structure or equipment.

3.1.7.2 Simulation of subsidiary components. All subsidiary components that comprise a principal unit shall be shock tested with the principal unit unless the Technical Authority specifically permits simulation of one or more (but not all) of a group of identical subsidiary components that are installed on a common subbase (see 6.2.2). Dummy masses used for simulating subsidiary components shall provide the same weight, CG, moment of inertia, and means of attachment as the actual subsidiary component.

3.1.7.3 Simulation of subassemblies. The requirements of 3.1.7.2 also apply to simulation of subassemblies during Type A or Type B tests. Requests for permission to simulate subassemblies during Type A or Type B tests will be considered by the Technical Authority in cases where subassemblies associated with a principal unit or subsidiary component are not available at the time the principal unit or subsidiary component is scheduled to be tested. Subassemblies that are not tested with their associated principal unit or subsidiary component shall be subject to Type C testing (see 3.1.5.3).

3.1.8 Conduct of shock tests. Shock tests shall be conducted in accordance with 3.1.8.1 through 3.1.8.9 and with the accepted shock test procedures required by the data ordering document (see 6.2.3). In order to assure consistent shock hardening, variation from the basic shock test parameters of 3.1.8.1 through 3.1.8.4, which define the severity of the shock test, shall not be permitted. The method of mounting and the test orientation of the equipment (see 6.6.43) shall reflect the shipboard installation (see 3.1.6.4.e). In the event that modification of these basic shock test parameters is required, approval of the modification shall be obtained from the Naval Sea Systems Command.

3.1.8.1 Lightweight shock test. For all items subject to lightweight shock testing, up to three blows at hammer heights of 1, 3, and 5 feet shall be applied parallel to each of three mutually perpendicular axes of the item being tested. This is accomplished by attaching the test item by fixtures to an anvil plate and striking the anvil plate by three mutually perpendicular blows. It is not acceptable to rotate the equipment on the fixture to achieve the mutually perpendicular blows. The sequence of the testing may be varied at the discretion of the contracting activity and the contractor. In some cases, it may be more beneficial to conduct a 1-foot test in each of the three mutually perpendicular axes, followed by the 3-foot tests and then the 5-foot tests. Operating conditions during lightweight shock tests shall be as specified (see 6.2.1). If this information is not specified, the operating conditions during tests shall be selected in accordance with 3.1.8.6. Separate items may be substituted for each additional set of blows, if desired by the contractor.

The lightweight shock test series is determined by the equipment mounting orientation (see 1.2.8) and shall be accomplished in accordance with tables I through IV with the test orientation (see 6.6.43) being equivalent to the mounting orientation aboard the ship (or an alternative test orientation approved by the Technical Authority). The top, side, and back blows on the machine represent the test orientation vertical, athwartship, and fore-aft axes of the equipment mounting orientation aboard the ship. Specifically, the following test series shall be used:

a. The test schedule in table I shall be used for shock testing the following classifications of surface ship and submarine equipment.

(1) Surface Ship Class I, deck mounted equipment, unrestricted mounting orientation

(2) Surface Ship Class I, II, I/II, or III, hull mounted equipment, unrestricted mounting orientation

(3) Submarine Class I, conventional or mitigated deck mounted equipment, unrestricted mounting orientation.

(4) Submarine Class I, conventional deck mounted equipment, vertical axis specified mounting orientation

(5) Submarine Class I, II, I/II, or III, hull or frame mounted equipment, unrestricted mounting orientation

(6) Submarine Class I, II, I/II, or III, hull or frame mounted equipment, vertical axis specified mounting orientation

TABLE I. LWSM test schedule 1.

Hammer Height	Test Orientation		
	Vertical	Athwartship	Fore-Aft
1 ft			
3 ft	X	X	X
5 ft	X	X	X

KEY:
X denotes 1 blow

b. The test schedule in table II shall be used for shock testing the following classifications of surface ship and submarine equipment:

(1) Surface Ship Class I, deck mounted equipment, vertical axis specified mounting orientation

(2) Surface Ship Class I, II, I/II, or III, hull mounted equipment, vertical axis specified mounting orientation

(3) Submarine Class I, mitigated deck mounted equipment, vertical axis specified mounting orientation

TABLE II. LWSM test schedule 2.

Hammer Height	Test Orientation		
	Vertical	**Athwartship**	**Fore-Aft**
1 ft		X	X
3 ft	X	X	X
5 ft	X		
KEY: X denotes 1 blow			

c. The test schedule in table III shall be used for shock testing the following classifications of surface ship and submarine equipment:

(1) Surface Ship Class I, deck mounted equipment, restricted mounting orientation

(2) Surface Ship Class I, II, I/II, or III, hull mounted equipment, restricted mounting orientation

(3) Submarine Class I, mitigated deck mounted equipment, restricted mounting orientation.

TABLE III. LWSM test schedule 3.

Hammer Height	Test Orientation		
	Vertical	**Athwartship**	**Fore-Aft**
1 ft		X	X
3 ft	X	X	
5 ft	X		
KEY: X denotes 1 blow			

d. The test schedule in table IV shall be used for shock testing the following classifications of submarine equipment:

(1) Submarine Class I, II, I/II, or III, hull mounted equipment, restricted mounting orientation

(2) Submarine Class I, conventional deck mounted equipment, restricted mounting orientation

(3) Submarine Class I, II, I/II, or III, frame mounted equipment, restricted mounting orientation

TABLE IV. LWSM test schedule 4.

Hammer Height	**Test Orientation**		
	Vertical	**Athwartship**	**Fore-Aft**
1 ft			X
3 ft	X	X	
5 ft	X	X	
KEY: X denotes 1 blow			

3.1.8.2 Medium weight shock test. Medium weight shock testing of surface ship and submarine equipment shall be conducted in accordance with the medium weight shock machine test schedule in table V. Operating conditions during any particular group or groups of blows shall be as specified (see 6.2.1). If this information is not specified, operating conditions during tests shall be selected in accordance with 3.1.8.6. Separate items may be substituted for items tested in each operating condition, if desired by the contractor, subject to approval of the Technical Authority.

The medium weight shock test series is determined by the equipment mounting orientation (see 1.2.8) with the test orientation (see 6.6.43) being equivalent to the mounting orientation aboard the ship. The equipment shall be installed on the machine such that, when the equipment is inclined, it is rotated about the test orientation axis to have the correct directional loading on the equipment representative of its installation aboard the ship. Medium weight shock testing of surface ship equipment shall be conducted in accordance with tables VI through X. Medium weight shock testing of submarine equipment shall be conducted in accordance with tables XI and XII.

TABLE V. Test schedule for medium weight shock machine.

Group number	I	II	III
Number of blows	1/	1/	1/
Anvil table travel, inches	**3**	**3**	**1.5**
Total weight on anvil table (pounds) 2/	**Height of hammer drop (feet)** 3/		
Under 1,000	0.75	1.75	1.75
1,000 – 2,000	1.0	2.0	2.0
2,000 – 3,000	1.25	2.25	2.25
3,000 – 3,500	1.5	2.5	2.5
3,500 – 4,000	1.75	2.75	2.75
4,000 – 4,200	2.0	3.0	3.0
4,200 – 4,400	2.0	3.25	3.25
4,400 – 4,600	2.0	3.5	3.5
4,600 – 4,800	2.25	3.75	3.75
4,800 – 5,000	2.25	4.0	4.0
5,000 – 5,200	2.5	4.5	4.5
5,200 – 5,400	2.5	5.0	5.0
5,400 – 5,600	2.5	5.5	5.5
5,600 – 6,200	2.75	5.5	5.5
6,200 – 6,800 and submarine frame mounted items 4/	3.0	5.5	5.5
6,800 – 7,400	3.25	5.5	5.5

NOTES:

1/ See tables VI through XII for number of blows per group.

2/ Total weight on anvil table is the sum of equipment weight plus weight of all mounting fixtures. Weight limits are as defined in 3.1.2.b.

3/ The height of hammer drop shall be measured by means of the existing markings on the scale of the machine, no corrections being made for the added anvil table travel for the blows of Groups I and II.

4/ For submarine frame mounted items, refer to 3.1.2.b for additional details regarding weight limits on the anvil table.

3.1.8.2.1 Surface ship medium weight shock test. The medium weight shock test series consists of groups of blows defined in table V. The series shall be tested in accordance with tables VI through X with the test orientation consistent with the mounting orientation aboard the ship. Specifically, the following test series shall be used:

a. The test schedule in table VI shall be used for shock testing the following classifications of surface ship equipment:

(1) Surface Ship Class I, deck and hull mounted equipment, unrestricted mounting orientation

(2) Surface Ship Class II, hull mounted equipment, unrestricted mounting orientation

TABLE VI. MWSM test schedule 1.

Test Orientation	Inclination Angle (see 6.6.18)		
	Group I	**Group II**	**Group III**
Fore-Aft 1/, 2/	90	90[A]	90
Athwartship 3/, 4/	90	90[A]	90
Vertical	0	0[B]	0

NOTES:

1/ The rotation angle of the equipment about the equipment's test orientation athwartship axis.

2/ For components that are axisymmetric about either the vertical or athwartship axes, including location of foundation attachment points, shock testing in the fore-aft direction is not required.

3/ The rotation angle of the equipment about the equipment's test orientation fore-aft axis.

4/ For components that are axisymmetric about the fore-aft axis, including location of foundation attachment points, shock testing in the athwartship direction is not required.

INCLINATION ANGLE KEY:

90 90°

0 0°

OPERATING CONDITION KEY (see 3.1.8.6):

A Operating Condition 2, if applicable; otherwise primary operating condition.

B Operating Condition 3, if applicable; otherwise Note A applies.

b. The test schedule in table VII shall be used for shock testing the following classifications of surface ship equipment:

(1) Surface Ship Class I, deck and hull mounted equipment, vertical axis specified mounting orientation

(2) Surface Ship Class II, hull mounted equipment, vertical axis specified mounting orientation

TABLE VII. MWSM test schedule 2.

Test Orientation	**Inclination Angle (see 6.6.18)**		
	Group I	**Group II**	**Group III**
Fore-Aft 1/, 2/	NT	30 B, 3/	30 3/
Athwartship 4/, 5/	NT	30 A, 3/	30 3/
Vertical	0	0 A	0

NOTES:

1/ The rotation angle of the equipment about the equipment's test orientation athwartship axis.

2/ For components that are axisymmetric about either the vertical or athwartship axes, including location of foundation attachment points, shock testing in the fore-aft direction is not required.

3/ The inclination angle may be between 30 and 90 degrees.

4/ The rotation angle of the equipment about the equipment's test orientation fore-aft axis.

5/ For components that are axisymmetric about the fore-aft axis, including location of foundation attachment points, shock testing in the athwartship direction is not required.

INCLINATION ANGLE KEY:

30	30°
0	0°
NT	No test required

OPERATING CONDITION KEY (see 3.1.8.6):

A Operating Condition 2, if applicable; otherwise primary operating condition.

B Operating Condition 3, if applicable; otherwise Note A applies.

c. The test schedule in table VIII shall be used for shock testing the following classifications of surface ship equipment:

(1) Surface Ship Class I, deck and hull mounted equipment, restricted mounting orientation

(2) Surface Ship Class II, hull mounted equipment, restricted mounting orientation

TABLE VIII. MWSM test schedule 3.

Test Orientation	**Inclination Angle (see 6.6.18)**		
	Group I	**Group II**	**Group III**
Fore-Aft 1/, 2/	30 3/	NT	NT
Athwartship 4/, 5/	NT	30B, 3/	30 3/
Vertical	0	0A	0

NOTES:

1/ The rotation angle of the equipment about the equipment's test orientation athwartship axis.

2/ For components that are axisymmetric about either the vertical or athwartship axes, including location of foundation attachment points, shock testing in the fore-aft direction is not required.

3/ The inclination angle may be between 30 and 90 degrees.

4/ The rotation angle of the equipment about the equipment's test orientation fore-aft axis.

5/ For components that are axisymmetric about the fore-aft axis, including location of foundation attachment points, shock testing in the athwartship direction is not required.

INCLINATION ANGLE KEY:

30	30° 3/
0	0°
NT	No test required

OPERATING CONDITION KEY (see 3.1.8.6):

A Operating Condition 2, if applicable; otherwise primary operating condition.

B Operating Condition 3, if applicable; otherwise Note A applies.

d. Use of reduced blow test schedules for vertical axis specified mounting orientation (see table IX) and restricted mounting orientation (see table X) shall be in accordance with 3.1.8.2.1.1.

3.1.8.2.1.1 Surface ship reduced blow test schedules. It is acceptable to use the reduced blow test schedules utilizing 30-degree fixtures on figure 16 or figure 17 for all blows for medium weight shock test qualification of surface ship equipment (see tables IX and X). These test schedules require a 15-percent increase in hammer height and limit the total weight on the anvil table to 5200 pounds. Use of reduced blow test schedules requires review and approval by the Technical Authority.

TABLE IX. Surface ship MWSM test orientation, inclination, and operating condition with reduced number of blows: vertical axis specified mounting orientation shock qualification. 1/

Test Orientation	Inclination Angle (see 6.6.18)		
	Group I	Group II	Group III
Either 2/	30	30[A]	30
Rotated 3/	NT	30[B]	30

NOTES:
1/ Number of blows is reduced in MWSM test series test schedule for vertical axis specified orientation shock qualification by increasing hammer height to 115% of hammer height in table V.
2/ The rotation angle of the equipment about either the equipment's test orientation fore-aft axis or athwartship axis.
3/ Test orientation shall be rotated 90 degrees about equipment vertical axis from test orientation in note 2.

INCLINATION ANGLE KEY:
30 30°
NT No test required

OPERATING CONDITION KEY (see 3.1.8.6):
A Operating Condition 2, if applicable; otherwise primary operating condition.
B Operating Condition 3, if applicable; otherwise Note A applies.

TABLE X. Surface ship MWSM test orientation, inclination, and operating condition with reduced number of blows: restricted mounting orientation shock qualification. 1/

Test Orientation	Inclination Angle (see 6.6.18)		
	Group I	Group II	Group III
Shipboard 2/	30	30[A,B]	30
Rotated 3/	30	NT	NT

NOTES:
1/ Number of blows is reduced in MWSM test series test schedule for restricted orientation shock qualification by increasing hammer height to 115% of hammer height in table V.
2/ The rotation angle of the equipment about the equipment's test orientation fore-aft axis.
3/ Test orientation shall be rotated 90 degrees about equipment vertical axis from test orientation in note 2.

INCLINATION ANGLE KEY:
30 30°
NT No test required

OPERATING CONDITION KEY (see 3.1.8.6):
A Operating Condition 2, if applicable; otherwise primary operating condition.
B Operating Condition 3 requires an additional Group II blow, if applicable; otherwise Note A applies.

3.1.8.2.2 Submarine medium weight shock test. The medium weight shock test series consists of groups of blows defined in table V. The series shall be tested in accordance with tables XI and XII consistent with the mounting orientation aboard the ship. Any submarine equipment combination of equipment class, mounting location, and orientation not listed in tables XI through XII may be acceptable for shock testing on the medium weight shock machine subject to exceptions identified in 3.1.6.1 and 3.1.6.4.c. Medium weight shock testing of submarine equipment shall be conducted with the normal operating conditions selected for use during Group I and III blows and the other conditions of operation selected for use during Group II blows in accordance with 3.1.8.6.b. Specifically, the following test series shall be used:

a. Hull, frame, and conventional deck mounted equipment. The test schedule in table XI shall be used for shock testing of submarine equipment with hull, frame, and conventional deck mounting locations.

TABLE XI. MWSM test orientation, inclination, and operating condition for submarine equipment with hull, frame, and conventional deck mounting locations. 1/

Test Orientation	**Inclination Angle (see 6.6.18)**		
	Group I	**Group II**	**Group III**
Fore-Aft 2/, 3/, 4/	90	90[A,B]	90
Athwartship 5/, 6/	90	90[A,B]	90
Vertical	0	0[A,B]	0

NOTES:

1/ For frame mounted components, the radial direction corresponds to athwartship, the tangential direction corresponds to vertical, and the longitudinal direction corresponds to fore-aft.

2/ The rotation angle of the equipment about the equipment's test orientation athwartship axis.

3/ For components that are axisymmetric about either the vertical or athwartship axes, including location of foundation attachment points, shock testing in the fore-aft direction is not required.

4/ The inclination angle shall be 30 degrees for all fore-aft blows for equipment with restricted mounting orientation.

5/ The rotation angle of the equipment about the equipment's test orientation fore-aft axis.

6/ For components that are axisymmetric about the fore-aft axis, including location of foundation attachment points, shock testing in the athwartship direction is not required.

INCLINATION ANGLE KEY:

90	90°
0	0°

OPERATING CONDITION KEY (see 3.1.8.6):

A Operating Condition 2, if applicable; otherwise primary operating condition.

B Operating Condition 3 requires an additional Group II blow, if applicable; otherwise Note A applies.

b. Mitigated deck mounted equipment. The test schedule in table XII shall be used for shock testing of submarine equipment with mitigated deck mounting locations.

TABLE XII. MWSM test orientation, inclination, and operating condition for submarine equipment with mitigated deck mounting locations.

Test Orientation	Inclination Angle (see 6.6.18)		
	Group I	**Group II**	**Group III**
Fore-Aft [1/, 2/]	30 [3/]	30 [3/] [A,B]	30 [3/]
Athwartship [4/, 5/]	30 [3/]	30 [3/] [A,B]	30 [3/]
Vertical	0	0	0

NOTES:

1/ The rotation angle of the equipment about the equipment's test orientation athwartship axis.

2/ For components that are axisymmetric about either the vertical or athwartship axes, including location of foundation attachment points, shock testing in the fore-aft direction is not required.

3/ The inclination angle may be between 30 and 90 degrees.

4/ The rotation angle of the equipment about the equipment's test orientation fore-aft axis.

5/ For components that are axisymmetric about the fore-aft axis, including location of foundation attachment points, shock testing in the athwartship direction is not required.

INCLINATION ANGLE KEY:

30 30°

0 0°

OPERATING CONDITION KEY (see 3.1.8.6):

A Operating Condition 2, if applicable; otherwise primary operating condition.

B Operating Condition 3 requires an additional Group II blow, if applicable; otherwise Note A applies.

3.1.8.3 Heavyweight shock test. The heavyweight shock test series consists of four shots, with test conditions as indicated by table XIII. Additional test shots at standoff distances greater than shot 1 standoff may be required by specifications (see 6.2.2), or may be conducted at the contractor's option in cases where it is desired to evaluate performance of the tested item at low shock levels before commencing the standard test series. Operating conditions during each shot shall be as specified (see 6.2.1). If this information is not specified, operating conditions during tests shall be selected in accordance with 3.1.8.6.

3.1.8.3.1 General heavyweight shock test schedule and shot geometries. Test schedule and shot geometries shall be in accordance with table XIII and figure 32, respectively.

TABLE XIII. Test schedule for heavyweight shock testing.

Test Conditions	Standard and Extended FSP	Intermediate FSP	Large FSP 1/	Large FSP 1/
Depth of explosive charge below water surface (for all shots)	24 feet	27 feet	36 feet	39 feet
Explosive charge weight/composition	60 lbs HBX-1	90 lbs HBX-1	250 lbs HBX-1	320 lbs HBX-1
Direction 2/ and standoff 3/				
Shot 1 4/ – Fore-aft	40 feet	44 feet	72 feet	86 feet
Shot 2 – Athwartship	30 feet	34 feet	54 feet	65 feet
Shot 3 – Athwartship	25 feet	28 feet	45 feet	54 feet
Shot 4 – Athwartship	20 feet	22 feet	36 feet	43 feet
Shot 4a 5/ – Athwartship	20 feet	22 feet	36 feet	43 feet
Shot 4b 5/ – Fore-aft	6/			

NOTES:

1/ LFSP testing shall be performed using the 320-lb charge geometry column. If 320-lb charges are unavailable, the 250-lb charge geometry column shall be used. The test report shall indicate charge size, standoff distances used, and charge depth (see 6.2.3).

2/ For the fore-aft direction shots, the explosive charge shall be located relative to the FSP so as to represent an underwater explosion occurring off the bow or stern of the ship in which the equipment is to be installed. Athwartship shots shall be oriented to represent explosions abeam of the ship.

3/ Refers to the horizontal distance between the explosive charge centerline and the near side of the FSP.

4/ Where shot 1 is conducted, it may be the last shot performed.

5/ Where shot 4a or shot 4b is conducted, it is acceptable to omit shot 1 (see 3.1.8.3.1.b).

6/ See shot 4b on figure 32 for standard FSP (see 3.1.8.3.1.b).

The heavyweight shock test series is determined by the equipment mounting orientation (see 1.2.8). Specifically, the following test series shall be used:

a. Unrestricted. Surface ship and submarine equipment with an unrestricted mounting orientation shall be tested in accordance with the test schedule in table XIV. For each test, the equipment is rotated so that a different equipment axis is parallel to the FSP vertical axis (i.e., shot 4 is performed three times).

b. Vertical Axis Specified. For surface ship and submarine equipment with vertical axis specified mounting orientation, the following apply:

(1) The first axis of vertical axis specified equipment shall be tested with a shot 4 standoff test on the FSP, designated shot 4 in accordance with table XIII. Then, vertical axis specified equipment shall be rotated 90 degrees about the FSP's vertical axis and shall be tested with a second shot 4 standoff test on the FSP, designated shot 4a. Shot 4a is identical to shot 4 in table XIII except the test equipment is rotated 90 degrees about the FSP's vertical axis.

(2) If it is impracticable for the equipment to be rotated on the FSP, a test setup with end shot 4b is acceptable for use in lieu of installing the equipment on a larger barge. See figure 32 for details.

c. Restricted. The standard test schedule (i.e., shots 1 through 4) with one shot 4 shall be used to qualify surface ship and submarine equipment with restricted mounting orientation.

3.1.8.3.2 General heavyweight shock test schedule of deck mounted equipment with DSF. For all classes of deck mounted equipment, the equipment shall be tested to the DSF target frequencies (see 6.6.8) representing the most severe shipboard dynamic environments (see 3.1.6.4.a). Select DSF target frequencies in accordance with 3.1.6.5. Table XIV is a general DSF test schedule that specifies standoffs and shot order in accordance with the deck mounted equipment mounting orientation and the number of DSF target frequencies. The sequence of the shots may be modified as approved by the Technical Authority.

TABLE XIV. Test schedule for heavyweight shock testing of deck mounted equipment with DSF.

Mounting Orientation	**DSF Target Frequency**	**Standoffs and Shot Order** 1/
Restricted - with one DSF target frequency	One single frequency	Shot 2 Shot 3 Shot 4 Shot 1
Restricted - qualification at multiple DSF target frequencies	First frequency	Shot 3 Shot 4
	Each additional frequency 2/	Shot 4 Shot 1
Vertical Axis Specified - with multiple DSF target frequencies	First frequency	Shot 2 Shot 3 Shot 4 Shot 4a
	Each additional frequency 2/	Shot 4 Shot 4a
Unrestricted - with multiple DSF target frequencies	First frequency	Shot 3 Shot 4 Shot 4 3/ Shot 4 3/
	Each additional frequency for each equipment axis 2/	Shot 4 Shot 4 3/ Shot 4a 4/

NOTES:

1/ Shot order and standoffs may be modified as approved by the Technical Authority.

2/ Select the frequency closest to the SRF of the resiliently mounted equipment under test first, unless otherwise approved by the Technical Authority.

3/ Equipment shall be rotated 90 degrees so that a different equipment horizontal axis is aligned with the FSP vertical axis for the next shot (i.e., shot 4 is performed three times for the first frequency).

4/ It is acceptable to use shot 4a for equipment with two or more frequencies.

3.1.8.3.2.1 Limitations on selection of DSF target frequency.

a. Standard DSF target frequencies used with table XIV shall be selected in accordance with 3.1.6.5. It may be acceptable, with Technical Authority approval, to limit the DSF target frequency for all classes of deck mounted equipment with only one mounting location to one frequency that represents the shipboard dynamic environment. Verification that the selected DSF target frequency represents the shipboard dynamic environment requires Technical Authority review and approval (see 6.5).

b. DSF target frequency for Class I deck mounted equipment, Class I portion of Class I/II deck mounted equipment, and Class III deck mounted equipment without the use of isolation devices shall be 25 Hz unless identified by the contracting activity as being installed in deck mounted locations with frequency greater than 25 Hz.

3.1.8.4 Medium weight deck simulating shock testing of Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment. The DSSM tray configuration (i.e., tray part number, spring part number, mass ratios, number of springs, etc.) is specified by the tables on figures 24 through 26, dependent upon DSSM isolated payload weight, DSSM fixture weight, and DSSM additional weight. The DSSM isolated payload weight, DSSM fixture weight, DSSM additional weight, and applicable DSSM tray configurations shall be documented in the test report for the item (see 6.2). All Class II deck mounted and, if applicable, Class I/II and Class III deck mounted equipment shall be tested in accordance with the number of springs specified in the appropriate figure's table entry for equipment of that DSSM equipment payload weight and sum of DSSM fixture weight and additional weight, whether the deck mounted equipment SRF is available or not. Operating conditions during medium weight deck simulating shock testing shall be as specified (see 6.2.1.k). If the operating condition information is not specified, operating conditions during tests shall be selected in accordance with 3.1.8.6. Separate items may be substituted for items tested in each operating condition, if desired by the contractor, subject to approval of the Technical Authority.

Medium weight deck simulating shock testing shall be conducted in accordance with the equipment mounting orientation (see 1.2.8), with the test orientation (see 6.6.43) being equivalent to the mounting orientation aboard the ship. The equipment shall be installed on the machine relative to the DSSM side-to-side center plane to have the correct directional loading on the equipment during the test representative of its installation aboard the ship. The DSSM side-to-side center plane is as shown on figure 23 (see 6.6.29). Medium weight deck simulating shock testing of Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment on all ships using the DSSM shall be conducted in accordance with the following:

a. Medium weight deck simulating shock testing is limited to Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment mounted on ships with surface ship deck frequency at installation location less than or equal to 37 Hz or submarine response frequency at installation location less than or equal to 37 Hz. If the ship deck frequency or submarine response frequency is greater than 37 Hz, equipment shall be tested as a hull mounted item.

b. DSSM testing of surface ship and carrier Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment requires the use of isolation devices (see 6.6.19) that are shock mounts (see 6.6.33). It shall be documented in the test report (see 3.1.12) that the isolation device is a shock mount using isolator vendor information, information from previous tests of similar equipment, analytical methods showing an SRF greater than or equal to 4 Hz and less than or equal to 10 Hz (e.g., Appendix A), or other methods approved by the Technical Authority.

c. Unless otherwise specified (see 3.1.8.4.a), all submarine Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment shall be tested in accordance with table XV and 3.1.8.4.1. If submarine Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment have LDCIDs installed and the equipment SRF has been determined to be greater than 37 Hz, then lightweight or medium weight shock testing shall be performed, unless the Technical Authority approves use of the DSSM (see 3.1.6.1.b, 3.1.6.1.c, and 3.1.6.1.d).

d. All surface ship and carrier Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment shall be tested as follows:

(1) Unless otherwise specified (see 3.1.8.4.a), all surface ship, excluding carrier, Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment shall be tested in accordance with table XVI and 3.1.8.4.2.1.

(2) Unless otherwise specified (see 3.1.8.4.a), all carrier Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment shall be tested in accordance with table XVII and 3.1.8.4.2.2.

(3) If the surface ship or carrier Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment have LDCIDs installed and the equipment SRF has been determined to be greater than 37 Hz, then lightweight or medium weight shock testing shall be performed, unless the Technical Authority approves use of the DSSM (see 3.1.6.1.b, 3.1.6.1.c, and 3.1.6.1.d).

e. Medium weight deck simulating testing of Class I/II deck mounted equipment shall be accomplished by conducting both the appropriate DSSM drop series and the appropriate lightweight or medium weight shock machine blow series on the item (see 3.1.6.1.c).

f. Medium weight deck simulating testing of Class III deck mounted equipment shall be accomplished by conducting both the appropriate DSSM drop series installed in the isolated mounting configuration and the appropriate lightweight or medium weight shock machine blow series on the same principal unit installed in the non-isolated mounting configuration, unless otherwise specified (see 6.2.1.i and 6.2.2.f), or if approved by the Technical Authority (see 3.1.6.1.d.)

3.1.8.4.1 Testing of Class II, Class I/II, and Class III equipment installed on submarine decks. The DSSM test schedule in table XV shall be used for medium weight deck simulating testing of submarine Class II equipment and, if applicable, Class I/II and Class III equipment installed on submarine decks, excluding submarine shock isolated decks (see 3.1.1.1). Use of table XV is subject to the direction provided in 3.1.8.4.

TABLE XV. DSSM test schedule of class II, class I/II, and class III equipment installed on submarine decks.

Mounting Orientation	Test Orientation	Drop Height (in)	Tray Configuration
Vertical Axis Specified	Shipboard	8	Figure 24
	Shipboard	11	Figure 24
	Rotated[A,B]	11	Figure 24
	Rotated[A,B]	13	Figure 25
	Shipboard	13	Figure 25
	Shipboard[A,B]	13	Figure 26
	Rotated	13	Figure 26
Restricted	Shipboard[A,B]	8	Figure 24
	Shipboard	11	Figure 24
	Shipboard[A,B]	9.5	Figure 25
	Shipboard	13	Figure 25
	Shipboard[A,B]	9.5	Figure 26
	Shipboard	13	Figure 26
	Rotated	3.5	Figure 26

NOTES:

1. Shipboard: install equipment for test with its test orientation fore-aft axis perpendicular to the DSSM side-to-side center plane.
2. Rotated: install equipment for test rotated 90 degrees about equipment vertical axis from orientation in note 1.

OPERATING CONDITION KEY (see 3.1.8.6):

[A] Operating Condition 2, if applicable; otherwise primary operating condition.

[B] Operating Condition 3, if applicable.

3.1.8.4.2 Testing of Class II deck mounted and, if applicable, Class I/II and Class III deck mounted equipment on surface ships and carriers. Tables XVI and XVII shall be used for testing Class II deck mounted equipment and, if applicable, Class I/II, and Class III deck mounted equipment on surface ships. Use of tables XVI and XVII is subject to direction provided in 3.1.8.4.

3.1.8.4.2.1 Testing of Class II, Class I/II, and Class III deck mounted equipment on surface ships except carriers. The DSSM test schedule in table XVI shall be used for medium weight deck simulating shock testing of Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment installed on all surface ships except carriers.

TABLE XVI. DSSM test schedule for class II, class I/II, and class III deck mounted equipment on surface ships except carriers.

Mounting Orientation	Test Orientation	Drop Height (in)	Tray Configuration [1/]
Vertical Axis Specified	Shipboard	7	Figure 25
	Shipboard[A,B]	9.5	Figure 25
	Shipboard	13	Figure 25
	Rotated[A,B]	13	Figure 25
Restricted	Shipboard	7	Figure 25
	Shipboard[A,B]	9.5	Figure 25
	Shipboard	13	Figure 25
	Rotated[A,B]	3.5	Figure 25

FOOTNOTE:

[1/] Select tray configuration by figure in accordance with 3.1.8.4.d.

NOTES:

1. Shipboard: install equipment for test with its test orientation fore-aft axis perpendicular to the DSSM side-to-side center plane.
2. Rotated: install equipment for test rotated 90 degrees about equipment vertical axis from orientation in note 1.

OPERATING CONDITION KEY (see 3.1.8.6):

[A] Operating Condition 2, if applicable; otherwise primary operating condition.

[B] Operating Condition 3, if applicable.

3.1.8.4.2.2 Testing of Class II, Class I/II, and Class III deck mounted equipment on carriers. The DSSM test schedule in table XVII shall be used for medium weight deck simulating shock testing of Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment installed on carriers.

TABLE XVII. DSSM test schedule of class II, class I/II, and class III deck mounted equipment on carriers.

Mounting Orientation	Test Orientation	Drop Height (in)	Tray Configuration 1/
Vertical Axis Specified	Shipboard	8	Figure 24
	Shipboard	11	Figure 24
	Rotated[A,B]	11	Figure 24
	Rotated	13	Figure 25
	Shipboard[A,B]	13	Figure 25
Restricted	Shipboard[A,B]	8	Figure 24
	Shipboard	11	Figure 24
	Shipboard[A,B]	9.5	Figure 25
	Shipboard	13	Figure 25
	Rotated	3.5	Figure 25

FOOTNOTE:

1/ Select tray configuration by figure in accordance with 3.1.8.4.d.

NOTES:

1. Shipboard: install equipment for test with its test orientation fore-aft axis perpendicular to the DSSM side-to-side center plane.
2. Rotated: install equipment for test rotated 90 degrees about equipment vertical axis from orientation in note 1.
3. DSSM testing for equipment installed on carrier decks with deck frequencies less than 4 Hz shall be reviewed and approved by the Technical Authority prior to medium weight deck simulating shock testing.

OPERATING CONDITION KEY (see 3.1.8.6):

A Operating Condition 2, if applicable; otherwise primary operating condition.

B Operating Condition 3, if applicable.

3.1.8.5 Testing of any items, including wetted surface mounted items, on the FSP or alternate shock test vehicles/machines. Shock testing on the FSP or alternate shock test vehicles/machines (SSTV, FSS, A/B-1, PWTV) will be subject to shock test parameters as approved by the Technical Authority prior to testing. These parameters can include shock factor, acceleration, velocity, pressure, etc.

3.1.8.5.1 Requirements for acceptable use of the DSF on the heavyweight shock test.

3.1.8.5.1.1 Location of equipment under test on DSF. Class II equipment and, if applicable, Class I/II and Class III equipment shall be placed on the central section of the DSF between the quarter points of the DSF (see figure 31). Other arrangements that can be demonstrated to achieve the same results or have limited installation-specific environments may be approved on a case basis by the Technical Authority. Class I equipment may be located anywhere between DSF pins.

3.1.8.5.1.2 DSF damping. The damping exhibited by the DSF should not exceed 5 percent of critical damping at the DSF target frequency. Damping in excess of 5 percent shall require retest or approval from the Technical Authority.

3.1.8.5.1.3 DSF mass to equipment mass ratios. The mass ratio between the DSF masses and the equipment masses (see 6.6.22 for definitions of masses) shall be as follows:

a. For Class I equipment on a DSF, the mass ratio of the DSF modal mass to the equipment dead mass shall be greater than or equal to 2:1.

(i.e., [DSF modal mass]:[equipment dead mass] ≥ 2:1)

If the DSF modal mass is unknown, it is acceptable to use 80 percent of the DSF total mass.

b. For Class II equipment and, if applicable, Class I/II and Class III equipment on a 12-16 Hz DSF, the mass ratio of the DSF live mass to the sum of the equipment live mass and half the equipment isolated mass shall be greater than or equal to 5:1.

(i.e., [DSF live mass]:[equipment live mass + 1/2 equipment isolated mass] ≥ 5:1)

c. For Class II equipment and, if applicable, Class I/II and Class III equipment on a 7-9 Hz DSF, the mass ratio of the DSF live mass to the sum of the equipment live mass and half the equipment isolated mass shall be greater than or equal to 10:1.

(i.e., [DSF live mass]:[equipment live mass + 1/2 equipment isolated mass] ≥ 10:1)

d. Mass ratios for other configurations shall be as approved by the Technical Authority.

3.1.8.5.1.4 FSP and DSF ballast. FSP ballast shall only be used to maintain trim. It is acceptable to use DSF ballast to obtain the DSF target frequency and acceptable equipment mass ratios.

3.1.8.6 Operation of equipment during shock tests. Items shall be shock tested in each of the operating conditions specified in 6.2.1. If operating conditions required for tests are not specified, operating conditions during tests shall be selected based upon the following requirements:

a. Grade A items shall be tested while operating in each of their normal operating conditions (see 6.6.26). For example, motors shall be tested while running at rated speed and at standstill, contactors shall be tested in open and closed positions, and equipment shall be tested at rated pressure and, if applicable, energized at voltages, current, and load conditions that will aid in detecting intermittent equipment problems. Unless otherwise specified (see 6.2.1), tests may be conducted at the prevailing ambient temperature of the shock test facility. For emergency or standby equipment, the normal operating condition shall consider the equipment to be operating. Grade B items shall be operated during shock tests only if operation during exposure to shock significantly increases the potential for shock damage of a type that would violate acceptance criteria (see 3.1.10.2).

b. For items with many possible normal operating conditions, the operating conditions that are judged most critical from a shock standpoint shall be represented during shock tests. Unless otherwise specified (see 6.2.1), no more than the three most significant operating conditions need be represented during shock tests. The operating conditions recommended to be selected during the shock test shall be presented to the Technical Authority for review and concurrence.

(1) For lightweight shock tests, the primary operating condition shall be tested in accordance with the requirements for lightweight shock machine testing tables I through IV (see 3.1.8.1). Second and third operating conditions shall be subject to the three orthogonal maximum hammer heights as outlined in the appropriate table. All subsequent operating conditions shall be subject to the three orthogonal maximum hammer heights as outlined in tables I through IV. New equipment may be substituted for each operating condition. Subsequent operating conditions require shock testing only to the maximum hammer heights regardless of whether new equipment is substituted for each operating condition. Failures experienced during testing of operating conditions shall require retest in accordance with 3.1.11.5.

(2) Medium weight shock tests of surface ship and submarine equipment shall be performed in accordance with the following:

(a) For performing medium weight shock testing of surface ship deck and hull mounted Class I equipment and surface ship hull mounted Class II equipment, the operating conditions shall be selected for use during Group I, II, and III blows using tables VI, VII, and VIII for unrestricted mounting orientation, vertical axis specified mounting orientation, and restricted mounting orientation, respectively.

(b) For performing reduced blow medium weight shock testing of surface ship equipment (see 3.1.8.2.1.1), tables IX and X shall be used to select operating conditions during Group I, II, and III blows for vertical axis specified mounting orientation and restricted mounting orientation, respectively.

(c) For performing medium weight shock testing of submarine equipment, the normal operating condition shall be selected for use during Group I and III blows, and other conditions of operation shall be selected for use during Group II blows (tables XI and XII provide shock test inclination schedules for Group I, II, and III blows).

(d) If three operating conditions are selected for use, two series of Group II blows shall be required. Failures experienced during testing of operating condition shall require retest in accordance with 3.1.11.5.

(3) For heavyweight shock tests, the normal operating condition shall be selected for use during shots 1, 4, 4a, and 4b (see 3.1.8.3). The next most likely operating condition shall be selected for use during shot 3, and the least likely operating condition during shot 2. Heavyweight shock test operating conditions (see 3.1.8.3 and 6.2.2) shall be specified or approved by the Technical Authority.

(4) For medium weight deck simulating shock testing of equipment, operating conditions during DSSM tests shall be selected for use in accordance with test schedules in 3.1.8.4 and tables XV, XVI, and XVII.

(5) Multi-directional equipment has many possible normal operating conditions and shall be tested in accordance with 3.1.8.6.b. Multi-directional equipment operating conditions shall take into account the orientation of subsidiary components and subassemblies during operation and may require testing in multiple positions, as well as multiple operating conditions for Grade A equipment. Explicit multiple positions and operating conditions of the equipment under test should be specified in accordance with 6.2.1 and shall be recorded on block 23, "Remarks/Approval Limitations", of figure 19. The equipment shock test procedure shall be reviewed and approved by the Technical Authority prior to test.

c. Where operation of items during tests, as required above, is not practical due to test facility limitations, the required operating conditions shall be simulated to the maximum extent practical. Acquisition documents may indicate requirements for partial simulation of actual shipboard operating conditions in such cases (see 6.2.2). Simulation of operating conditions, if other than as specifically permitted in acquisition documents, shall be subject to approval by the Technical Authority.

3.1.8.7 Monitoring of items during tests. Performance of tested items shall be monitored during shock tests to the extent necessary to verify compliance with shock test acceptance criteria (see 3.1.10). Acquisition documents may indicate requirements for monitoring of items during shock tests (see 6.2.1). Instrumentation for measuring acceleration, velocity, and displacement is not generally required, but in order to monitor performance, instrumentation may be required for any particular test as specified in the acquisition documents.

3.1.8.8 Fastener tightening during shock tests. If it is anticipated that tightening will be necessary during a shock test, the lengths of accessible bolting, screws, and similar accessible fasteners, including hold-down bolts, associated with the tested item shall be measured before equipment installation on the test fixture. Accessible fasteners may be tightened to pre-shot torque after the first shock blow/shot/ drop without verification (e.g., by bolt length measurements) of bolt yielding or stretching. For subsequent blows/shots/drops (i.e., blow/shot/drop #2 and follow-on), these fasteners may be tightened only as necessary to compensate for loosening due to seating-in of mating surfaces, as demonstrated by suitable measurements. Seating-in of mating surfaces is defined as a bearing surface crushing or a bearing surface being slotted, allowing the bolts to loosen without yielding. If, for blows/shots/drops subsequent to the first blow/shot/drop, it cannot be demonstrated that fasteners have not yielded, the fasteners shall not be tightened and performance tests shall be conducted with the fasteners in the as-found condition. See 3.1.6.4 k for torqueing requirements for test item hold-down bolts. Torques for applicable bolting shall be measured and recorded following each shock test blow/shot/drop. Excessive yielding or loosening of fasteners shall be considered a violation of shock test acceptance criteria. Yielding or loosening of fasteners and yielding or cracking of structural members or component parts shall be reported in shock test reports when such reports are required by the contract or order (see 6.2.1). When internal inspections of an item (e.g., enclosure, cabinet, etc.) are desired during high-impact shock testing, the access panel's securing method (e.g., slide latch, thumb screw, etc.) shall be restored to the as-found post-test blow/shot/drop condition prior to subsequent test blows/shots/drops.

3.1.8.9 Balancing method for medium weight shock test assembly. Balancing of the medium weight shock test assembly is essential to prevent excessive rotation of the test assembly during a blow, which can result in damage to the anvil table hold-down bolts. Alignment of the centers of gravity of the test item and fixtures shall be considered during special fixture or intermediate structure design. However, calculations are not an acceptable substitute for using the static balancing method described below. Ballast should be rigid and compactly secured to the MWSM test set-up at the lowest level possible. Securing ballast weight to the anvil table via cantilevers is prohibited.

a. Static balancing of the MWSM shall be accomplished after the entire test assembly (component and fixtures) has been installed on the shock machine but prior to final tightening of the channel clamps and t-bar hold-down bolts. For safety while balancing an assembly on any of the inclined fixtures, maintain the assembly under the control of lifting or rigging equipment until final tightening has occurred. Static balancing is required in both directions orthogonal to the vertical axis of the machine.

b. Raise the anvil table by the air jacks and place the balancing stands provided with the MWSM under the anvil table pads on opposite sides of the table. Slowly lower the jacks to allow the table to rest on the balancing stands. Adjust the test assembly position in the first axis until the table rocks on the balancing stands without tipping to one side or the other. Carefully keep the assembly moving parallel to the axis of alignment while adjusting its position. Tighten the hold-downs for that direction and lift the table again to shift the balancing stands to the anvil table pads in the other axis. Lower the table and adjust the load in the second axis as required. Raise the table to remove the balancing stands. It is recommended to return the balancing stands to the original axis and verify that no change in balance has occurred in that axis. At the completion of balancing, tighten all fasteners.

c. When balancing inclined test assemblies, it is most advantageous to balance the inclined direction after performing an initial balance in the other axis.

d. After the inclined axis has been balanced, recheck the first axis and make slight adjustments only as necessary.

e. If the assembly cannot be balanced, use counterweights bolted to the anvil table or otherwise to the lowest level possible. If counterweight is added above the supporting channels, the new total weight must be calculated and used to verify that the number of supporting channels used is still appropriate. In addition, the new total weight on the anvil table must be calculated to determine the proper hammer heights for testing.

f. When using inclined fixtures, mark the initial location of the assembly on the inclined rails. Measure the movement of the assembly (in inches) along the rails after each shock blow. Divide the weight (lbs) of the assembly on the rails by 1000. If the movement measurement exceeds this value, return the assembly to its original location on the rails or rebalance the table.

3.1.9 Pre and post-shock test functional testing and inspection. Prior to shock tests, after each blow/shot/drop, and at the completion of the shock test series, Grade A and Grade B items shall be given tests and inspections in accordance with 3.1.9.1 and 3.1.9.2 to determine if specified shock test acceptance criteria (see 3.1.10) have been satisfied. Detailed requirements for functional testing and inspection of tested items shall be as specified for the particular item (see 6.2.1). If these requirements have not been specified, the contractor shall develop functional testing and inspection criteria based upon the requirements of 3.1.9.1 and 3.1.9.2 (see 6.2.3).

3.1.9.1 Functional testing. Prior to shock tests, after each blow/shot/drop, and after the shock test series, functional testing is required for Grade A items only. Obtaining pre-shock test performance data shall be specified if there is sufficient justification. When practical, functional testing at the test site is desired to avoid disputes regarding possibility of additional damage during shipment. If functional testing at the test site is considered feasible and is desired, pre-shock test, post blow/shot/drop, and post shock test series functional testing shall be specified in the acquisition documents. Unless otherwise approved by the Technical Authority, all functional performance testing shall be accomplished prior to disassembly or repair of the item, and shall be accomplished prior to installation of the item in the ship. In general, functional performance tests shall include, but not necessarily be limited to, checking the input-output of the component or equipment, its operating temperatures (bearing, coil windings), and cyclic tests, as appropriate to determine compliance with acceptance criteria (see 3.1.10). Hydraulic, pneumatic, and fluid systems equipment shall be hydrostatically tested to demonstrate strength and to test for leaks, if not previously checked during shock testing. Electrical equipment shall be tested for shorts to detect breakdown of insulation.

3.1.9.2 Inspection. All shock tested Grade A items shall be inspected prior to shock tests and after each blow/shot/drop. At the completion of the shock test series, all Grade A items shall be disassembled and inspected for breakage, deformation, and misalignment. Where cracking would be a cause for rejection, areas highly stressed during shock tests shall be checked for cracks using dye penetrant, magnetic particle, or other tests. Dimensions of critical tolerance areas shall be checked. Inspection of Grade B items for purposes of determining compliance with shock test acceptance criteria shall be limited to the extent required to reveal the existence of any condition that could create a hazard (see 3.1.10.2 and 6.6.16).

3.1.10 Shock test acceptance criteria.

3.1.10.1 Grade A items. Grade A items shall withstand shock tests conducted in accordance with this specification without unacceptable effect upon performance and without creating a hazard (see 6.6.16). If applicable acquisition documents or specifications do not define shock test acceptance criteria (see 6.2.1), these criteria shall be developed in accordance with the following:

a. For each performance criterion specified for the item by the applicable military specification or purchase order, a corresponding shock test acceptance criterion shall be developed that indicates the degree, if any, of degradation of performance allowable as a result of exposure to shock. Allowed degradation of performance shall be limited to that which will have no unacceptable effect upon performance of the item, either by itself or in combination with other forms of allowed degradation.

b. Each shock test acceptance criterion shall be identified with requirements to monitor the item during shock tests and post blow/shot/drop and post shock test series functional tests or inspections as required to verify compliance with the acceptance criterion (see 6.2.1). Monitoring requirements should distinguish between acceptance criteria that can be satisfied by inspection immediately following each blow/shot/drop (e.g., trip throttle valves and quick closing valves remain open, pressurized components remain leak-tight) and criteria for which monitoring must be continuous throughout the shock motion (e.g., there shall be no intermittent short circuits and open circuits in electrical equipment, no abnormal output of control, governor regulating equipment).

c. Shock test acceptance criteria shall be expressed primarily in terms of performance parameters that can be readily evaluated during shock tests, after each blow/shot/drop, or after the shock test series. Minor physical damage to the tested item, such as small cracks, minor yielding of structure, out-of-tolerance clearances, and similar damage shall not be cause for shock test disapproval unless such damage causes unacceptable impairment of equipment performance, results in a hazard, or results in substantially shortened equipment useful life.

d. Momentary malfunction of any Grade A item shall be considered acceptable only if it is automatically self-correcting and only if no consequent derangement, maloperation, or compromise of the Grade A capability is caused by the momentary malfunction. For momentary malfunctions to be considered acceptable, the intended use of the component must be known and the shock test report must include a description of any momentary malfunctions encountered during testing. The shock test report (see 6.2.3) shall include rationale demonstrating that these malfunctions are acceptable for the intended use. Acceptance criteria for likely momentary malfunctions, where known in advance of shock testing, shall be included in the shock test procedure. Acceptance criteria for momentary malfunctions shall be consistent both with the intended use of the component and with any information provided by acquisition documents regarding momentary malfunctions under shock. (See 6.4.t for examples of acceptable versus unacceptable momentary malfunctions.)

e. Unless otherwise specified (see 6.2.2), shock test acceptance of Grade A items shall not be contingent upon the ability of the item to satisfy noise and vibration standards after exposure to shock.

f. Shock test acceptance criteria contained in 3.1.10.2.a, 3.1.10.2.b, and 3.1.10.2.c are also applicable to Grade A items.

3.1.10.2 Grade B items. Grade B items shall withstand shock tests conducted in accordance with this specification without creating a hazard (see 6.6.16) to personnel operating or manning Grade A equipment, including personnel at battle stations, or to Grade A items. Unless otherwise specified (see 6.2.1), the following shock test acceptance criteria shall apply to Grade B items, including all criteria identified in the definition of hazard (see 6.6.16):

a. The shock tested item, portions thereof, or the contents thereof shall not come adrift due to exposure to shock. Exceptions to this criterion, which shall be approved by the Technical Authority on a case basis, will be acceptable in cases where it can be demonstrated that the weight, shape, and all other characteristics of the item that has come adrift are such as to preclude a significant impact threat to personnel or adjacent Grade A items.

b. Injurious, flammable, radioactive, acidic, caustic, or otherwise hazardous liquids, solids, or gases shall not be released as a result of exposure of the tested item to shock. Exceptions to this criterion, which shall be approved by the Technical Authority on a case basis, will be considered in cases where it can be demonstrated that the nature, location, rate, or total possible amount of leakage is such as to prevent development of a significant threat to Grade A systems, personnel, or to the ship as a whole. In addition, and for purposes of this criterion, any fluid whose operating temperature is above 150 degrees Fahrenheit (°F) or below 0 °F shall be considered hazardous. Fluids at any temperature shall be regarded as hazardous if they might cause any electrical short.

c. Tested items shall not demonstrate a potential for fire hazards. Any evidence of electrical shorts, release of flame, smoke, or sparks shall be cause for rejection of the tested item, unless otherwise specifically approved by the Technical Authority on a case basis.

d. It is not required that Grade B items be operable after shock testing.

3.1.10.2.1 Supplemental acceptance criteria for Grade B items. Grade B item shock test acceptance criteria, in addition to those listed above, may be specified if necessary to suit specific or unusual applications (see 6.2.1).

3.1.11 Resolution of shock test failures. In cases where shock testing causes damage or malfunctions that violate shock test acceptance criteria, repeat shock tests shall be performed in accordance with 3.1.11.1 through 3.1.11.4 to resolve the failure.

3.1.11.1 Lightweight. When the acceptance criteria are violated after completion of three blows in one or more axes during lightweight shock testing of the item, and corrective design modifications are made, repetition of the three orthogonal maximum hammer heights and completion of unfinished blows (in any order) shall be performed during retest. Where different operating conditions have been tested, these operating conditions shall be retested at only the maximum hammer height. See 3.1.11.5.a for additional retest requirements.

3.1.11.2 Medium weight. When the acceptance criteria are violated after completion of three blows in one or more axes during medium weight shock testing of the item, and corrective design modifications are made, repetition of either the Group II or III blow in each of those axes is required. See 3.1.11.5.b for retest requirements. The contractor may recommend, for approval by the Technical Authority, the choice of either Group II or III blow, except in the following cases:

a. Where the Group II and III blows represent different operating conditions, identify the operating condition that gives the most negative effect on the performance of the equipment, and repeat the blow for each axis.

b. Where available data (e.g., filtered acceleration data) shows that either the Group II or Group III blow is significantly more severe than the other, the more severe blow shall be repeated for each completed axis.

3.1.11.3 Heavyweight. For heavyweight shock tests, the following criteria shall apply to repeat testing (see 3.1.11.5.c for retest requirements) to verify the adequacy of corrective design modifications:

a. Shot 1 (or 4a or 4b) shall be repeated before continuing the test series if damage in violation of acceptance criteria is discovered after any shot of the test series.

b. Shot 4 shall be repeated if damage in violation of acceptance criteria occurs during that shot. Damage occurring during shots 2 or 3 and discovered prior to the conduct of shot 4 will not necessitate repeat of shots 2 and 3, unless the damage is related to operating conditions represented only during those shots. Damage in violation of acceptance criteria shall be corrected via design modifications before proceeding to the next shot of the test series unless otherwise approved by the Technical Authority.

c. In cases where shock test damage in violation of acceptance criteria is not discovered until post-test teardown or until conduct of post-test operational tests, shot 1 (or 4a or 4b) and shot 4 shall be repeated. If the damage is possibly related to operating conditions selected for use only during shots 2 and 3, these shots shall also be repeated.

d. Selection of heavyweight shock test shots to be repeated, and procedures for such tests, shall be recommended by the contractor and approved by the Technical Authority prior to performing the repeat tests.

3.1.11.4 Medium weight deck simulating shock testing. When the acceptance criteria are violated after completion of a drop series during medium weight deck simulating shock testing of the item, and corrective design modifications are made, drops of the maximum drop height for those series must be repeated (e.g., for table XV, vertical axis specified, conduct all 13-inch drops). See 3.1.11.5.d for retest requirements.

3.1.11.5 Retest requirements. Damage in violation of acceptance criteria incurred at any time during the lightweight, medium weight, heavyweight, or medium weight deck simulating shock test series shall be corrected by a design modification. If the damaged component was subject to manufacturing defects, the damage shall be corrected as specified in 3.1.11.5.2.1. See 3.1.11.8 for direction regarding design modifications.

a. LWSM. Completion of unfinished blows and repetition of the three orthogonal maximum hammer heights, regardless of whether they have been completed before design modification, shall be performed during retest. If it can be demonstrated that the design change is not sensitive to orientation or operating condition(s), then the Technical Authority may approve reduction of retest requirements. Technical Authority approval of reduction in testing requirements for retest will be based on the extent of the redesign and its effect on the operating condition or multiple operating conditions. It is acceptable to make design modifications after a lower hammer height blow without repetition of lower hammer height blows.

b. MWSM. The Group III blows for the first operating condition and Group II blows for other operating conditions shall be repeated during the retest in accordance with 3.1.11.2. If it can be demonstrated that the design change is not sensitive to orientation or operating condition(s), then the Technical Authority may approve reduction of retest requirements. Technical Authority approval of reduction in testing requirements for retest will be based on the extent of the redesign and its effect on the operating condition or multiple operating conditions. It is acceptable to make design modifications after a Group I blow without repetition of the Group I blows. It is acceptable to refurbish or replace test equipment with identical equipment after six blows with Technical Authority approval. It is acceptable to refurbish or replace test equipment with identical equipment to avoid excessive cumulative damage after nine blows without Technical Authority approval.

c. FSP. It is acceptable to perform redesign and modification of failed components during testing and retesting after shots 2 and 3. Unless approved by the Technical Authority, retest of all qualifying shots shall be required when design modifications are made after a qualifying shot (shot 4 or shot 1).

d. DSSM. For medium weight deck simulating shock testing, the maximum drop height in each direction and each frequency must be repeated in the retest for each operating condition.

3.1.11.5.1 Corrective design modifications for subsidiary components or subassemblies of the tested item. In cases where corrective design modifications would be confined to subsidiary components or subassemblies of the tested item, the contractor may recommend, for approval by the Technical Authority, that only the affected subsidiary components or affected subassemblies be subject to repeat testing. Approval by the Technical Authority to proceed in this manner will be contingent upon demonstration by the contractor that such tests can be conducted in a manner that realistically represents conditions and loadings experienced by the affected subsidiary component or subassembly during the original shock test, and that modifications made to the affected subsidiary component or subassemblies will not serve to reduce the shock resistance of those portions of the originally tested item that are not subject to repeat testing. In order to permit convenient retesting of the item, if retesting is required by the Technical Authority, resolution of acceptability of the proposed procedure shall be accomplished, if possible, before removal of the tested item from the test facility.

3.1.11.5.2 Modifications during test. Equipment shall not be adjusted and shall not be groomed back to its original condition between blows, drops, or shots, regardless of how minor the adjustment, with the exception of fastener torque adjustments in accordance with 3.1.8.8.

3.1.11.5.2.1 Incorrect or incomplete item assembly. If after one of the initial blows of the lightweight shock machine or medium weight shock machine, initial drops of the DSSM, or one of the initial shots of heavyweight shock testing, it is determined that a component was not assembled correctly or that a component was missing, it is acceptable to make corrections subject to review and approval by the Technical Authority. All corrections shall be documented in the final test report.

3.1.11.6 Minor corrective design modifications. In cases where corrective design modifications are minor and can be easily demonstrated to correct the problem without adversely affecting any other shock properties of the item tested, the contractor may propose the modification, with supporting justification, and recommend, for approval by the Technical Authority, that the retest be waived and the item accepted.

3.1.11.7 Alternate shock test vehicle/machine test failures. Resolution of shock test failures of items being qualified on an alternate shock test vehicle/machine shall be recommended by the contractor and approved by the Technical Authority.

3.1.11.8 Design modifications. Any corrective design modifications incorporated into the equipment during testing shall be integrated into the permanent design of the equipment.

3.1.12 Shock test reporting. Unless otherwise specified (see 6.2.1), all items shock tested in accordance with this specification require a shock test report (see 6.2.3). The contractor shall provide a copy of the test report and supporting documentation to the Technical Authority for approval.

3.1.13 Acceptance of shock tested items. Figure 19 shall be completed and submitted by the contractor or submitting activity to the Technical Authority for all shock test reports as specified (see 6.2.3). The Technical Authority will use the completed figure 19, or other official correspondence containing the same information, to convey shock test approval information to the contractor or submitting activity. The information shown on figure 19 will be forwarded by the Technical Authority to all parties that received copies of the shock test report.

3.1.14 Disposition of shock tested items. Upon completion of shock test activities, shock tested Grade A and Grade B items shall normally be delivered for use aboard ship after reconditioning and refurbishment, as necessary, to assure compliance with all applicable pre-delivery requirements. Approval from the Technical Authority is required to deliver naval nuclear, shock tested, Grade A items for use aboard ship after reconditioning and refurbishment as necessary to assure compliance with all applicable pre-delivery requirements. Applicable acquisition documents may specify specific requirements for supplemental pre-delivery testing or examination of all shock tested items, or may require disposal of the tested item in the manner specified (see 6.2.2). Shock tested valves shall not be installed in any ship as sea valves or hull penetrations. Shock tested shock, noise, and vibration isolation devices (e.g., Resilient Mount, DIM [Distributed Isolation Material], LDM [Limited Displacement Mount]) shall not be installed in any ship.

3.1.15 Use of Government-owned shock test facilities. Unless otherwise specified by the contracting activity (see 6.2.2), shock tests shall be conducted at commercial test facilities. If a Government facility is requested, a request shall be prepared (see 6.2.3).

3.2 Extension of previous shock test approvals. In cases where acquisition documents require that the item being acquired comply with the shock testing requirements of this specification, this requirement may be satisfied by demonstrating that previously conducted and approved shock tests apply to the item being acquired and provide a basis for acceptance of the item. A previously approved extension of a similar item shall not be used as the basis for extension. Requirements applicable to extension of previous shock test approvals are contained in 3.2.1 through 3.2.2.1.

3.2.1 General. General criteria applicable to shock test extension shall be as follows:

a. Shock test extension requests are required for all items that are either identical or similar to items previously tested and approved by the Technical Authority. Shock tests of items identical or similar to those previously qualified by test shall be repeated if the classification, in accordance with 1.2, for the new item requires a more severe shock test. Items identical or similar to items shock qualified to the requirements of MIL-S-901C, MIL-S-901D, MIL-S-901D with Interim Change No. 1 or 2, or MIL-DTL-901E are acceptable as extension candidates with proper review, approval, and documentation.

For similar items to be qualified by extension, shock design and qualification considerations shall address item design differences (e.g., dimensions, materials, fabrication, etc.). In addition, extension rationale shall address differences in system, operational, or shock qualification requirements, and differences in the shock environment (e.g., shipboard mounting location, mounting orientation, configuration, etc.) in order to demonstrate adequacy for shock.

b. Lightweight and heavyweight shock tests previously conducted and approved in accordance with previous issues of this specification may be cited as a basis for shock test extension, irrespective of differences between this issue and previous issues of this specification. However, equipment that falls into the heavyweight shock test category, which is similar to equipment previously qualified by testing on the medium weight shock machine, shall be eligible for qualification by extension, for submarine usage, if the requirements of 3.2.1.c(3) are fulfilled and approved by the Technical Authority.

c. Medium weight shock tests previously conducted and approved in accordance with previous issues of this specification may be cited as a basis for shock test extension irrespective of differences between this issue and previous issues of this specification, with the following exceptions:

(1) Previous medium weight shock testing shall have included (or been supplemented by) testing in two directions as required by 3.1.8.2. Inclined tests performed on the fixture shown on figure 18 or similar Technical Authority-approved 30-degree fixture will be accepted in lieu of two separate inclined tests (see tables VII through X and XII, and XI when note 4 is invoked).

(2) Equipment classified as medium weight, which is similar to equipment previously qualified by testing on the lightweight shock machine, shall be eligible for qualification by extension, except for shell mounted items.

(3) For submarines, medium weight shock testing of hull and frame mounted equipment shall be eligible for qualification by extension if the following requirements are fulfilled and approved by the Technical Authority. The least costly method of evaluation or analysis that satisfies these requirements shall be used.

(a) An evaluation or an analysis verifies that the equipment previously tested at a 30-degree incline would also have adequate shock resistance if inclined 90 degrees in the same direction as the item would incline aboard ship if the ship were to roll about its fore-aft axis, or the equipment is so arranged aboard ship to reduce the shock environment to that produced by the 30-degree inclined test.

(b) An evaluation or an analysis verifies that the equipment has adequate shock resistance if inclined 30 degrees in the same direction as the item would incline aboard ship if the ship were to pitch about its athwartship axis.

(c) For frame mounted equipment, an evaluation or an analysis verifies that the equipment would have adequate shock resistance if tested using hammer drop heights listed in note 4 of table V.

d. Shock test extensions applicable to principal units shall be based primarily upon previous tests of similar principal units; it shall not be acceptable to base shock test extensions of principal units upon previous tests of subsidiary component or subassemblies. Similarly, shock test extensions applicable to subsidiary components shall not be based upon previous shock tests of subassemblies.

e. Design, mounting, and service differences (if any) between the new item and the originally tested and approved items shall be limited in scope and extent such that the effect of these differences upon shock resistance can be accurately evaluated on an engineering basis. Where differences exist between new items and previously approved items, it shall be shown that the new items provide equal or greater shock resistance than the originally tested items. Differences to be identified and evaluated should include, but are not limited to, the following: shape, mounting orientation, weight, material composition, critical clearances, failure modes, rated pressure, rated torque, etc.

f. Damage, malfunction, or degradation of performance noted in the shock test report for the previously tested item, if accepted without corrective action or accepted with corrective action unconfirmed by retesting, shall be specifically evaluated for acceptability in the new item or new application.

g. The new item shall be shown to be no more susceptible to shock-induced malfunctions than the originally shock tested and approved item. Only malfunctions that would lead to violation of shock test acceptance criteria need be considered. Such malfunctions could, for example, include shock induced actuation of latches, switches, relays, circuit breakers, or alarms.

h. The shipboard mounting location, mounting orientation, and dynamic characteristics intended for the new item shall be no more severe from a shock standpoint than the mounting location, mounting orientation, and dynamic characteristics represented during the original shock test. The shock test extension criteria contained in table XVIII shall be applied to determine the acceptability of new shipboard mounting locations and mounting orientations.

i. Class II equipment test approvals shall not be extended to cover Class I applications. Unless otherwise specified (see 6.2.2), Class I equipment shock test approvals shall not be extended to cover Class II applications.

j. In cases where subsidiary components or subassemblies that were not represented during the original shock tests are added to the new item, or in cases where new subsidiary components or subassemblies are substituted for those represented during the original shock test, evidence shall be provided to show that the new subsidiary components or subassemblies are in compliance with the other requirements of this specification.

k. The overall effect upon shock resistance of adding, substituting, or removing subsidiary components or subassemblies as described in 3.2.1.j shall be evaluated. For instance, if a new subassembly heavier than the one represented during previous shock testing of a principal unit is to be substituted, the effect of this added weight upon the shock resistance of the new principal unit shall be evaluated in accordance with 3.2.1.a through 3.2.1.p.

l. Items produced and tested by a given manufacturer may be used as a basis for extension to items produced by a different manufacturer only when built to the same production level technical data package (TDP) drawings (as defined in MIL-STD-31000). For electrical equipment manufactured by other than the original manufacturer or by different manufacturing processes, shock qualification extension will be evaluated on a case basis by the Technical Authority.

m. Items previously shock tested and approved on the basis of requirements for Grade B items shall not be extended to applications as Grade A items, unless it can be demonstrated that the previous test and subsequent inspections demonstrated compliance with requirements for Grade A items in all respects. Previous shock tests of Grade A items may be cited as a basis for extension to applications as Grade B items.

n. A variety of items may be extended from a single shock tested item provided that all items can be easily compared for shock resistance. Typical items that may fall into this category are piping supports, piping system castings, ventilation system fittings, repair parts stowage attachments, and foundations. Clarification of allowable extensions for valves where a particular design is employed for a range of sizes shall be in accordance with MIL-STD-798, or as approved by the Technical Authority.

o. In cases where brittle materials (generally any material with an elongation capability of less than 10 percent, plus any additional program requirements) must be utilized in the new item in areas where fracture would violate shock test acceptance criteria, it shall be shown that these materials possess equal or better fracture toughness than those in corresponding locations of the originally approved item, and that shock loading of parts composed of such materials in the new item will be no more severe than experienced during shock tests by corresponding parts of the originally approved item.

p. Applicable acquisition documents may contain additional requirements applicable to shock test extension of specific items (see 6.2.2).

q. Where shock test extension approval is believed to be warranted, despite the fact that one or more extension conditions cannot be fulfilled, a full explanation of why extension should be granted shall be provided for consideration by the Technical Authority. This explanation shall be accompanied by supporting documentation (e.g., an analysis).

3.2.2 Shock test extension requests. Shock test extension requests shall be prepared (see 6.2.3) and submitted to the Technical Authority for approval.

3.2.2.1 Acceptance of shock test extension requests. Figure 19 shall be completed by the contractor or submitting activity and requires review and approval by the Technical Authority for all extension requests. The Technical Authority will use the completed figure 19, or other official correspondence containing the same information, to convey shock test extension approval information to the contractor or submitting activity. The information shown on figure 19 will be forwarded by the Technical Authority to all parties that received copies of the shock test extension request.

TABLE XVIII. Mounting limitations for shock test extension. [1/]

Shock Category of Original Shock Test [2/]	**Test Fixture Used During Original Shock Test**	**Acceptable New Shipboard Mounting Locations** [3/]	**Acceptable New Shipboard Mounting Orientations** [4/]
Lightweight	Standard [5/]	Frame [6/], Hull [6/], any Deck [6/, 7/, 8/]	[6/]
	Non-Standard [5/]	[9/, 6/, 10/]	
Medium Weight	Standard [5/]	Frame [6/, 11/], Hull [6/], any Deck [6/, 7/, 8/]	[6/]
	Non-Standard [5/]	[9/, 6/, 10/]	
Medium Weight Deck Simulating	[12/]		
Heavyweight or Alternate Shock Test Vehicle/Machine	Submarine Shock Mitigated Deck-Type (see 3.1.6.4.c)	Submarine Shock Mitigated Deck [13/]	[6/]
	Deck-Type [8/] (see 3.1.6.4.c)	Surface Ship Deck, Submarine Conventional Deck, or Submarine Shock Mitigated Deck [13/]	
	Hull-Type (see 3.1.6.4.f)	Hull, any Deck [7/, 8/]	
	Frame-Type (see 3.1.6.4.n)	Frame, Hull, any Deck [7/, 8/]	
	Shell-Type (see 3.1.6.4.i)	Shell, Hull, Frame, any Deck [7/, 8/]	
	Wetted Surface-Type (see 3.1.6.4.g and 3.1.6.4 h)	Wetted Surface	

NOTES:

1/ Acceptable new shipboard mounting plane (see 1.2.7) same as represented during the original test.

2/ See 1.2.1.

3/ See 1.2.6.

4/ See 1.2.8.

5/ Standard test fixtures are those identified as such by 3.1.6.2, 3.1.6.3, and 3.1.6.3.1. Other test fixtures are non-standard.

6/ Same or less severe as represented during the original test (see 3.2.1.a).

7/ Class I equipment only.

8/ "Deck" is used to categorize submarine conventional deck and surface ship decks.

9/ Hull mounted locations will also be acceptable unless the non-standard fixture was specifically designed to simulate deck-type conditions.

10/ New shipboard mounting should be no more severe than non-standard fixture was intended to represent.

11/ Only acceptable if hammer heights for frame mounted were used.

12/ DSSM extensions shall be executed in accordance with 3.2.

13/ New shipboard mounting location shall be no more severe than deck fixture was intended to simulate.

3.3 Equipment and drawing marking.

3.3.1 Drawings. The information specified in 3.3.1.1 through 3.3.1.4 shall be included on the applicable assembly drawings or other appropriate drawings (e.g., installation or outline drawings). Where no drawing exists, the information shall be specified on the applicable data sheet. The specified information is not required to be noted on assembly drawings of components, subassemblies, and subsidiary components that have been shock qualified as a part of a principal unit or higher level assembly. If practical, the information may be added at the next normal drawing revision either prior to, or subsequent to, the shock tests (all information except the shock test report and approval letter reference may be added before the shock tests). However, the information shall be included within 2 years of the shock tests unless a different date is agreed to by the Technical Authority.

3.3.1.1 For items approved on the basis of shock testing. If not already present, the following information shall be included on the equipment assembly drawings or other appropriate drawings:

a. Shock test category (see 1.2.1).

b. Shock grade (see 1.2.2).

c. Equipment type and class (see 1.2.3 and 1.2.4).

d. Shock test type (see 1.2.5).

e. Mounting location aboard ship (see 1.2.6).

f. Mounting plane aboard ship (see 1.2.7).

g. Mounting orientation aboard ship (see 1.2.8).

h. Applicable shock test report (see 3.3.1.5).

i. Approval letter reference (see 3.3.1.5).

j. Description of grade, size, material, and specifications of hold-down bolts (and of any other hold-down or locating devices) used to secure or locate the tested items to their foundation or test fixture during shock tests.

3.3.1.2 For items approved by extension of previous shock test approvals. If not already present, the following information shall be included on the equipment assembly drawings or other appropriate drawings:

a. Shock test category (see 1.2.1).

b. Shock grade (see 1.2.2).

c. Equipment type and class (see 1.2.3 and 1.2.4).

d. Shock test type (see 1.2.5).

e. Mounting location aboard ship (see 1.2.6).

f. Mounting plane aboard ship (see 1.2.7).

g. Mounting orientation aboard ship (see 1.2.8).

h. Applicable shock test report on which extension is based (see 3.3.1.5).

i. Extension approval letter reference (see 3.3.1.5).

j. Description of grade, size, material, and specifications of hold-down bolts (and of any other hold-down or locating devices) used to secure or locate the tested items to their foundation or test fixture during shock tests.

3.3.1.3 Limitations. If limitations have been placed upon application of the item by the letter approving the shock test or the shock test extension, these limitations shall also be included on the assembly drawings of the item.

3.3.1.4 Shock, noise, or vibration isolation devices. Shock, noise, or vibration isolation devices used during the shock tests of the item shall also be specifically identified in the drawing notes (see 3.4).

3.3.1.5 Exclusions. The information on the applicable shock test report or analysis (see 3.3.1.1.h and 3.3.1.2.h) and approval reference (see 3.3.1.1.i and 3.3.1.2.i) is not required to be included on assembly drawings of components designed by the Design Yard and built by the Shipbuilder. This information shall instead be stored in and retrievable via the Design Yard component shock qualification Data Collection System or Database. For these Design Yard component drawings, additional notation shall be included to provide the required direction for where this information is stored and how to access it.

3.4 Marking of equipment requiring shock, noise, or vibration isolation devices. When use of shock, noise, or vibration isolation devices between equipment and ship structure (or foundation) is required for Class II, Class I/II, or Class III equipment, the National Stock Number (NSN) (or commercial designator if no NSN is applicable) of the required mounting shall be indicated on the equipment. The marking shall be accomplished by a separate identification plate conforming to MIL-DTL-15024 and MIL-P-15024/5. This marking shall read as follows:

Mounting No. (or commercial designator) __________________________
only must be used to mount this equipment.

4. VERIFICATION

4.1 Shock test facilities. Shock tests performed in accordance with this specification shall be conducted on an approved shock testing vehicle/machine. The Technical Authority maintains a listing of shock testing facilities with approved vehicles/machines. Shock machines or FSPs not referred to in this listing require inspection by the designated Government representative (see 6.6.6) and certified by the test agency and the designated Government representative to the Naval Surface Warfare Center (Carderock Division) to be constructed and installed in accordance with the drawings referenced herein prior to acceptance of items shock tested at these facilities. Alternative testing vehicles/machines (see 1.2.1.2) not included in this listing shall be approved by the Technical Authority prior to testing.

4.2 Number of items requiring tests. Unless otherwise specified (see 6.2.2), shock test approval shall be based upon shock testing of a single item. Acquisition documents may require periodic shock testing of items from different manufacturing lots, particularly when the shock resistance of such items is unusually sensitive to minor variations in workmanship or construction.

5. PACKAGING

This section is not applicable to this specification.

6. NOTES

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

6.1 Intended use. Requirements contained in this specification are intended to establish general shock test criteria, and to provide a basis for selection by the contracting activity or contractor of detailed shock test requirements (see 6.2.1), which must be tailored to suit the design, function, and application of the specific item to be tested.

6.2 Acquisition requirements.

6.2.1 Specification of shock test requirements in acquisition documents. Acquisition documents should specify the following:

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

b. Test category (see 1.2.1 and 3.1.2).

c. Applicable shock grade (see 1.2.2 and 3.1.3).

d. Equipment type and, if established, class (see 1.2.3, 1.2.4, and 3.1.4).

e. Shock test type (see 1.2.5, 3.1.5, and 3.1.5.3). If Type B tests are required because the principal unit is too large or too heavy to permit shock testing, also describe how the principal unit is to be broken down into shock-testable groups of subsidiary components (see 3.1.5.2).

f. Equipment mounting location aboard ship (see 1.2.6).

g. Equipment mounting plane aboard ship (see 1.2.7).

h. Equipment mounting orientation aboard ship (see 1.2.8).

i. Method of mounting items for tests. Designate standard test fixtures to be used (see 3.1.6, 3.1.6.1, and 3.1.8.4) or describe the design of the required test fixture (see 3.1.6.4). Define requirements, if any, for torquing of hold-down bolts (see 3.1.6.4.k).

j. Method of simulating shipboard connections (see 3.1.7.1).

k. Conditions of equipment operation to be selected during tests (energized, de-energized [or both], pressurized, rated speed, temperatures, or other operating conditions). For lightweight shock tests, state the operating condition during each of the series of blows (see 3.1.8.1 and 3.1.8.6). For medium weight shock tests, state the operating condition to be selected during Group I and III blows, and the operating condition or conditions to be selected during Group II blows (see 3.1.8.2 and 3.1.8.6). For heavyweight and alternate vehicle/machine shock tests, state the operating condition to be selected during each test shot (see 3.1.8.3 and 3.1.8.6). For medium weight deck simulating shock testing, state the operating condition during the initial series of five drops (see 3.1.8.4). For secondary or tertiary operating conditions, state the additional drops that are required for each operating condition, as necessary.

l. Shock test acceptance criteria and associated pre-shock test, post blow/shot/drop, and post-shock test series functional testing and inspection requirements. In accordance with 3.1.10.1, define minimum acceptable performance of Grade A items during and following each blow/shot/drop and following completion of the shock test series, such as extent of momentary malfunction, if permitted, and degree of permanent functional impairment allowed. State requirements applicable to important characteristics, such as alignment, dielectric strength, and pressure-tight integrity. Furnish supplemental acceptance criteria for Grade B items if applicable (see 3.1.10.2 and 3.1.10.2.1). Identify requirements for monitoring equipment during tests and for functional testing and inspection before the shock test, after each blow/shot/drop, and at the completion of the shock test series (see 3.1.8.7, 3.1.9, and 3.1.10.1.b) as required to demonstrate compliance with acceptance criteria.

m. Equipment for which shock test reports are not required (see 3.1.12).

6.2.2 Supplemental ordering data. The following ordering data or any portion thereof should be specified in addition to the acquisition requirements of 6.2.1 in cases where the contracting activity finds it necessary to modify or augment the normal requirements of this specification. Unless otherwise specified, the contractor is not required to develop supplemental ordering data for approval by the Technical Authority if such data is not furnished by applicable purchase documents.

a. Limitations upon selection of shock test category (see 1.2.1, 3.1.2, and 3.1.2 f).

b. Requirements for approval by the Technical Authority of data of 6.2.1 developed by the contractor for lightweight, medium weight, and medium weight deck simulating shock tests (see 3.1.1, 3.1.1.2, and 6.5).

c. Use of Government-owned alternate shock test vehicles/machines (see 3.1.2.e).

d. Approval to shock test Class III equipment in the non-isolated configuration only (see 3.1.6.1.d and 3.1.8.4 f).

e. Additional requirements for shock machine or FSP testing of deck mounted Class I, Class II, Class I/II, or Class III equipment (see 3.1.6.4.c).

f. Additional requirements for selection of standard test fixtures or for design of non-standard test fixtures by the contractor, including specific criteria to simulate shipboard mounting conditions (see 3.1.6.4.c and 3.1.6.4.j).

g. Permission or requirements to utilize the IFSP or LFSP or other Government-owned shock test facilities (see 3.1.6.4.h, 3.1.15, and 6.2.3).

h. Requirements for additional evaluation, analysis, or alternate testing for equipment having natural frequencies below 4 Hz (see 3.1.6.5.1.1.d).

i. Specific requirements for weight or design of dummy masses (see 3.1.7.1.a).

j. Permission or requirements to simulate one or more of a group of identical subsidiary components or subassemblies (see 3.1.7.2).

k. Requirements for heavyweight shock test shots at standoffs greater than shot 1 standoff (see 3.1.8.3).

l. Specific requirements for partial simulation of operating conditions during shock tests in cases where it is not practical to fully simulate shipboard operating conditions (see 3.1.8.6.c).

m. Additional limitations upon allowable loosening of fasteners (see 3.1.8.8).

n. Special post shock test noise and vibration criteria (see 3.1.10.1.e).

o. Requirements for supplemental pre-delivery testing or examination of shock tested items (see 3.1.14).

p. Requirements for disposition of shock tested items (see 3.1.14).

q. Government-owned testing facility and vehicle/machine, if applicable (see 3.1.15).

r. Additional criteria applicable to shock test extension (see 3.2.1.i and 3.2.1.p).

s. Requirements for marking of drawings, when different than specified (see 3.3.1).

t. Number of articles requiring tests, when different than specified (see 4.2).

u. Requirements for additional distribution of high-impact shock test procedures (see 6.3.a).

v. Requirements for additional distribution of shock test reports (see 6.3.b).

w. Requirements for additional distribution of shock test extension requests (see 6.3.d).

x. Specification of an SRF less than or equal to 37 Hz, allowing standard Navy mounts (S9073-A2-HBK-010), fitted with auxiliary snubbers as necessary, to be used as LDCIDs (see 6.6.21).

y. Specification of the velocity to be used in determining the SRF for isolation devices (see 6.6.21).

z. Requirements for witnessing of lightweight or medium weight shock tests or associated post-test inspections (see 6.7.2.b).

6.2.3 Associated Data Item Descriptions (DIDs). This specification has been assigned an Acquisition Management Systems Control (AMSC) number authorizing it as the source document for the following DIDs. When it is necessary to obtain the data, the applicable DIDs must be listed on the Contract Data Requirements List (DD Form 1423).

DID Number	DID Title
DI-ENVR-80706	Shock Test Extension Request
DI-ENVR-80707	Request for Use of Government-Owned Shock Test Facilities
DI-ENVR-80708	Shock Test Report
DI-ENVR-80709	High-Impact Shock Test Procedures
DI-ENVR-80710	Shock Qualification Data Sheet

The above DIDs were current as of the date of this specification. The ASSIST database should be researched at http://quicksearch.dla.mil to ensure that only current and approved DIDs are cited on the DD Form 1423.

6.3 Distribution of deliverable data. Distribution by the contractor of data required by this specification is as follows:

a. Shock test procedures:

(1) Technical Authority: Two copies, unless otherwise specified (see 6.2.2).

(2) Contracting activity: One copy, if contracting activity is not identical to the Technical Authority (see 6.2.2).

(3) Manufacturers of items to be tested: In cases where the contractor is not the manufacturer of principal units or subsidiary components to be tested, or is not the manufacturer of a subassembly that is to undergo Type C testing, these manufacturers should be furnished a copy of the shock test procedures for information. Distribution of shock test procedures to manufacturers of subassemblies, which comprise subsidiary components or principal units to be tested, may be required (see 6.2.2).

(4) Ship design yard: One copy for information, if the design yard is not one of the above activities.

(5) Performing shock test facility: One copy for information.

(6) Other: As specified (see 6.2.2).

b. Shock test reports:

(1) Technical Authority: Two copies, unless otherwise specified (see 6.2.2). In cases where a local representative of the Technical Authority has certified shock test or post-shock test information, a copy of the report should also be forwarded to that representative.

(2) Contracting activity: One copy, if the contracting activity is not identical to the Technical Authority (see 6.2.2).

(3) Manufacturers of tested items: In cases where the contractor is not the manufacturer of tested principal units or subsidiary components, or is not the manufacturer of a subassembly that has undergone Type C testing, these manufacturers should be furnished a copy of the test report for information. Distribution of shock test reports to manufacturers of subassemblies, which comprise tested subsidiary components or principal units, may be required (see 6.2.2).

(4) Ship design yard: One copy for information, if the design yard is not one of the above activities.

(5) Performing shock test facility: One copy for information.

(6) Other: As specified (see 6.2.2).

c. Distribution of requests for use of Government-owned heavyweight shock test facilities should be forwarded to the Technical Authority. Distribution of requests for use of Government-owned lightweight and medium weight shock test facilities should be forwarded to the test facility with an information copy to the Technical Authority. DI-ENVR-80707 applies.

d. Shock test extension requests:

(1) Technical Authority: Two copies, unless otherwise specified (see 6.2.2).

(2) Contracting activity: One copy, unless otherwise specified (see 6.2.2).

(3) Manufacturers of items subject to shock test extension approval: In cases where the contractor is not the manufacturer of the item that is subject to shock test extension approval, the manufacturer should be furnished a copy of the shock test extension request for information.

(4) Ship design yard: One copy for information, if the design yard is not one of the above activities.

(5) Other: As specified (see 6.2.2).

6.4 General information. The following information is provided as guidance for designers and others responsible for fulfilling the provisions of this specification:

a. All items will exhibit some deflection during exposure to shock; nothing is "rigid", except in a relative sense.

b. To account for relative deflection between components during shock loadings, the designer should endeavor to build maximum tolerance for relative motion between component parts into his design. Examples of relative motion-tolerant design are:

(1) Maximized clearances between rotating and non-rotating parts.

(2) Design such that momentary impact between rotating and non-rotating parts will not significantly affect equipment performance.

(3) Provision of sufficient slack in wiring to prevent pull-out or breaking of wires during shock excursions.

(4) Stiffened or braced structure and avoidance of designs and structural arrangements (such as cantilevered elements) that tend to deflect excessively.

(5) Provision of ample clearance between separately mounted components or equipment to prevent shock-induced impact.

(6) Design of control systems such that shock-induced relative motions do not cause significant false signals to be introduced into control system logic.

(7) Design of systems utilizing limit switches on safety tripout devices such that shock-induced relative motions will not cause inadvertent shock-induced shutdown of vital equipment.

(8) Use of flexible shaft couplings, flexible waveguide sections, and flexible tubing or piping loops where necessary to accommodate relative motion.

(9) Avoidance of requirements to rigidly connect items to two elements of ship structure that could deflect relative to each other during shock loadings.

c. Desirable material properties for shock resistant design are high yield strength, high ductility (at least 10 percent elongation), high fracture toughness, and, in some cases, low density (to reduce inertial forces). Undesirable material properties are brittleness, low impact resistance, high nil-ductility transition temperature, and high notch sensitivity. Cast iron and cast aluminum have proven generally unsatisfactory when used in strength members in shock-resistant applications. Use of these materials as strength members in shock resistant applications may be prohibited by separately invoked specifications.

d. In general, ample cross-sections should be provided in potentially highly stressed areas, and factors causing stress concentrations, such as notches or sudden changes of cross-section, should be avoided. Structural continuity should be achieved whenever practical, with the aim of distributing shock-induced stresses throughout structures in a reasonably uniform manner.

e. Well-constructed positive securing means, such as hinges or shafts with bearings, should be utilized instead of knife-edge pivots in the design of support of moving parts of mechanisms such as voltage regulators and relays.

f. Levers, linkages, and other moving parts of mechanisms should be dynamically balanced (either individually or on a system basis) whenever practical in order to reduce the likelihood of shock-induced malfunction. This criterion is particularly applicable to items such as circuit breakers, rotary solenoids, relays, governor systems or other control systems, and emergency shutdown systems.

g. Cantilevered mounting of equipment or components should be avoided; experience indicates that this method of mounting commonly leads to excessive deflections, high stresses, and consequently to shock test failures and shipboard vibration problems.

h. Friction cannot be depended upon as a means for maintaining the relative position of alignment-sensitive components during exposure to shock, regardless of the apparent static holding power of the frictional connection. Positive locating and holding means such as fitted bolts or rabbetted joints should be utilized in alignment-critical applications. Positive means should also be used for securing tapered dowels and similar items in lieu of relying upon friction alone as a means for securing such devices. Positive locking devices should be used to prevent wires, circuit boards, etc., from loosening from connections.

i. Electronic cabinets and other items that are designed to facilitate quick maintenance access or removal must have positive, shock-resistant means for latching, secure closure, lock-in, or support when in their normal operating position. Such latching or locking devices should be quickly and easily operated and should not require special tools. For example, use of one or two single-turn positive latches to secure an electronics cabinet drawer sliding assembly is the preferred approach; use of ten cap screws to accomplish the same function is discouraged.

j. Where bolts (including cap screws, machine screws, and studs) are installed in clearance holes, the clearance should be minimized to cause proper sharing of bolt shear loads and to reduce the adverse effects of impacting due to load reversals under shock. The following clearance criteria are recommended (and may be invoked as a requirement by applicable specifications):

Nominal bolt diameter	Maximum diameter of hole
¾ inch and smaller	Nominal bolt diameter plus 1/32 inch
Larger than ¾ inch	Nominal bolt diameter plus 1/16 inch

k. Where alignment must be maintained, fitted bolts or other positive methods should be used. Nearly all bolted joints tend to loosen under shock. Proper bolt design, sufficient pre-stress, and adequate finishing and sizing of joint surfaces can eliminate or reduce this tendency. For joints employing O-rings or other types of gaskets, proper bolt pre-stressing is essential to prevent the flanges from momentarily parting under shock with possible displacement of the gasket due to the internal hydrostatic forces.

l. In general, where required by separately invoked specifications, bolts should be tightened (pre-stressed) to a maximum value consistent with the allowable stress, the effects of combined loads, and operating conditions. Lock nuts may help to preserve the initial pre-stressing and will normally assist in minimizing the possibility of additional damage in the event the joint does become loose following shock loadings. Except for very light items such as gauges, mounting bolts less than ½ inch in diameter should not be used because of the inherent risk of over stressing during initial or subsequent tightening. Reduced shank or hollow bolts increase the capability of the bolt to absorb energy; however, in order to maintain tight and unseparated joints, it is preferable in almost every case of bolted joint design to transmit energy rather than attempt to absorb it.

m. When possible, locate welded joints away from highly stressed areas. The effects of stress reversals should be considered in joint selection. For instance, welds loaded only in compression under normal conditions will experience both tensile and compressive loadings in the shock environment. Weld design should make allowance for corrosion, difficulty in welding, discontinuities, and other factors that tend to reduce weldment strength. The effect of heat on the material as a result of welding, especially for aluminum and similar materials, should be determined and allowed for. In general, 100-percent efficient joint designs should be used to develop strength needed to resist shock loadings. The ability to perform weld inspections satisfactorily should be considered in the design of joints. Experience indicates that a seemingly disproportionate number of shock test failures have been caused by improper selection of welding procedures or by lack of effective production quality control in this area.

n. Threaded pipe and fittings should be avoided. When threaded connections cannot be avoided, flexibility should be provided to minimize the load on the threads. Flexibility should be provided in piping runs between different components or where they are attached to structures that can have relative movement under shock. The inertial effects of piping can be large, and sufficient support should be provided so as not to over-stress or elastically deform the equipment or associated valves or fittings excessively. Shock test requirements for piping system components for naval shipboard use are specified in MIL-STD-798.

o. Subject to limitations, which may be separately specified, shock mounts may be employed, based on a definite need, and only after a careful review of the design indicates that it is not otherwise feasible to meet the shock requirements. Where a need for shock protection is established, the mount characteristics should be determined based on knowledge of the particular shock environment and the dynamic nature of the equipment. Mounts must also be compatible with other shipboard environments such as vibration and service conditions and, as such, may be separately required to meet the requirements of MIL-M-17185 or MIL-PRF-32407. (Note: MIL-M-17185 was inactivated for new design and superseded by MIL-PRF-32407.)

p. Isolation devices intended primarily to serve as noise or vibration isolating devices provide nonlinear characteristics, and the load mitigating properties under normal environmental loadings often change radically with the large amplitudes and high rates of loading encountered in the shock environment. Isolation device deflection under shock, especially for base mounted equipment, should be considered when specifying the clearances around the equipment and in the design of waveguide, piping, and similar continuous systems. Isolation devices should have a positive, mechanical captive feature in their design. Resilient mounts originally designed for the purpose of mitigating shipboard or equipment noise or vibration do not necessarily provide good shock mitigation properties, and on many occasions have proven detrimental in the shock environment owing to hard bottoming of the mounts or due to the introduction of resonance problems, which in effect cause the mounting system to amplify shock motions. For these reasons, and because resilient mounting systems necessarily demand weight, space (clearance), and maintenance requirements in excess of corresponding rigidly mounted arrangements, the application of resilient mounts is commonly restricted by applicable specifications.

q. Design of items for resistance to the adverse effects of vibration will normally also enhance shock resistance. It is particularly important in both shock and vibration resistant applications to avoid structural resonance between small components and large masses in the same (attached) system, and to use positive securing means for the item and its components. Shock-induced vibratory amplitudes and associated absolute displacements are normally much greater than those associated with normal vibration environments.

r. It should not be automatically assumed by the designer that standard-line equipment must be redesigned in order to satisfy the requirements of this specification. Standard-line (or commercial) items have often passed the shock tests required by this specification because:

(1) The item tested was originally designed to withstand high operating loads (internal pressure, tensile or torsional loads, etc.) and thus is also inherently resistant to shock loadings.

(2) The item will remain functional despite minor shock-induced distortion of structural members or internal parts. (Shock test acceptance criteria for Grade A items are normally keyed to the ability of tested items to function properly during and after exposure to shock, rather than to the physical condition of items following shock tests.)

(3) Separately invoked or self-imposed requirements intended to provide resistance against shock loadings caused by handling or shipping of items have caused ruggedness to be built into the design.

s. Information concerning shock test devices and tested equipment response is available from COMNAVSEASYSCOM, 1333 Isaac Hull Avenue SE, Washington Navy Yard, DC 20376.

t. Design provisions to limit the extent or effect of momentary malfunctions under shock (e.g., redundant contacts) will depend to some extent on the design of the system in which a component is intended to be used. Examples of momentary malfunctions (see 3.1.10.1.d) and the considerations affecting their acceptability include the following:

(1) Loss of suction: Acceptable for bulk liquid transfer pumps, bilge stripping pumps, fire pumps, lube oil pumps, and similar pumps, provided that the interrupted pressure or flow from the pump returns to normal without manual actions and resumes quickly enough to avoid wiped bearings, upset of fluid control systems, etc. This same malfunction is unacceptable for items such as control oil pumps where falling control oil pressure causes a manual-reset trip valve to close, fuel oil pumps where the interruption may be long enough to extinguish burner flames, pumps where manual action to reprime the suction or stop the pump is necessary to prevent pump damage, and in similar cases.

(2) Lifting of relief valves: Acceptable if the valve reseats without assistance with normal system pressure maintained at the inlet piping to the valve, provided no hazard is created by valve effluent. Unacceptable if the valve fails to reseat without assistance, if effluent could cause a hazard, or if the valve is tested with equipment incapable of sustaining a prolonged (several seconds) normal lift and reseat of the valve.

(3) Interruption of instrument reading: Acceptable for basic gauges whose readings are taken manually, provided no manual protective action or automatic securing of the equipment would result from the interrupted reading. Unacceptable for instruments monitored by automatic control systems where loss of instrument reading, false reading, or loss of sensor signal causes an automatic protective action.

(4) Governor/regulator control signal fluctuation: Acceptable only if the specified characteristics of the equipment being controlled are known and the fluctuation of control signal can be shown to result in a change in the parameters of the equipment being controlled that is small enough to be acceptable. Unacceptable if the control signal fluctuation results in controlled equipment parameters outside the acceptable range (e.g., excessive or inadequate speed, frequency, voltage, pressure, etc., resulting in damage or interrupted operation of the controlled equipment or downstream equipment dependent on the output of the controlled equipment).

(5) Contact bounce, trip, or change of state: Contact bounce in relay, switch, or circuit breaker contacts is acceptable only as defined by the applicable acquisition documents. Shock-induced bounce of contacts not designed for opening or closing under load (e.g., disconnect devices) is unacceptable. Shock-induced tripping of Grade A circuit breakers or change of state of Grade A switches is unacceptable. If no requirements for contact bounce are set forth in applicable acquisition documents, then bounce-open of closed contacts is acceptable only if self-correcting and brief enough that no impairment of downstream equipment results, while bounce-closed of open contacts is unacceptable.

(6) Loss of program or data: Loss of program or stored data is unacceptable. Momentary loss of data being received or transmitted is acceptable provided it is automatically detected and corrected without significant impact on communications link capacity or on controlled functions dependent on the transmitted data.

u. Guidelines for testing low-frequency or displacement sensitive equipment are given in SVM-18, Shock and Vibration Design Manual. These guidelines should be considered by those contractors having access to SVM-18.

v. Alternate shock test vehicles such as the SSTV and A/B-1 have limited availability and tests conducted on them are expensive relative to machine or FSP shock tests.

w. Setup and operation of lightweight shock machine:

(1) The forward springs of the lightweight shock machine should be examined prior to test and after each side or edge blow. The forward springs should be adjusted so that the spring can compress 1.5 inches during the shock blow.

(2) Unless the hammer is raised in preparation for a blow, it should be either in the post-blow at rest position, or secured by its safety device.

(3) Before each blow, check all bolted and clamped fixture joints for fastener tightness.

(4) The springs, hammer, anvil table impact pads, hold-down bolts, and structural welds should be inspected periodically.

x. Setup and operation of medium weight shock machine:

(1) Overhead or secondary support. In vertical testing, if a deck-mounted item has secondary support from a vertical or overhead surface, it may be necessary to use a second fixture to provide secondary mounting points (see 3.1.6.4.p). This second fixture should be mounted to a separate set of supporting channels.

(2) Bolted connections. Before each blow, check all bolted and clamped fixture joints for fastener tightness.

(3) Group III blows. Performance of Group III blows is accomplished by raising the anvil table with the air jacks to limit table travel to 1.5 inches.

(4) Hammer height calibration. The hammer height indicator should read zero when the anvil table is raised on the air jacks. Releasing the hammer from this position should not move the anvil table. These checks should be performed periodically, or prior to each test.

(5) Machine integrity. The springs, hammer, anvil table impact pads, hold-down bolts, and structural welds should be inspected periodically.

(6) Safety. Unless the hammer is raised in preparation for a blow, it should be either in the post-blow at rest position, or secured by its safety device.

(7) Dynamic imbalance. When testing an item that has a cantilevered reactive load, fixture rigidity is critical to preventing dynamic imbalance during shock blows.

y. Non-standard test fixtures may be designed to reduce the weight of a standard test fixture such that testing of a component that would otherwise be required to be tested on a heavyweight platform can be performed on a medium weight shock machine.

z. Figure 20 provides examples of equipment classes and the rationale for the assignment of a particular class or combination. Figure 21 provides examples of testing requirements for classes of equipment and mounting configurations. Figure 22 provides flowcharts of the shock testing requirements for the qualification of equipment.

aa. Appendix A provides, as guidance only, an example for calculating the SRF (see 6.6.34).

6.5 Items requiring approval by the Technical Authority. The items listed below require approval by the Technical Authority. To minimize requirements for separate approval action by the Technical Authority, contract ordering data should include information related to the requests listed below, whenever possible. Note that additional requirements for approval by the Technical Authority of information related to shock testing may be added to the contract ordering data if deemed necessary.

a. Permission to utilize alternate shock test vehicles/machines (see 1.2.1.2).

b. Permission to utilize lightweight or medium weight machine testing to qualify wetted surface mounted items (see 3.1.2).

c. Ordering data for heavyweight or alternate vehicle/machine shock tests when independently developed by the contractor (see 3.1.1.3).

d. Ordering data for lightweight, medium weight, and medium weight deck simulating shock tests when independently developed by the contractor, when required by 6.2.2, or when submitted by the contractor (see 3.1.1.3) except for shipyard, design yard, or government prime contractors.

e. Permission to accept tested items based upon requirements for Grade B items, if shock grade is not specified (see 3.1.3).

f. Permission to perform Type B test when recommended by the contractor (see 3.1.5.2).

g. Permission for repeat shock testing of subsidiary components or subassemblies only (see 3.1.5.2.b, 3.1.5.3, and 3.1.11.5).

h. Permission to perform Type C test (see 3.1.5.3).

i. Permission to use non-standard mounting fixtures for lightweight tests (see 3.1.6.2).

j. Permission to use non-standard mounting fixtures for medium weight tests (see 3.1.6.3).

k. Acceptance of test fixture yielding or cracking during shock tests (see 3.1.6.4.d).

l. Permission to simulate one or more of a group of identical subsidiary components in the test of a principal unit (see 3.1.7.2).

m. Permission to simulate subassemblies during Type A and B tests (see 3.1.7.3).

n. Approval of modification of the basic shock test parameters (see 3.1.8).

o. Approval to substitute separate items for items that have been exposed to six (or more) medium weight shock test blows (see 3.1.8.2 and 3.1.11.5.b).

p. Approval of FSP or alternate shock test vehicle/machine test fixtures (see 3.1.6.4 m).

q. Approval of selection of heavyweight or alternate vehicle/machine shock test operating conditions (see 3.1.8.6.b[3]). NOTE: This information should be included in the heavyweight or alternate vehicle/machine shock test ordering data referred to in 6.5.c.

r. Approval of functional performance testing to be accomplished after disassembly or repair of the item (see 3.1.9.1).

s. Approval of exceptions to standard shock test acceptance criteria (see 3.1.10.2.a, 3.1.10.2.b, and 3.1.10.2.c).

t. Permission to proceed to next shot of the heavyweight shock test series without correction of damage in violation of acceptance criteria (see 3.1.11.3.b).

u. Selection of heavyweight shock test shots to be repeated and procedures for such tests (see 3.1.11.3.d).

v. Approval of shock test reports (see 3.1.12 and 3.1.13).

w. Permission to utilize Government-owned shock test facilities (see 3.1.15).

x. Approval to deliver shock tested Grade A items for use aboard ship after reconditioning and refurbishing as necessary to assure compliance with all applicable pre-delivery requirements (see 3.1.14).

y. Approval to test Class III equipment in the rigidly mounted configuration only (see 3.1.6.1.d).

z. Approval of repeat shock testing schedules and procedures following violation of acceptance criteria (see 3.1.11.1, 3.1.11.2, 3.1.11.3, 3.1.11.4, and 3.1.11.5).

aa. Approval to exceed maximum allowable weights of all FSPs (see 3.1.2.c[1]-[3]).

bb. Requests for approval of items on the basis of shock test extension (see 3.2.2).

cc. Approval to test Class II, Class III, and Class I/II equipment that use LDCIDs to Class I equipment requirements, and approval of the LDCID (see 3.1.6.1.b, 3.1.6.1.c, and 3.1.6.1.d).

dd. Approval to perform additional evaluation, analysis, or alternate testing of equipment having natural frequencies below 4 Hz (see 3.1.6.5.1.1.d).

ee. Approval to use test fixtures designed in accordance with 3.1.6.4.a and 3.1.6.4.b (see 3.1.6.4 m).

ff. Approval to limit DSF target frequencies for all classes of deck mounted equipment with one mounting location to one frequency that represents the shipboard dynamic environment (see 3.1.8.3.2.1.a).

6.6 Definitions. Definitions of terms used herein are as indicated in 6.6.1 through 6.6.44.

6.6.1 Ballast.

a. FSP ballast: Mass added to the inner bottom or other primary structure of the FSP, or to the pedestals of the DSF, that has the primary effect of leveling the barge in the water.

b. DSF ballast: Removable or permanently attached non-structural mass that is used to tune the DSF fundamental frequency to the DSF target frequency.

c. DSSM ballast: Removable or permanently attached non-structural mass that affects the frequency response of the DSSM.

6.6.2 Certification. Verification of the accuracy of reported information of shock tests, post-test inspections, and functional tests. It does not imply acceptance of the adequacy or results of the procedures, tests, or inspections. The term is also defined as the verification that a shock test machine or FSP is constructed and installed in accordance with the drawings referenced herein.

6.6.3 Contracting activity. The activity having authority and responsibility to initiate purchase orders, agreements, or documents for acquisition of services, materials, or items.

6.6.4 Contractor. A party who has entered into a formal written agreement with the contracting activity to provide the services, materials, or items described in this specification and specifically identified in the written agreement. Unless otherwise specified, the contractor is the party who is furnishing the system whose hardware is being shock qualified in accordance with the requirements of this specification.

6.6.5 Deck simulating fixture (DSF). A tunable fixture consisting of beams, deck plating, and longitudinal/transverse stiffeners installed on the FSP that is intended to represent the dynamic characteristics of a ship's deck, as reviewed and approved by the Technical Authority.

6.6.6 Designated Government representative. A representative of the Government agency specified in the acquisition document to witness or certify shock test procedures, post-test inspections, or functional tests. The term is also defined as the representative of the Government agency specified by the Technical Authority to inspect shock test machines or FSPs or to certify them to be constructed and installed in accordance with drawings referenced herein.

6.6.7 DSF quarter points. The DSF quarter points are located halfway between the DSF pins and the center point of the DSF. The quarter point locations change depending on the DSF's pinned length as illustrated on figure 31.

6.6.8 DSF target frequency. The fundamental response frequency that the DSF is tuned to during a shock qualification test. The DSF target frequency is determined by shipboard response frequency, the equipment's SRF, the equipment's shipboard mounting orientation, the equipment location, and the equipment class (see 3.1.6.4.c).

6.6.9 Equipment. The principal unit, subsidiary component, or sub-assembly that is the subject of the shock qualification test series.

6.6.10 Evaluation of hazards. For the purposes of determining whether or not an item could constitute a hazard as a result of coming adrift, it is assumed as a minimum that an item will project to the shock hazard envelopes defined below. (In these definitions, the word "deck" refers to any extended surface or structure that will limit the downward motion of the item. The word "bulkhead" refers to any extended vertical or steeply inclined surface.)

a. The upper boundary of the shock hazard envelope is a horizontal plane 2 feet above the highest point of the item. The lateral shock hazard envelope (defined below) extends upward to this plane and downward to the deck.

b. For cases in which the distance between the deck and the highest point of the item does not exceed 5 feet, lateral shock hazard envelope all around is equal to the greatest dimension of the item (with foundation), but is not greater than 5 feet nor less than 2 feet.

c. For deck mounted items whose highest point is more than 5 feet above the deck, lateral shock hazard envelope all around is equal to the distance between the deck and the highest point of the item.

d. For bulkhead, overhead, or mast mounted items whose highest point is more than 5 feet above the deck, lateral shock hazard envelope all around is equal to the height of the item itself (top to bottom, including foundation) plus one-half of the distance between the deck and the lower edge of the item (with foundation). For items in this category, whose longest lateral dimension exceeds 5 feet, lateral shock hazard envelope all around is not less than 5 feet.

The shock hazard envelopes defined above are modified as deemed appropriate to account for intervening structure, or to account for structure, piping, or cables that would tend to swing or project the item beyond the normal shock hazard envelope. Shock hazard envelopes for items mounted in a manner not described above should be developed in a manner that reflects the intent of this specification.

6.6.11 Flexible element. Any interface system between equipment and its foundation that causes the SRF of the system to be less than or equal to 37 Hz.

6.6.12 Floating shock platform (FSP). A barge that can be used for shock testing large or heavy equipment installed in hull, deck, and wetted surface mounting locations aboard naval ships.

a. Standard FSP. A barge that has approved versions 22 to 34 feet long and 16 feet wide. Standard FSPs have a variable payload capacity dependent upon length, between 50,000 and 70,000 pounds (see 3.1.2.c[1]).

b. Extended FSP (EFSP). A barge that is 46 feet long and 16 feet wide. The EFSP has a 100,000-pound payload capacity (see 3.1.2.c[2]).

c. Intermediate FSP (IFSP). A barge that is 40 feet long and 20 feet wide. The IFSP has a 250,000-pound payload capacity (see 3.1.2.c[3]).

d. Large FSP (LFSP). A barge that is 50 feet long and 29 feet wide. The LFSP has a 400,000-pound payload capacity (see 3.1.2.c[4]).

6.6.13 Foundation/sway braces.

a. Lower foundation: Equipment lower foundation is a foundation that provides equipment support for the base of the equipment.

b. Upper foundation: Equipment upper foundation provides lateral support, may provide vertical support for the upper end of equipment, and is required to be included during shock testing. Upper foundation should not be confused with sway brace or vice versa.

c. Sway brace: Equipment sway brace provides minimal lateral support for the upper portion of the equipment. The sway brace provides minimal structural support during a shock event aboard a ship.

6.6.14 FSP/DSSM payload.

a. FSP/DSSM payload capacity: the maximum total sum of the weight of the equipment being tested, the fixture with ballast, the ancillary equipment, and fluids. The FSP payload capacity is dependent upon the vertical location of the CG of the system consisting of the payload, fixtures, dummy mass, and ancillary equipment.

b. DSSM isolated payload weight: the weight of the equipment above the isolation devices.

c. DSSM fixture weight: the weight of the DSSM fixture.

d. DSSM additional weight: the weight of ballast, the ancillary equipment, and fluids.

6.6.15 Haunched frames.

a. Haunched frame. Any hull plating stiffener that merges with or butts to a partial bulkhead or floor structure, or integral tank top or side.

b. Haunched portion of a typical frame. That portion of a frame that serves as a partial bulkhead or tank floor but does not include the portion that serves as a transition between the typical portion of the frame and the tank top or partial bulkhead.

6.6.16 Hazard. An item constitutes a "hazard" if, as result of shock, it is possible for it, or a portion of it, to:

a. Strike and injure personnel operating or manning Grade A equipment, including personnel at battle stations.

b. Strike and cause significant impairment or malfunction of Grade A items or systems.

c. Cause an electrical short as a result of internal damage or as a result of coming adrift and striking an electrical conductor or electrical equipment. If the electrical system in which the short might occur is protected by Grade A protective devices, this criterion is limited in applicability to cases in which the short could result in loss of electrical power to a Grade A system, cause malfunction or significant impairment of a Grade A system, or could cause ignition of flammable or explosive materials, including ordnance.

d. Cause release of injurious, flammable, radioactive, acidic, caustic, or otherwise hazardous liquids, solids, or gases as a result of internal damage or as a result of coming adrift and striking another item. Exceptions to this criterion, which must be approved by the Technical Authority on a case basis, will be accepted in cases where it can be demonstrated that the nature, location, rate, and total possible amount of leakage is such as to preclude development of a significant threat to personnel, Grade A systems, or to the ship as a whole. For purposes of this criterion, fluids whose temperatures exceed 150 °F or are below 0 °F are considered potentially injurious. Fluids at any temperature are regarded as hazardous if they might cause an electrical short (see 6.6.16.c) or affect electrical, hydraulic, water, or other services required by a Grade A system to the extent that significant impairment or malfunction of the Grade A system might result. Examples of adverse effects: unacceptable variation or unacceptable reduction of pressure, flow-rate, or voltage; leakage of a fluid from a system, which could quickly deprive a Grade A system of that required fluid.

e. Strike Grade A items or personnel at battle stations if it comes adrift, unless it is apparent that the weight, shape, or other characteristics are such as to preclude unacceptable impact damage, or unless the item is contained or prevented from striking Grade A items and personnel.

6.6.17 Identical item. An item is identical to another item when:

a. Its design temperature and design and test pressures are no greater than for the other item, and

b. It is alike in the following ways: design (including materials), installation (including mounting location), and functional aspects, and when:

(1) It is manufactured from the same revision of the same production level TDP drawing (or equivalent fully detailed NAVSEA Standard Drawing), or

(2) It is manufactured from different revisions of the same production level TDP drawing, but differences are either editorial or have no impact on the shock response of the item, or

(3) It is manufactured by different manufacturers and meets the requirements of (1) or (2) above; this should not apply to electrical items where the manufacturing process affects the design of the component, or

(4) It is manufactured from a drawing other than a production level TDP drawing, but information is sufficient to confirm that the item meets the requirements of (a) and (b) and the intent of (1) or (2) above, and the drawing has been approved by the Technical Authority.

6.6.18 Inclination angle. The angle of rotation of the equipment about a test orientation axis perpendicular to a vertical plane of the shock machine (for example, the DSSM side-to-side center plane).

6.6.19 Isolation devices. A device that has a flexible portion between the equipment and its shipboard foundation or has a flexible portion interior to the equipment.

6.6.20 Item. A complete and definable unit or a component of machinery, equipment, system, or structure. An item can be a principal unit, subsidiary component, or subassembly. An item can also be a group of units or a system.

6.6.21 Limited displacement capability isolation devices. A Limited Displacement Capability Isolation Device (LDCID) is an isolation device that is primarily intended to reduce transmission through the mount of vibratory energy due to low-amplitude noise, environmental vibration, or machinery/equipment internally generated energy sources. LDCIDs incorporate features that severely limit mount deflection and, consequently, may raise the SRF to greater than 37 Hz, or a lower frequency if specified (see 6.2.2), under maximum MIL-DTL-901 qualification shock inputs to which the component will be subjected in the qualification test. LDCIDs have all of the following characteristics for each principal loading direction (Note: the principal loading direction for a surface ship is vertical; the principal loading directions for a submarine are vertical and athwartship):

a. A low-stiffness element, either explicit, integrated, or due to the nonlinear behavior of the flexible element material or design, which in combination with the effective mass acting on the isolation device, produces an isolation-mounted component frequency that is sufficiently low to attenuate transmission of low-amplitude noise, environmental vibration, or machinery/equipment internally-generated vibratory energy.

b. A high-stiffness element, either explicit, integrated, or due to the nonlinear behavior of the flexible element material or design, which limits displacements of the equipment relative to the equipment's foundation under high-amplitude MIL-DTL-901 qualification shock events. The high-stiffness element must act to limit displacement at the highest MIL-DTL-901 qualification loading that the component will experience during the qualification test in all principal orthogonal directions.

c. The engagement of the high-stiffness element must increase the SRF when the mount is subjected to the highest MIL-DTL-901 shock input. The calculation of the SRF by a method such as, but not limited to, that described in Appendix A, assumes an instantaneous velocity change as the input to the base of the mount. This velocity change is identified in Appendix A or is as specified (see 6.2.2). The average magnitude of this velocity change ranges from 96 in/sec to 150 in/sec, and is related to the type of shock machine used (LWSM or MWSM) and the weight of component and the fixture used and, for the LWSM, the blow direction. See Naval Research Laboratory Report NRL 7396, dated 07/14/1972, for information on expected velocity changes for the LWSM and MWSM. The SRF may also be computed from a nonlinear analysis of the mounts using time history inputs. These time history inputs and the analysis method require approval by the Technical Authority. Additionally, the SRF requirement may be met by other methods as approved by the Technical Authority; for example, the maximum displacement of the device is limited by its physical size. Determination of LDCID mounts must be accomplished in three positive and negative orthogonal directions.

d. Examples of LDCIDs include, but are not limited to: Ring and Bushing Mounts and Limited Displacement Mounts (S9073-A2-HBK-010), and single or double layer (for example) of DIM (Distributed Isolation Material, S9078-AA-HBK-010/DIM). LDCIDs also include standard navy mounts (S9073-A2-HBK-010) fitted with additional external snubbering, as necessary, that raises the item's SRF under maximum MIL-DTL-901 qualification shock loadings to frequencies greater than 37 Hz (see Appendix A).

6.6.22 Mass.

a. DSF live mass: The DSF modal mass plus any dead mass on the DSF.

b. DSF modal mass: The portion of the DSF total mass responding at the DSF target frequency.

c. DSF total mass: The mass of the DSF plus any dead mass on the DSF.

d. Equipment dead mass: Equipment and foundation mass that exhibits an SRF greater than 2 times the DSF target frequency.

e. Equipment isolated mass: Equipment and foundation mass that exhibits an SRF less than 0.7 times the DSF target frequency.

f. Equipment live mass: Equipment and foundation mass that exhibits an SRF that is within 0.7 to 2 times the DSF target frequency.

6.6.23 Mounting configuration. Refers to whether isolation devices are mounted to the test machine or test fixture during Class I, Class II, Class I/II, and Class III equipment shock qualification testing. May be one of two situations: isolated and non-isolated.

6.6.24 Multi-directional equipment. Refers to an item that has component(s) where component directional position may vary during operation about one or more axis (e.g., directional antenna) independent of its mounting orientation (see 3.1.8.6.b[5]).

6.6.25 Noise and vibration mount. An isolation device specifically designed to isolate the ship from the equipment-generated noise (i.e., structureborne noise) or the equipment from the ship (e.g., vibration isolation). Noise and vibration isolation devices do not necessarily provide good shock mitigation, are detrimental to shock mitigation in many cases, and may require snubbers or other mechanical features to capture mounted equipment during shock events.

6.6.26 Operating conditions. Operating modes and positions representing shipboard operation during testing.

6.6.27 Principal units. Items that are directly supported by the ship structure or by a foundation that is directly attached to the ship structure, and items mounted in piping systems, ducting systems, and similar systems that are supported by ship structure. The shock response of a principal unit is primarily a function of the rigidity and mass of the item and the shipboard mounting structure, the shipboard mounting location, and the configuration of the item. Examples typically include diesel-generator sets, air conditioning plants, switchboards, steam generators, missile launchers, and valves (if installed in piping that is supported by ship structure).

6.6.28 Reviewer signature. This handwritten or electronic signature on figure 19 is the reviewer's individual verification and certification of the following facts: (1) that this approval action is based on personal review of the subject test report or test extension request; (2) that this review has considered all shock approval criteria and shock guidance provided by this document, other acquisition documents, current shock policy instructions, and the reviewer's past experience and knowledge; and (3) that the remarks and limitations shown on figure 19 include statement or references to (a) any shortcomings in equipment performance discovered during shock testing, and (b) the extent, if any, to which testing could not be made fully representative of shipboard operating conditions.

6.6.29 Side-to-side center plane. A plane generally located at the centerline of and perpendicular to the machine's anvil or base plate.

6.6.30 Ship structure. The main support structure of the ship, including pressure hull shell and support structure, non-pressure hull plating and support structure, tanks (built-in), the sail, superstructure, trunks, structural bulkheads, deck modules, and decks.

6.6.31 Shipboard response frequency.

6.6.31.1 Ship deck frequency. On surface ships, the fundamental response frequency of the deck supporting the equipment at the location in which the equipment is installed.

6.6.31.2 Submarine response frequency. On submarines, the fundamental response frequency of the submarine at the location in which the equipment is installed.

6.6.32 Shock excursion envelope. The volume bounded by the dimensions of the Class II equipment plus the maximum displacement or travel that the Class II equipment can move in any direction during a shock event. Class I/II and Class III equipment shock excursion envelopes are defined equivalently, if applicable.

6.6.33 Shock mount. An isolation device specifically designed to mitigate the equipment ship shock environment during shock events.

6.6.34 Shock response frequency (SRF). The effective frequency of a linear or nonlinear system when excited by motions reflecting the character of ship motions under full design level underwater explosion response. Sample calculations are provided in Appendix A as guidance. The item's SRF may be used to determine the correct test fixture frequency (see 3.1.6.5) on some test machines and is used to determine when Class II, Class I/II, and Class III equipment may be tested to Class I equipment requirements (see 3.1.6.1).

6.6.35 Subassemblies. Items that are a part of a principal unit or a subsidiary component. The shock response of the subassembly is significantly affected by that of the associated principal unit or subsidiary component, but the shock response of the principal unit or subsidiary component is not significantly affected by that of the subassembly. Examples are thermometers, gauges, meters, relays, and resistors.

6.6.36 Submarine conventional deck. Any deck or platform internal to the pressure hull that is not a shock isolated or mitigated deck. A conventional deck may be supported by various means (e.g., stanchions, missile tube structure, structural bulkheads, or combination thereof).

6.6.37 Submarine shock isolated deck. A deck structure specifically designed to mitigate shock to a level approved by the Technical Authority in order to utilize commercial off-the-shelf equipment.

6.6.38 Submarine shock mitigated deck. A deck or platform that is designed to mitigate shock to a level approved by the Technical Authority.

6.6.39 Subsidiary components. Items that are the major parts of a principal unit. The shock response of the subsidiary component is significantly affected by that of the associated principal unit and all associated subsidiary components. The shock responses of the associated principal unit and all associated subsidiary components are significantly affected by that of the subsidiary component. Examples are the diesel engine of a diesel-generator set, or the electric motor of an air conditioning unit.

6.6.40 Surface ship decks. All non-structural bulkheads, decks, and platforms; and all deckhouses and superstructure at or above the main deck level.

6.6.41 System. An arrangement or combination of items, all of which are necessary to perform a specific operational function or functions (such as a main propulsion system, a refrigeration system, fire control system, or hydraulic system).

6.6.42 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. NOTE: The Technical Authority is not authorized to approve contract deliverable data, except as authorized by the Contracting Activity (see 6.6.3).

6.6.43 Test orientation. The equipment is oriented on the test machine with respect to a specific test machine axes such that the orientation of the equipment, when installed on the test machine or fixture, is consistent with the fore-aft, athwartship, and vertical axes of the equipment as installed aboard the ship.

a. For equipment with restricted mounting orientation, the test orientation fore-aft, athwartship, and vertical axes of the equipment are selected as follows:

(1) Fore-aft will be the fore-aft axis of the equipment as installed on the ship.

(2) Athwartship will be the athwartship axis as installed on the ship.

(3) Vertical will be the vertical axis as installed on the ship.

b. For equipment with vertical axis specified mounting orientation, the test orientation fore-aft, athwartship, and vertical axes of the equipment are selected as follows:

(1) Fore-aft will be the horizontal axis of the equipment with the longest length.

(2) Athwartship will be the horizontal axis of the equipment with the shortest length.

(3) Vertical will be the vertical axis as installed on the ship.

c. For equipment with unrestricted mounting orientation, the test orientation fore-aft, athwartship, and vertical axes of the equipment are selected as follows:

(1) Fore-aft will be the axis of the equipment with the longest length.

(2) Athwartship will be the axis of the equipment with the shortest length.

(3) Vertical will be the axis mutually perpendicular to the test orientation fore-aft and athwartship axes.

6.6.44 Witness. The observer (or observance) of a shock test procedure, post-test inspection, or functional test. Signature of or certification by a witness does not imply acceptance of the adequacy or the results of the procedures, tests, or inspections.

6.7 Contractual and administrative provisions considered essential for acquisition.

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

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

6.7.2 Shock test witness and report certification requirements (see 6.6.2 and 6.6.44). Performing activities are to certify compliance with all test requirements and prepare information in accordance with 6.2.3. This information will also be certified by the designated Government representative in accordance with the following:

a. For heavyweight and alternate vehicle/machine shock tests, the designated Government representative should witness the shock test, the actual post-test inspection, and functional tests, and should certify reported shock test, post-test inspection, and functional test information.

b. For lightweight, medium weight, and medium weight deck simulating shock tests, the designated Government representative should certify reported shock test, post-test inspection, and functional testing information, when the shock tests, associated shock test inspections, or functional tests are witnessed by a Government representative. Unless otherwise specified (see 6.2.2), the Government representative is not required to witness lightweight, medium weight, or medium weight deck simulating shock tests, associated post-test inspections, or functional tests. (Guidance for Government representatives: It is expected, at a minimum, that designated Government representatives will witness shock tests, associated shock test inspections, and functional tests on a sampling basis at all activities performing under a given contract. Tests and inspections of relatively complex or high-value items should normally be witnessed.)

c. The contractor is to provide advance notice of shock test and post-test inspection schedules, as necessary, to permit the designated Government representative to make arrangements for witnessing these events.

6.8 Subject term (key word) listing.

Alternate shock test vehicle/machine

Carrier shock extension

Carrier shock testing

Deck simulating fixture

Deck simulating shock machine

Equipment shock class

Equipment shock type

Figure 19

Floating shock platform

Lightweight shock machine

Medium weight shock machine

Operating conditions during shock testing

Principal unit

Restricted mounting orientation

Shock Grade A

Shock Grade B

Shock test fixture

Subassembly

Submarine shock extension

Submarine shock testing

Subsidiary component

Surface ship shock extension

Surface ship shock testing

Unrestricted mounting orientation

Vertical axis specified mounting orientation

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.

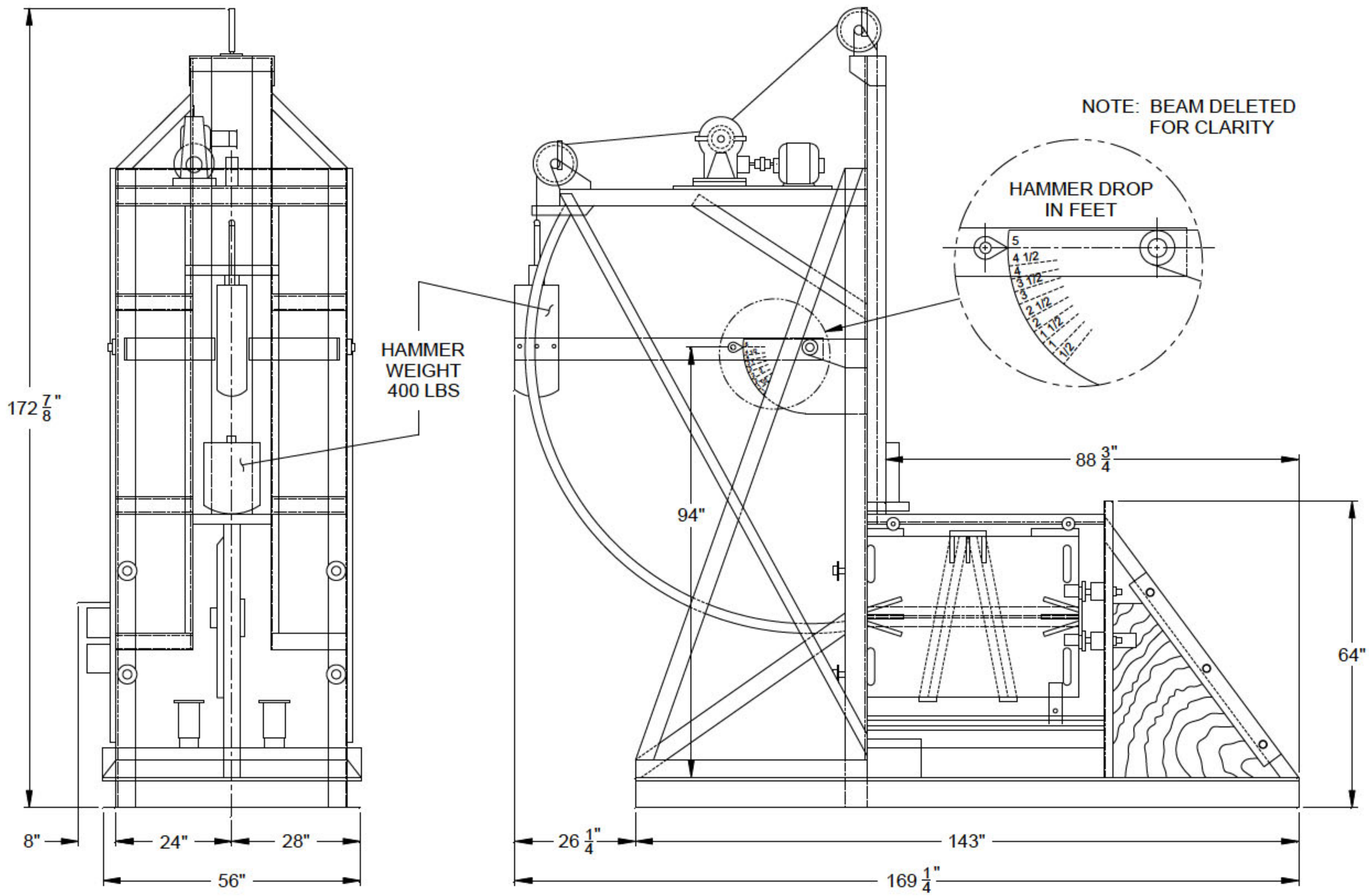


FIGURE 1. Lightweight shock machine (LWSM) for testing lightweight equipment.
(See BUSHIPS drawing 10-T-2145-L for construction details.)

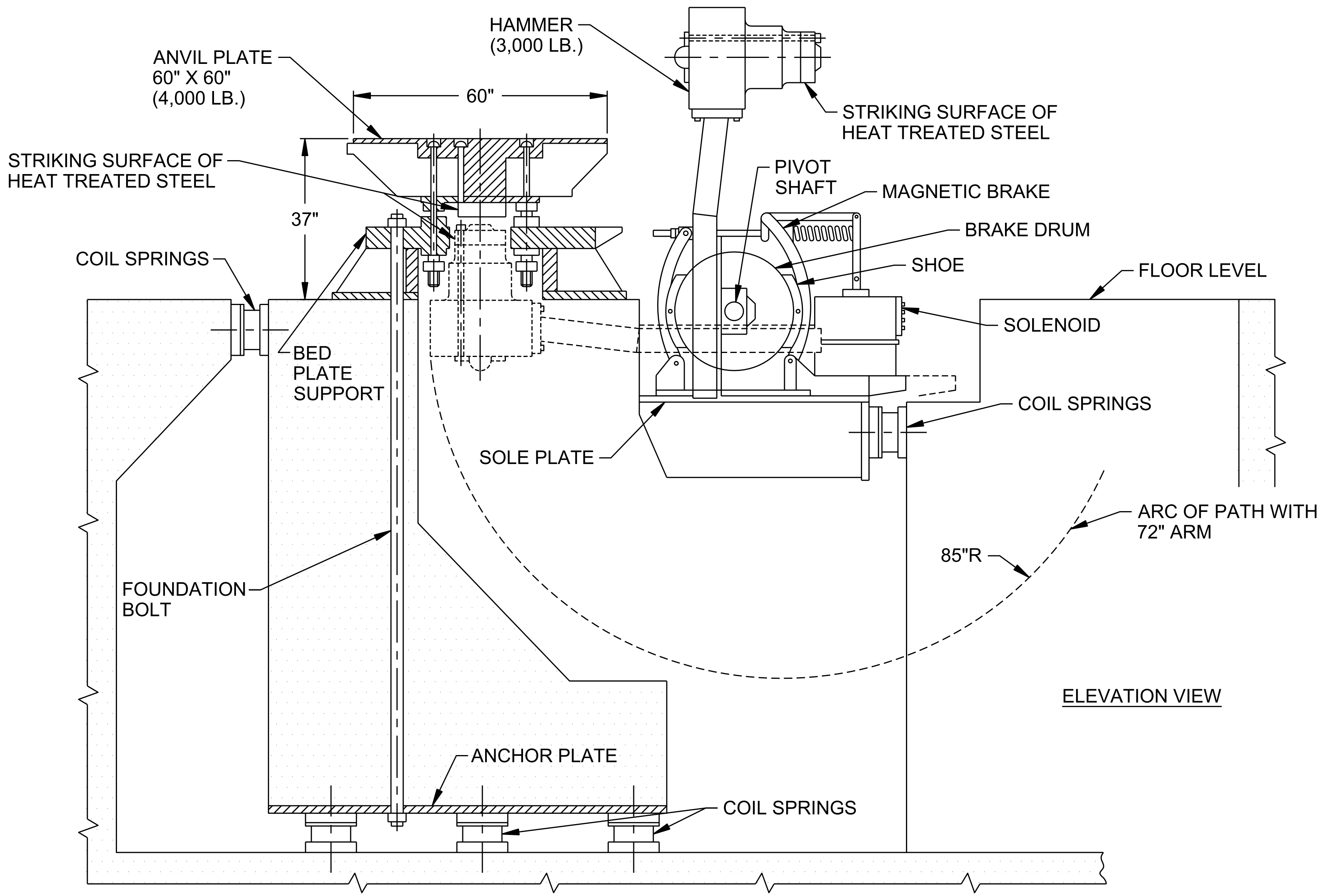
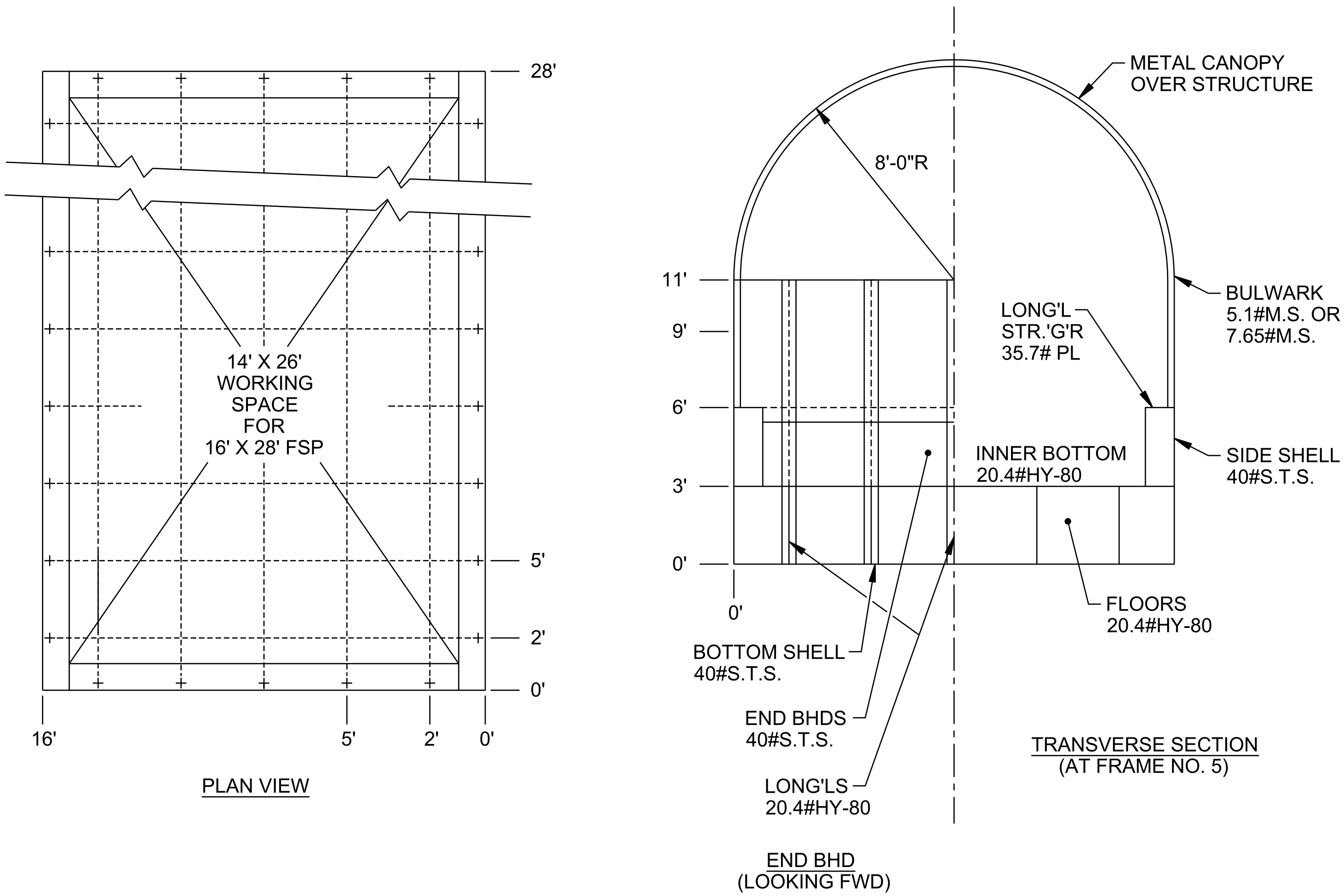


FIGURE 2. Medium weight shock machine (MWSM) for testing medium weight equipment.
(See BUSHIPS drawing N0807-655947 for construction details.)



NOTES:

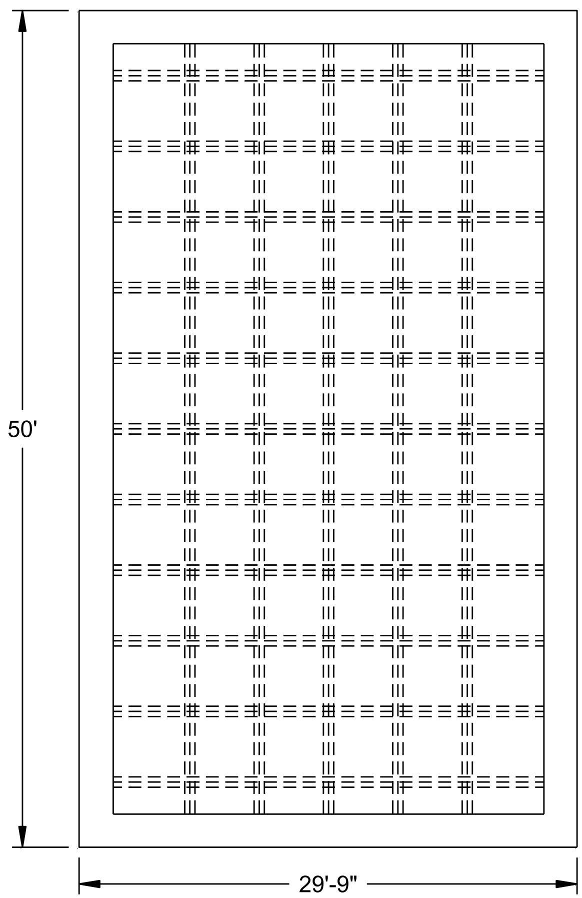
1. SOME FLOATING SHOCK PLATFORMS ARE 22 FEET RATHER THAN 28 FEET LONG.
2. SEE BUSHIPS DWG. 645-1973904 FOR CONSTRUCTION DETAILS.

FIGURE 3. Standard floating shock platform (standard FSP).

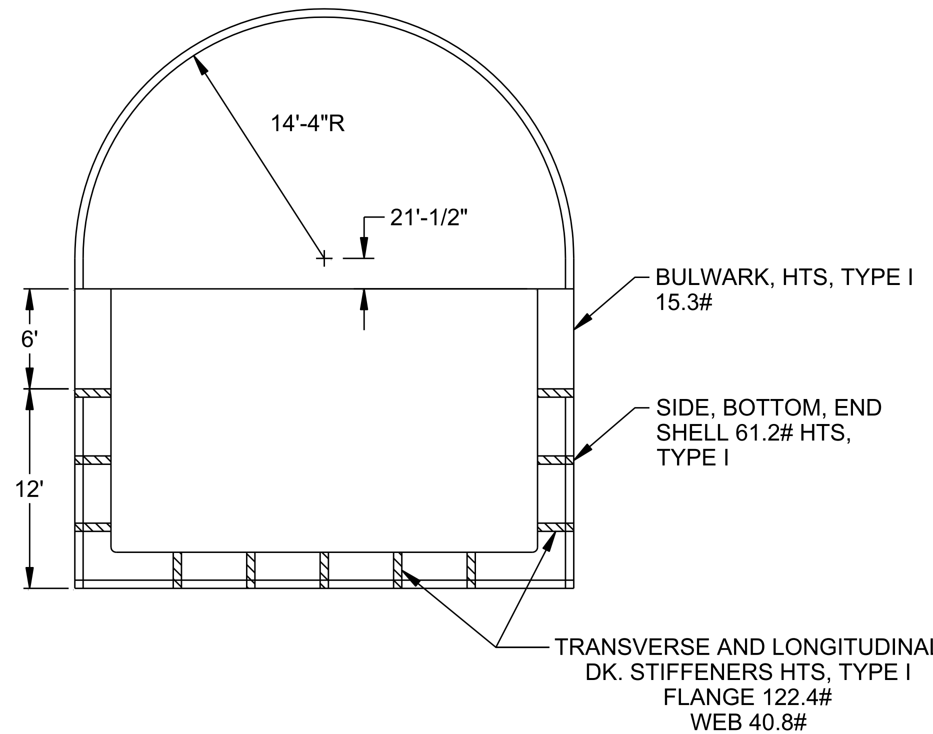
FIGURE 3a. Extended floating shock platform (EFSP).

FIGURE 3b. Intermediate floating shock platform (IFSP). (Sheet 1 of 2)

FIGURE 3b. Intermediate floating shock platform (IFSP). (Sheet 2 of 2)



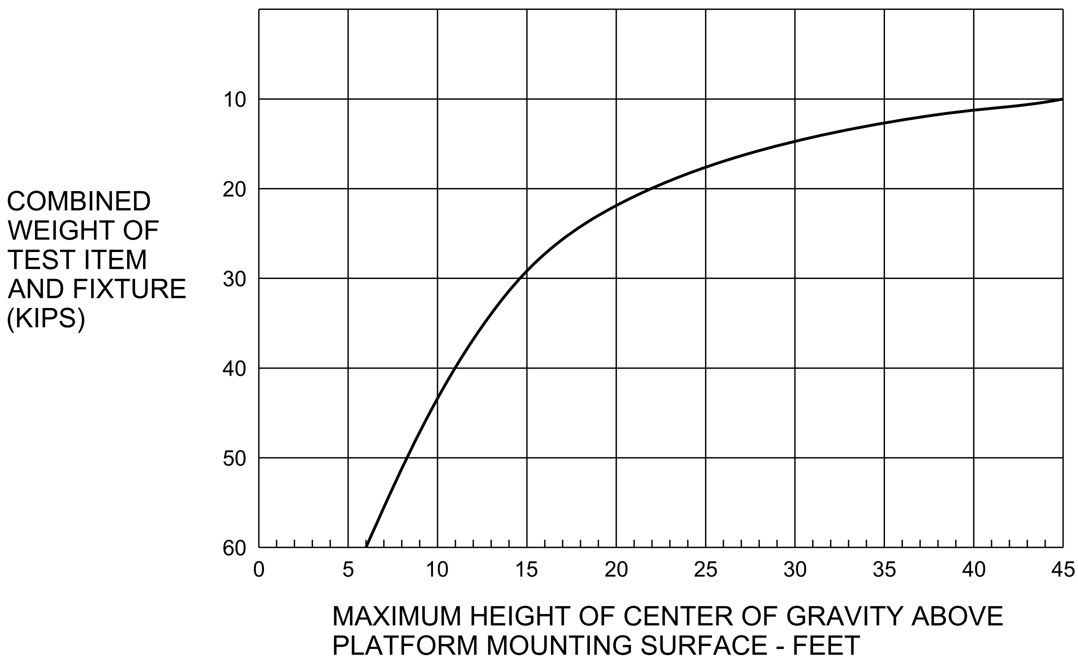
WORKING SPACES:
1. 46'-7" LONG X 26'-4" TRANSV. WORKING SPACE WITHOUT CATWALK.
2. 42'-7" LONG X 22'-4" TRANSV. WORKING SPACE WITH 24" WIDE CATWALK.



* NOTE: LFSP HAS NO INNERBOTTOM.

FOR ADDITIONAL DETAILS, SEE DWG. SF-645-H1644

FIGURE 4. Large floating shock platform (LFSP).



FOR ITEMS MOUNTED BELOW PLATFORM, SEE NOTES 2, 3, AND 4 BELOW.

NOTES:

1. THIS INFORMATION IS FOR GUIDANCE ONLY AND IS APPLICABLE TO THE 28-FOOT STANDARD FSP (SAN FRANCISCO NAVAL SHIPYARD DRAWING SF-645-H-1528).
2. THE MAXIMUM SUGGESTED LOAD LIMIT FOR ALL TESTED ITEMS IS 60,000 LBS FOR ITEMS MOUNTED ABOVE OR BELOW THE PLATFORM. MAXIMUM WEIGHTS INCLUDE WEIGHT OF ITEM, FIXTURE, ANCILLARY EQUIPMENT, AND FLUIDS.
3. THE VERTICAL CG LIMITS ARE SHOWN FOR ITEMS TO BE MOUNTED ABOVE THE PLATFORM. BOTH WEIGHT AND CG LIMITS MAY BE EXCEEDED AT THE DISCRETION OF THE ITEM SUPPLIER AND THE SHOCK TEST FACILITY, BUT AN OUTRIGGER MAY BE REQUIRED TO MINIMIZE ROLL.
4. THERE IS NO LIMIT ON THE VERTICAL CG FOR TEST ITEMS MOUNTED BELOW THE PLATFORM.
5. THIS CURVE IS BASED ON A TRANSVERSE METACENTRIC HEIGHT OF SLIGHTLY MORE THAN 1.0 FOOT.

FIGURE 5. Standard FSP – maximum permissible height of vertical CG for tested items; maximum working area – 14 feet by 26 feet.

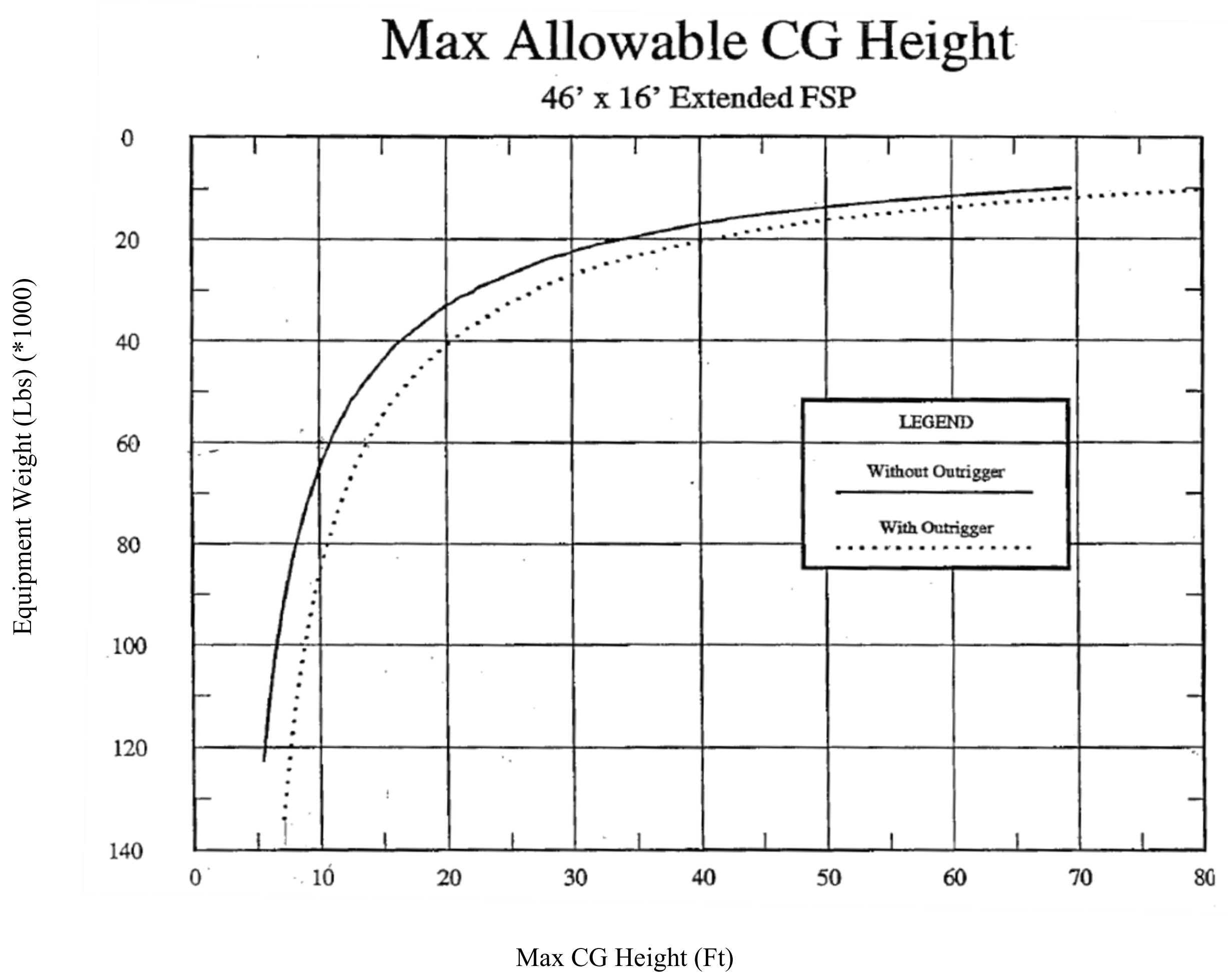
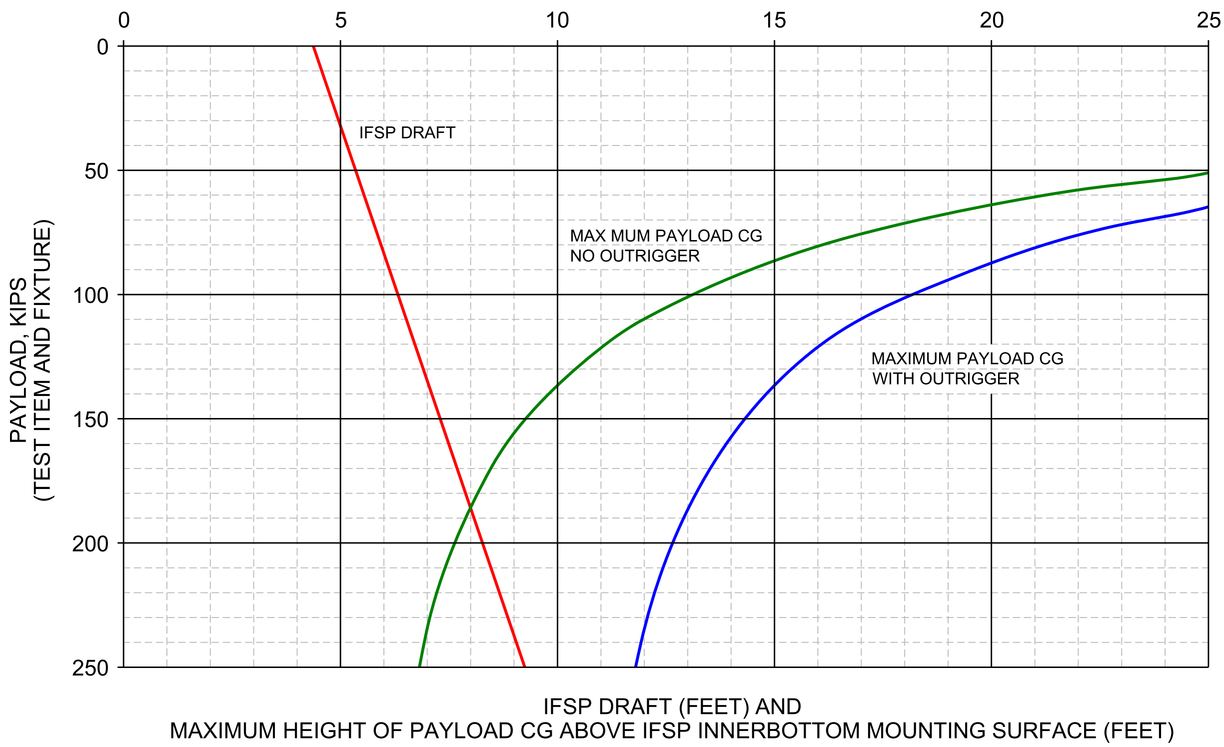


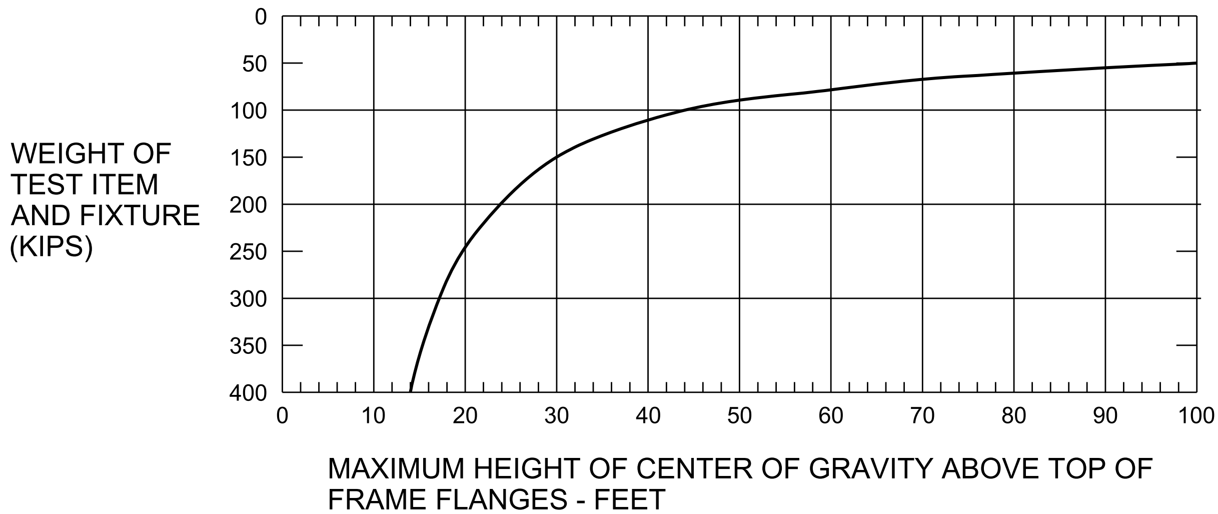
FIGURE 5a. EFSP – maximum permissible height of vertical CG for tested items.



NOTES:

1. THIS INFORMATION IS PROVIDED FOR GUIDANCE ONLY AND IS APPLICABLE TO THE INTERMEDIATE FLOATING SHOCK PLATFORM (20 FT. WIDE X 40 FT. LONG, HI-TEST LABORATORIES, INC. DRAWING HT-IFSP-1).
2. THE LOAD LIMIT RANGE IS 60,000 LBS TO 250,000 LBS FOR ITEMS MOUNTED ABOVE OR BELOW THE PLATFORM. MAXIMUM WEIGHTS INCLUDE WEIGHT OF ITEM, FIXTURE, ANCILLARY EQUIPMENT, AND FLUIDS. THE USE OF THE IFSP FOR PAYLOADS OUTSIDE THIS RANGE REQUIRES CASE BY CASE APPROVAL AND MAY NEED A CHANGE IN STANDOFF.
3. THE VERTICAL CG LIMITS ARE SHOWN FOR ITEMS TO BE MOUNTED ABOVE THE PLATFORM. BOTH WEIGHT AND CG LIMITS MAY BE EXCEEDED AT THE DISCRETION OF THE ITEM SUPPLIER AND THE SHOCK TEST FACILITY, WITH TECHNICAL AUTHORITY APPROVAL AS NOTED IN NOTE 2 ABOVE.
4. THERE IS NO LIMITATION ON THE VERTICAL CG FOR TEST ITEMS MOUNTED BELOW THE PLATFORM.
5. THESE CURVES ARE BASED ON A TRANSVERSE METACENTRIC HEIGHT OF 1.0 FOOT.

FIGURE 5b. IFSP – maximum permissible height of vertical CG for tested items.

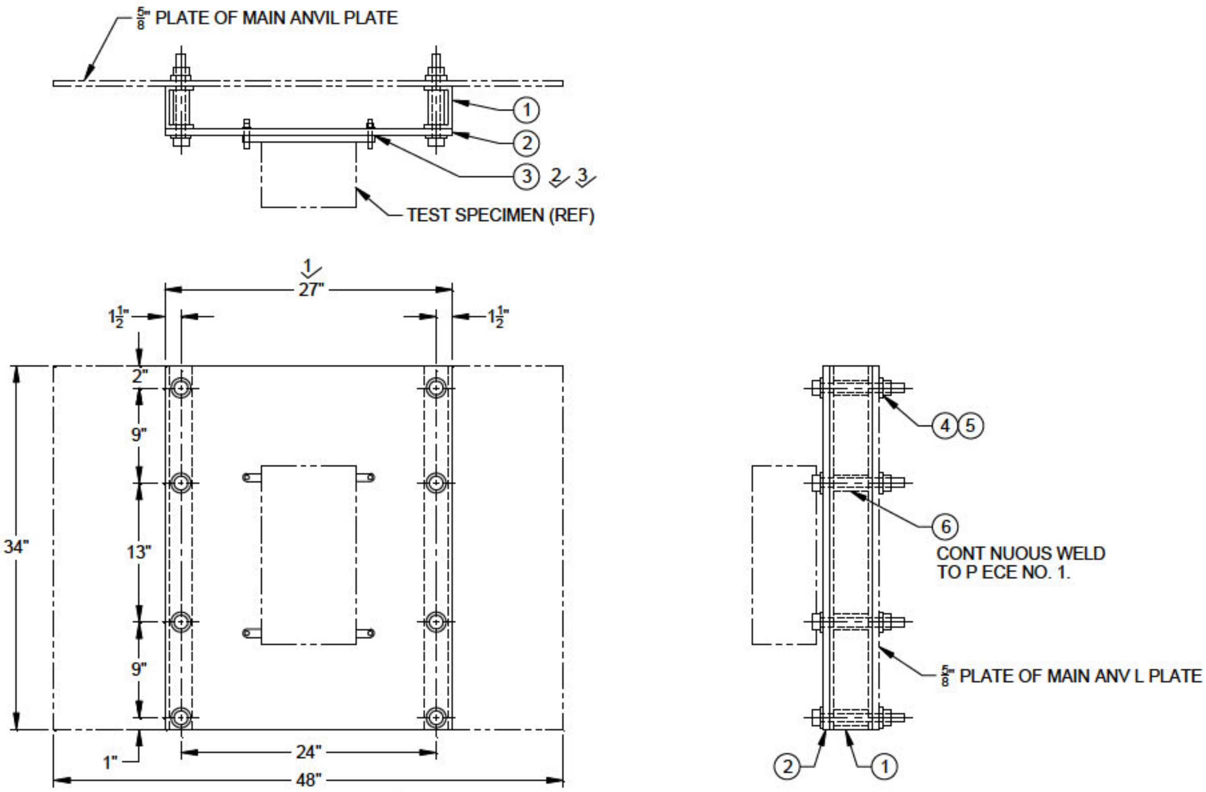


FOR ITEMS MOUNTED BELOW PLATFORM, SEE NOTES 2, 3, AND 4 BELOW.

NOTES:

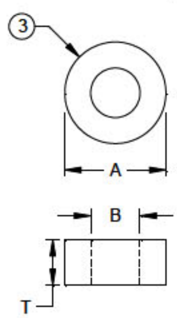
1. THIS INFORMATION IS FOR GUIDANCE ONLY AND IS APPLICABLE TO THE LARGE FLOATING SHOCK PLATFORM (LFSP) (SAN FRANCISCO NAVAL SHIPYARD DRAWING H-81898-SF-645-H-1644).
2. THE MAXIMUM SUGGESTED LOAD LIMIT FOR ALL TESTED ITEMS IS 400,000 LBS FOR ITEMS MOUNTED ABOVE OR BELOW THE PLATFORM. MAXIMUM WEIGHTS INCLUDE WEIGHT OF ITEM, FIXTURE, ANCILLARY EQUIPMENT, AND FLUIDS.
3. THE VERTICAL CG LIMITS ARE SHOWN FOR ITEMS TO BE MOUNTED ABOVE THE PLATFORM. BOTH WEIGHT AND CG LIMITS MAY BE EXCEEDED AT THE DISCRETION OF THE ITEM SUPPLIER AND THE SHOCK TEST FACILITY.
4. THERE IS NO LIMIT ON THE VERTICAL CG FOR TEST ITEMS MOUNTED BELOW THE PLATFORM.
5. THIS CURVE IS BASED ON A TRANSVERSE METACENTRIC HEIGHT OF 2.0 FEET.

FIGURE 6. LFSP – maximum permissible height of vertical CG for tested items.



SPACER DIMENSIONS 1

BOLT SIZE	DIMENSIONS (NCHES) A	B	T
$\frac{1}{4}$	$\frac{3}{4}$	$\frac{9}{32}$	$\frac{3}{8}$
$\frac{5}{16}$	$\frac{3}{4}$	$\frac{11}{32}$	$\frac{3}{8}$
$\frac{3}{8}$	$\frac{7}{8}$	$\frac{13}{32}$	$\frac{3}{8}$
$\frac{1}{2}$	$1\frac{1}{4}$	$\frac{9}{16}$	$\frac{1}{2}$
$\frac{5}{8}$	$1\frac{1}{2}$	$\frac{11}{16}$	$\frac{5}{8}$
$\frac{3}{4}$	$1\frac{3}{4}$	$\frac{13}{16}$	$\frac{3}{4}$



PC. NO.	ITEM	SIZE	NO. REQ'D
1	CAR BUILDING CHANNEL	4" X 13.8#	2
2	AUX LIARY MOUNTING PL.	$\frac{1}{2}$" NOTE 1	1
3	SPACER	SEE BELOW	1/BOLT
4	H.T. BOLT AND NUT	$\frac{3}{4}$"-10 X 7" LG.	8
5	WASHER	2" O.D. X $\frac{13}{16}$" I D.	16
6	1" STD PIPE SPACER	2 $\frac{15}{16}$" LG.	8

NOTES:
1. SIZE MAY BE INCREASED IN WIDTH ONLY FROM 27" TO A MAXIMUM OF 36" AS REQUIRED FOR LARGE ITEMS OF EQUIPMENT.
2. MATERIAL STEEL.

1 SPACER DIMENSIONS TO BE USED WHEN SECURING EQUIPMENT TO THE 1/2" AUXILIARY MOUNTING PANEL (PIECE NO. 2).

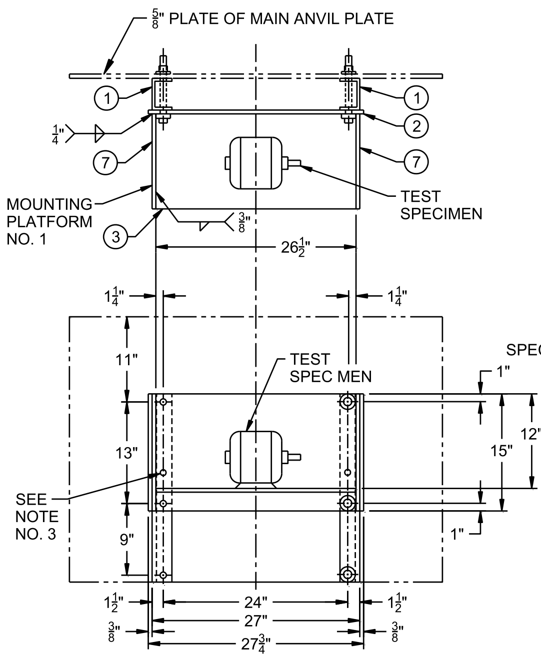
2 SPACERS SHALL BE USED FOR EACH EQUIPMENT MOUNT NG BOLT WHEN SECUR NG EQUIPMENT TO THE 1/2" AUXILIARY MOUNTING PANEL.

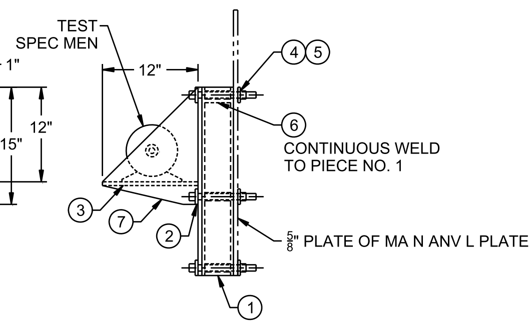
3 MOUNTING DIRECTLY TO THE 1/2" AUXILIARY MOUNTING PANEL IS CONT NGENT UPON SHIPBOARD INSTALLATION DRAWINGS THAT NDICATE WELDED OR BOLTED FOUNDATIONS TO THE SHIP'S BULKHEAD AND TECHNICAL AUTHORITY APPROVAL.

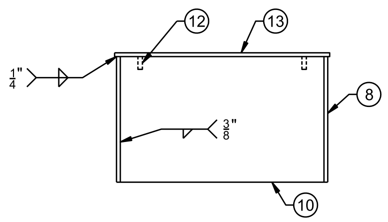
FIGURE 7. Fixture 4A standard mounting for back mounted equipment (type "A" test LWSM).

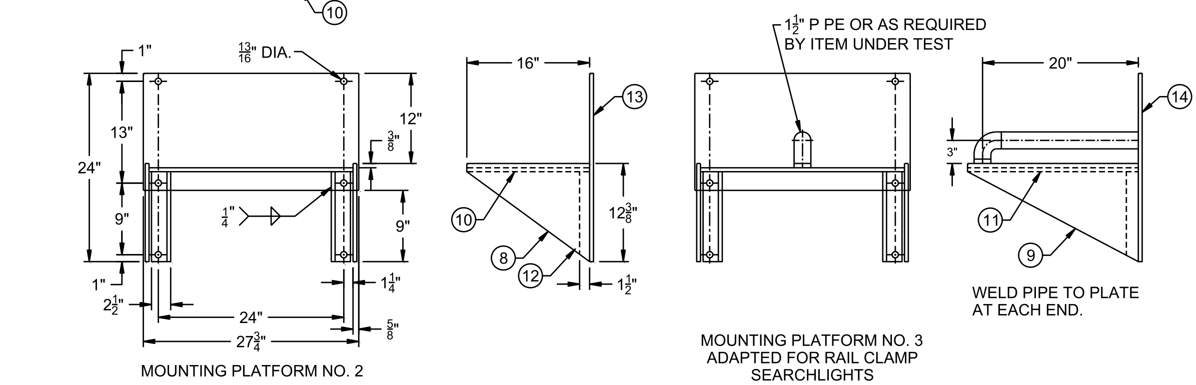
PC. NO.	ITEM	SIZE	NO. REQ'D
1	CAR BUILDING CHANNEL	4" X 13 8#	2
2	AUXILIARY MOUNTING PL.	$\frac{3}{8}$"	1
3	HORIZONTAL MOUNTING PL.	$\frac{1}{2}$"	1
4	BOLT AND NUT H.T.	$\frac{3}{4}$"-10 X 7" LG.	6
5	WASHER	2" O.D. X $\frac{13}{16}$" I.D.	12
6	STANDARD P PE SPACER	1" X 2 $\frac{15}{16}$" LG.	6
7	GUSSET PLATE	$\frac{3}{8}$"	2
8	GUSSET PLATE	$\frac{3}{8}$"	2
9	GUSSET PLATE	$\frac{3}{8}$"	2
10	HORIZONTAL MOUNTING PL.	$\frac{1}{2}$"	1
11	HORIZONTAL MOUNTING PL.	$\frac{1}{2}$"	1
12	STIFFENER	$\frac{3}{8}$"	4
13	AUXILIARY MOUNTING PL.	$\frac{3}{8}$"	1
14	AUXILIARY MOUNTING PL.	$\frac{3}{8}$"	1

MATERIAL STEEL.





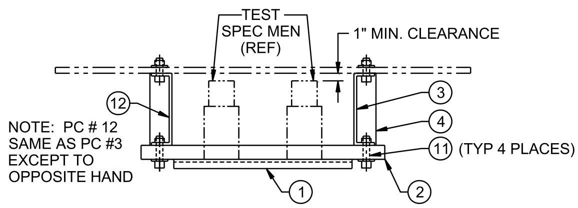




NOTES:

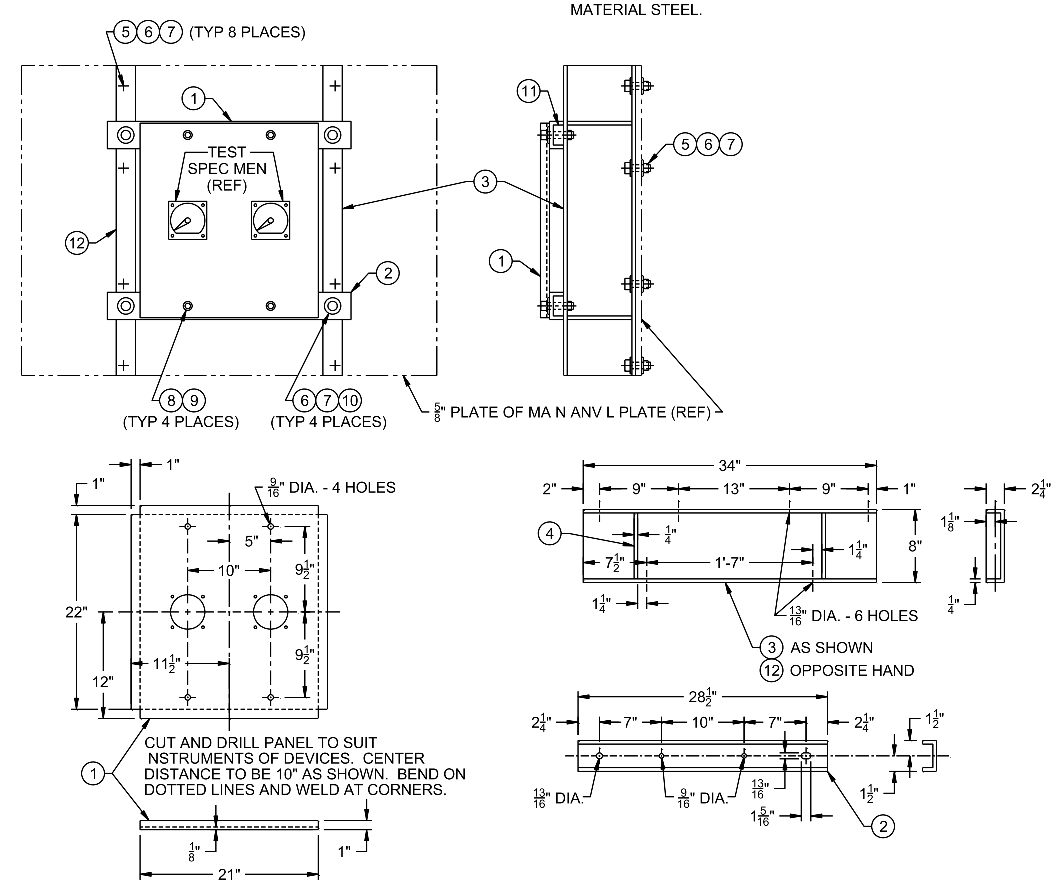
1. THERE ARE 3 MOUNTING PLATFORMS. MOUNTING PLATFORM NO. 3 SHALL BE SIMILAR TO MOUNTING PLATFORM NO. 2 EXCEPT THAT THE DEPTH OF THE HORIZONTAL MOUNTING PLATE AND THE SIDE GUSSET PLATES SHOULD BE INCREASED TO 22 INCHES.
2. THE SMALLEST MOUNTING PLATFORM SHOULD BE SELECTED WHICH WILL SATISFACTORILY ACCOMMODATE THE EQUIPMENT.
3. IF THE DEEP GUSSETS INTERFERE WITH MOUNTING THE EQUIPMENT, THE EXTRA BOLT HOLES SHOULD BE USED IN BOLTING PLATFORM NO. 1 IN THE INVERTED POSITION TO THE FOUR LOWER BOLT HOLES OF THE ANVIL PLATE.
4. FOR ADDITIONAL DETAILS, SEE BUSHIPS DRAWING 10-T-2145-L.

FIGURE 8. Fixture 4C standard mounting for base mounted equipment (type “A” test LWSM).



PC. NO.	ITEM	SIZE	NO. REQ'D
1	PANEL	1/8" X 24" X 23"	1
2	STANDARD CHANNEL	3" X 5# X 28 1/2"	2
3	FABRICATED SPACER	2 1/4" X 8" X 34"	1
4	SPACER ST FFENER	1/4" X 7 1/2" X 2"	4
5	BOLT AND NUT	3/4"-10 X 1 3/4" LG.	8
6	WASHER	2" O D. X 13/16" I.D.	12
7	WASHER	1 3/8" O.D. X 13/16" I.D.	12
8	BOLT AND NUT	1/2"-13 X 1" LG.	4
9	WASHER	1 3/8" O.D. X 9/16" I.D.	4
10	BOLT AND NUT	3/4"-10 X 2 1/2" LG.	4
11	BLOCK	2 1/2" X 2" X 1 1/4"	4
12	FABRICATED SPACER	2 1/4" X 8" X 34"	1

MATERIAL STEEL.



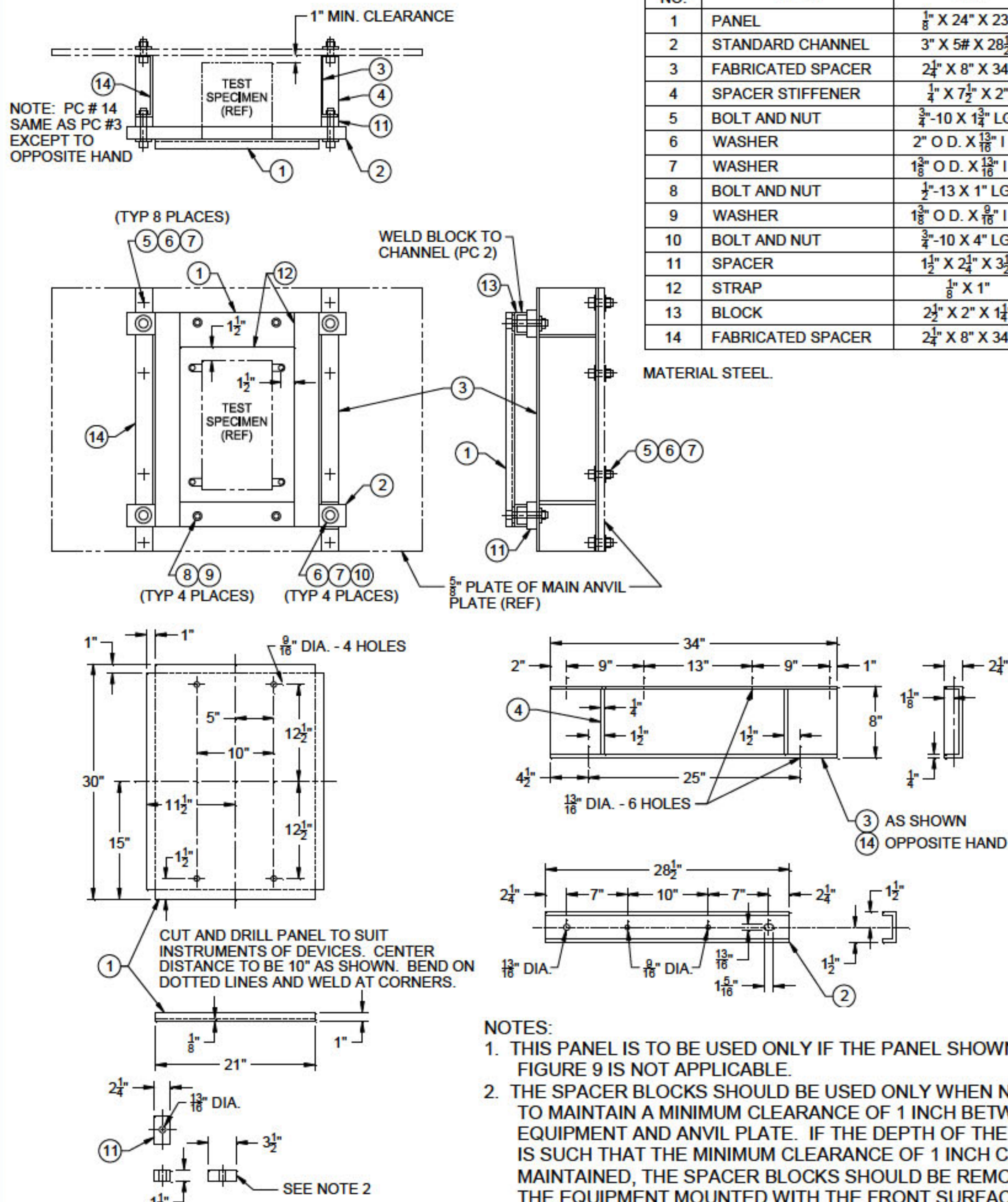
NOTES:

1. TWO IDENTICAL ITEMS OF EQUIPMENT SHALL BE MOUNTED ON THE PANEL PROVIDED THERE IS A MINIMUM SEPARATION OF 3 INCHES WHERE THE INDICATED 10-INCH CENTERS ARE USED (TOTAL WEIGHT NOT TO EXCEED 40 LBS).
2. IF ONLY ONE EQUIPMENT IS TO BE TESTED, A COUNTERBALANCE OF APPROXIMATELY THE SAME WEIGHT SHALL BE MOUNTED IN A CORRESPONDING POSITION ON THE OPPOSITE SIDE OF THE PANEL. MOUNTING DIMENSIONS FOR THE COUNTERBALANCE SHALL BE THE SAME AS FOR THE ITEM OF EQUIPMENT.
3. IN THE EVENT THAT THE REQUIREMENTS OF NOTES 1 AND 2 CANNOT BE MET, THE EQUIPMENT SHALL BE MOUNTED CENTRALLY ON THE PANEL. IF THE INDIVIDUAL EQUIPMENT WEIGHT IS IN EXCESS OF 20 LBS, THE PANEL SHALL BE REINFORCED AS SHOWN ON FIGURE 11.
4. EQUIPMENT IN EXCESS OF 40 LBS SHOULD BE TESTED ON THE PANEL SHOWN ON FIGURE 11.
5. IF THE DEPTH OF THE EQUIPMENT IS SUCH THAT THE MINIMUM CLEARANCE OF 1 INCH CANNOT BE MAINTAINED, THE EQUIPMENT SHOULD BE TURNED AROUND SO THAT THE FRONT FACES THE ANVIL PLATE.
6. PC. NOS. 5, 8, AND 10 SHALL BE HEAT TREATED STEEL.
7. FOR ADDITIONAL DETAILS, SEE BUSHIPS DRAWING 10-T-2145-L.

FIGURE 9. Fixture 6D-1 standard mounting for electrical switchboard meters and other panel mounted equipment (type "C" test LWSM).

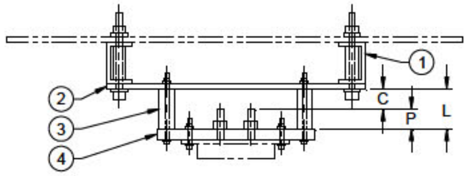
PC. NO.	ITEM	SIZE	NO. REQ'D
1	PANEL	1/8" X 24" X 23"	1
2	STANDARD CHANNEL	3" X 5# X 28 1/2"	2
3	FABRICATED SPACER	2 1/4" X 8" X 34"	1
4	SPACER STIFFENER	1/4" X 7 1/2" X 2"	4
5	BOLT AND NUT	3/4-10 X 1 3/4" LG.	8
6	WASHER	2" O D. X 13/16" I D.	12
7	WASHER	1 3/8" O D. X 13/16" I D.	12
8	BOLT AND NUT	1/2-13 X 1" LG.	4
9	WASHER	1 3/8" O D. X 9/16" I D.	4
10	BOLT AND NUT	3/4-10 X 4" LG.	4
11	SPACER	1 1/2" X 2 1/4" X 3 1/2"	4
12	STRAP	1/8" X 1"	4
13	BLOCK	2 1/2" X 2" X 1 1/4"	4
14	FABRICATED SPACER	2 1/4" X 8" X 34"	1

MATERIAL STEEL.



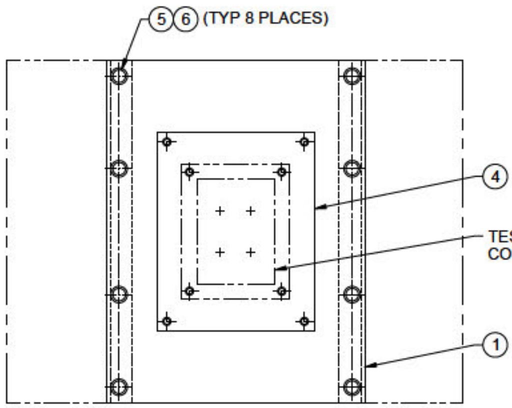
NOTES:
1. THIS PANEL IS TO BE USED ONLY IF THE PANEL SHOWN ON FIGURE 9 IS NOT APPLICABLE.
2. THE SPACER BLOCKS SHOULD BE USED ONLY WHEN NECESSARY TO MAINTAIN A MINIMUM CLEARANCE OF 1 INCH BETWEEN THE EQUIPMENT AND ANVIL PLATE. IF THE DEPTH OF THE EQUIPMENT IS SUCH THAT THE MINIMUM CLEARANCE OF 1 INCH CANNOT BE MAINTAINED, THE SPACER BLOCKS SHOULD BE REMOVED AND THE EQUIPMENT MOUNTED WITH THE FRONT SURFACE TOWARD THE ANVIL PLATE.
3. PC. NOS. 5, 8, AND 10 SHALL BE HEAT TREATED.
4. FOR ADDITIONAL DETAILS, SEE BUSHIPS DRAWING 10-T-2145-L.

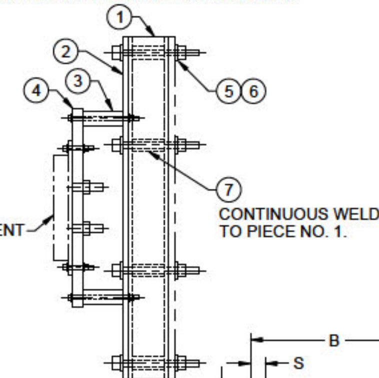
FIGURE 10. Fixture 6D-2 standard mounting for electrical indicating switchboard meters and other panel mounted equipment (type "C" test LWSM).



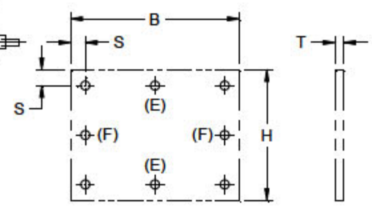
PC. NO.	ITEM	SIZE	NO. REQ'D	MATERIAL
1	CAR BU LDING CHANNEL	4" X 13.8#	2	STEEL
2	AUXILIARY PLATE 1	$\frac{1}{2}$" X 27" X 34"	1	STEEL
3	SPACER	SEE BELOW	-	STEEL
4	PLASTIC MOUNTING PANEL	SEE BELOW	-	LAMINATED (MIL-P-15035)
5	BOLT AND NUT	$\frac{3}{4}$"-20 X 7"	8	STEEL (HEAT TREATED)
6	WASHER	2" O.D. X $\frac{13}{16}$" I.D.	16	STEEL
7	STANDARD PIPE SPACER	1" PS X 2$\frac{15}{16}$" LG.	8	STEEL
8	MOUNT NG HARDWARE	SEE TABLE		H.T. STEEL

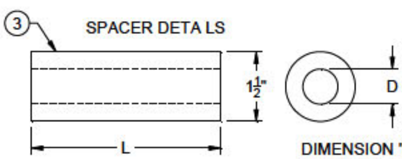
1 THE SIZE OF THE AUX LIARY PLATE SHOULD BE INCREASED TO $\frac{1}{2}$" X 36 X 34 INCHES FOR PANEL NUMBERS 5 AND 6.





DIMENSION "A", AS MEASURED FROM THE CENTER OF ANY MOUNTING HOLE OF PC. 4 TO THE COMPONENT MOUNTING BASE, SHALL BE NOT LESS THAN 2$\frac{1}{2}$ INCHES.





DIMENSION "D" SHALL BE $\frac{17}{32}$" FOR $\frac{1}{2}$ DIA. BOLTS AND $\frac{21}{32}$" DIA. FOR $\frac{5}{8}$" BOLTS

HOLES (E) ARE DRILLED EQUIDISTANT FROM CORNER HOLES ON SAME CENTER LINE - PANEL NO.5 AND 6 ONLY. HOLES (F) ARE DRILLED EQUIDISTANT FROM CORNER HOLES ON SAME CENTER LINE - PANEL NO. 4 AND 6.

SPACER SIZE (INCHES)

WHEN P (NOTE ASSEMBLY TOP V EW) IS:		L	NOTES
LESS THAN	GREATER THAN		
$\frac{3}{4}$	-	1$\frac{1}{2}$	
3$\frac{1}{2}$	$\frac{3}{4}$	P + $\frac{3}{4}$	
-	3$\frac{1}{4}$	4	CUT OUT $\frac{1}{2}$ INCH THICK AUXILIARY MOUNTING PLATE (PIECE NO. 2) TO GIVE $\frac{3}{4}$ INCH CLEARANCE AROUND REAR PROJECTIONS.

PANEL SIZE (NCHES) 2 3

PANEL NO.	B	H	T	S	NO. AND SIZE OF BOLTS	DIA. OF BOLT HOLES
1	9	12	$\frac{3}{4}$	1	4: $\frac{1}{2}$"-13	$\frac{9}{16}$"
2	12	16	1	1	4: $\frac{1}{2}$"-13	$\frac{9}{16}$"
3	16	20	1	1	4: $\frac{1}{2}$"-13	$\frac{9}{16}$"
4	20	24	1	1	6: $\frac{1}{2}$"-13	$\frac{9}{16}$"
5	32	24	1	1$\frac{1}{2}$	6: $\frac{5}{8}$"-11	$\frac{11}{16}$"
6	36	34	1	1$\frac{1}{2}$	6: $\frac{5}{8}$"-11	$\frac{11}{16}$"

2 THE PANEL EMPLOYED SHALL BE THE SMALLEST SIZE SHOWN THAT WILL RESULT IN CLEARANCE (NOTE ASSEMBLY FRONT ELEVATION VIEW) OF AT LEAST 2$\frac{1}{2}$ INCHES.

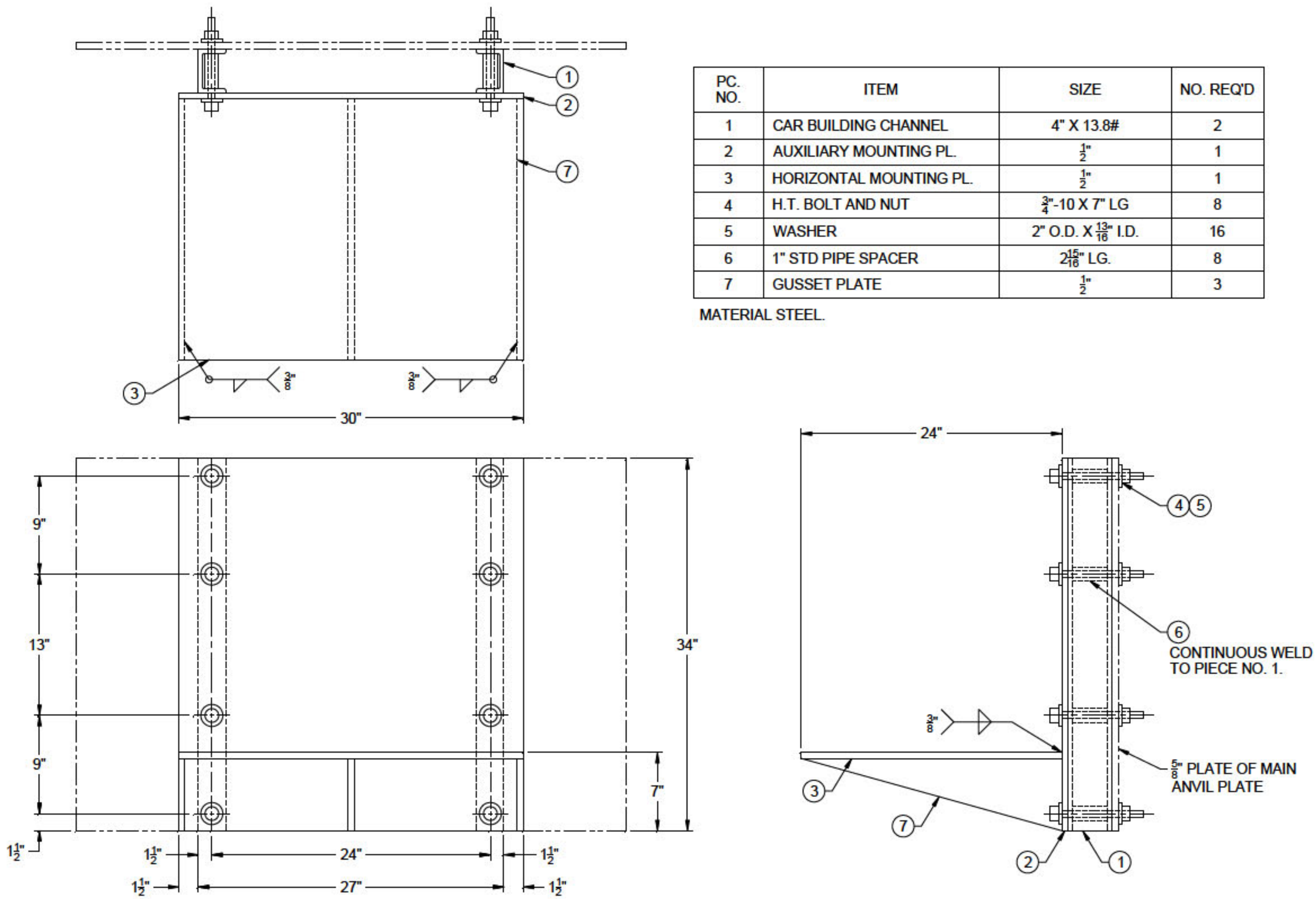
3 THE MANUFACTURER IS TO PROVIDE THE APPROPRIATE PANEL, TOGETHER WITH ALL SPACERS AND MOUNTING FOR BOLTS, WHEN SUBMITTING A COMPONENT TO A NAVAL LABORATORY FOR TEST.

FOR ADDITIONAL DETAILS, SEE BUSHIPS DWG 10-T-2145-L

FIGURE 11. Fixture 6E standard mounting for controller components (contactors, relays, resistors, etc.) (type "C" test LWSM).

PC. NO.	ITEM	SIZE	NO. REQ'D
1	CAR BUILDING CHANNEL	4" X 13.8#	2
2	AUXILIARY MOUNTING PL.	$\frac{1}{2}$"	1
3	HORIZONTAL MOUNTING PL.	$\frac{1}{2}$"	1
4	H.T. BOLT AND NUT	$\frac{3}{4}$"-10 X 7" LG	8
5	WASHER	2" O.D. X $\frac{13}{16}$" I.D.	16
6	1" STD PIPE SPACER	$2\frac{15}{16}$" LG.	8
7	GUSSET PLATE	$\frac{1}{2}$"	3

MATERIAL STEEL.



FOR ADDITIONAL DETAILS, SEE BUSHIPS DWG 10-T-2145-L

FIGURE 12. Fixture 11-C standard mounting for base mounted equipment (LWSM).

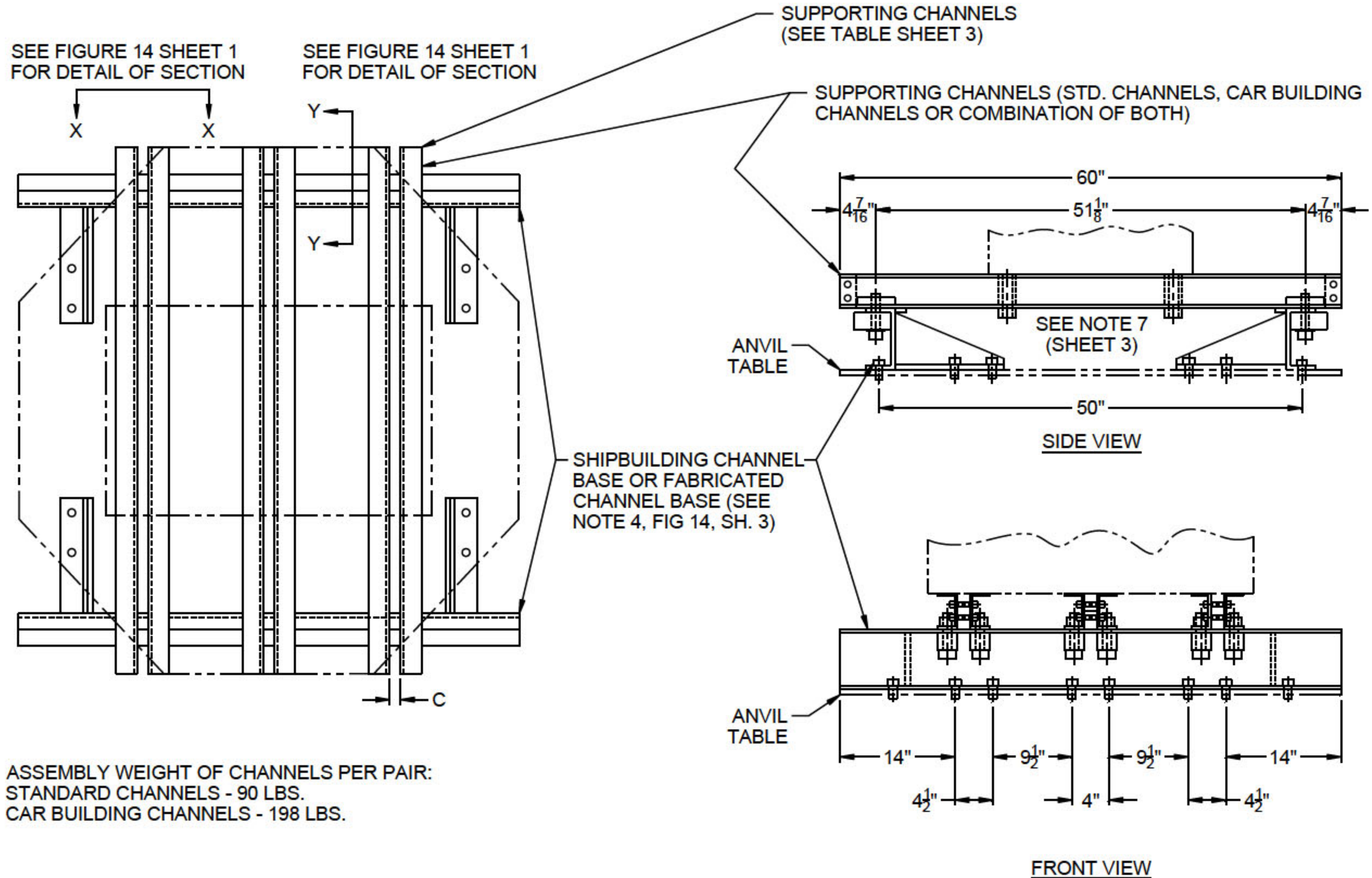


FIGURE 13. Standard mounting platform for testing equipment on the MWSM. (Sheet 1 of 3)

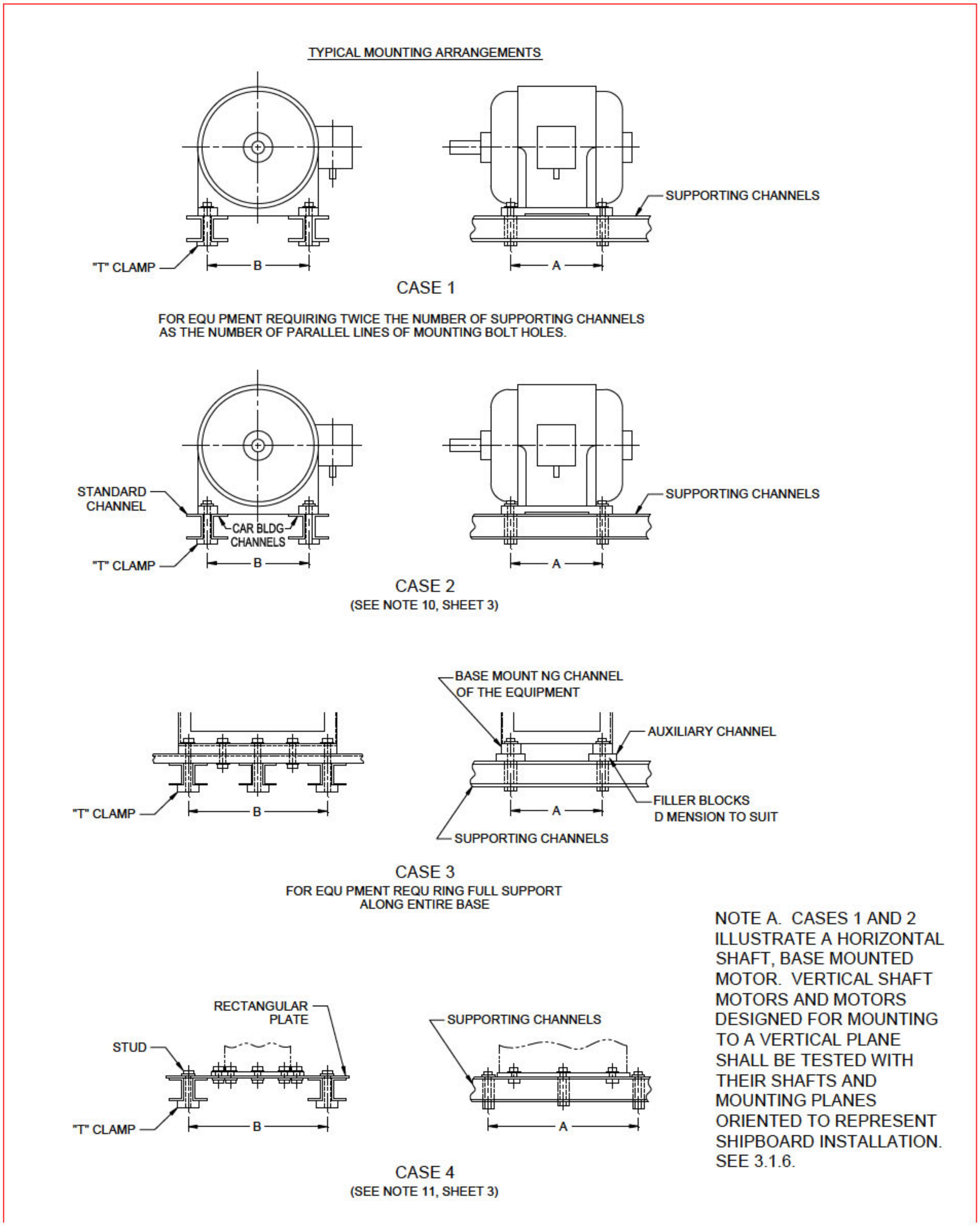


FIGURE 13. Standard mounting platform for testing equipment on the MWSM. (Sheet 2 of 3)

NUMBER OF SUPPORTING 4" CAR BUILDING CHANNELS REQUIRED FOR A GIVEN EQUIPMENT WEIGHT AND SIZE

WEIGHT OF EQUIPMENT (SEE NOTE 4) LBS	CENTER DISTANCE BETWEEN BOLT HOLES DIMENSION "A" (INCHES)																	
	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44
500	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
600	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
700	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
800	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2
900	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
1000	4	4	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2
1100	4	4	4	4	3	3	3	3	3	3	2	2	2	2	2	2	2	2
1200	4	4	4	4	4	3	3	3	3	3	2	2	2	2	2	2	2	2
1300	5	5	4	4	4	4	4	3	3	3	3	2	2	2	2	2	2	2
1400	5	5	5	4	4	4	4	4	3	3	3	3	2	2	2	2	2	2
1500	5	5	5	5	5	4	4	4	3	3	3	3	3	2	2	2	2	2
1600	6	5	5	5	5	4	4	4	4	3	3	3	3	2	2	2	2	2
1700	6	6	6	5	5	5	4	4	4	4	3	3	3	3	3	3	3	3
1800	6	6	6	6	5	5	5	4	4	4	4	3	3	3	3	3	3	3
1900	7	6	6	6	6	5	5	5	4	4	4	3	3	3	3	3	3	3
2000	7	7	6	6	6	5	5	5	4	4	4	4	3	3	3	3	3	3
2100	7	7	7	6	6	6	5	5	5	4	4	4	3	3	3	3	3	3
2200	8	7	7	7	6	6	6	5	5	5	4	4	3	3	3	3	3	3
2300	8	8	7	7	7	6	6	5	5	5	4	4	4	3	3	3	3	3
2400	8	8	8	7	7	6	6	6	5	5	5	4	4	3	3	3	3	3
2500		8	8	7	7	7	6	6	5	5	5	4	4	4	4	4	4	4
2600			8	8	7	7	7	6	6	5	5	4	4	4	4	4	4	4
2700				8	8	7	7	6	6	5	5	5	4	4	4	4	4	4
2800				8	8	7	7	7	6	6	5	5	4	4	4	4	4	4
2900					8	8	7	7	6	6	5	5	4	4	4	4	4	4
3000					8	8	7	7	6	6	6	5	5	4	4	4	4	4
3100						8	8	7	7	6	6	5	5	4	4	4	4	4
3200						8	8	7	7	6	6	5	5	4	4	4	4	4
3300							8	8	7	7	6	5	5	5	5	5	5	5
3400							8	8	7	7	6	6	5	5	5	5	5	5
3500								8	8	7	6	6	5	5	5	5	5	5
3600								8	8	7	6	6	5	5	5	5	5	5
3700								8	8	7	6	6	5	5	5	5	5	5
3800								9	8	7	7	6	5	5	5	5	5	5
3900								9	8	7	7	6	6	5	5	5	5	5
4000								9	8	8	7	6	6	5	5	5	5	5
4100								9	8	8	7	6	6	6	6	6	6	6
4200								9	9	8	7	7	6	6	6	6	6	6
4300								10	9	8	7	7	6	6	6	6	6	6
4400								10	9	8	8	7	6	6	6	6	6	6
4500								10	9	9	8	7	6	6	6	6	6	6
4600								10	9	9	8	7	7	6	6	6	6	6
4700								10	9	9	8	7	7	6	6	6	6	6
4800									10	9	8	8	7	6	6	6	6	6
4900									10	9	8	8	7	7	7	7	7	7
5000									10	9	8	8	7	7	7	7	7	7
5100									10	10	9	8	7	7	7	7	7	7
5200									10	10	9	8	8	7	7	7	7	7
5300										10	9	8	8	7	7	7	7	7
5400										10	9	9	8	7	7	7	7	7
5500										10	9	9	8	7	7	7	7	7
5600										10	9	9	8	8	7	7	7	7
5700											10	9	9	8	8	8	8	8
5800											10	9	9	8	8	8	8	8
5900											10	9	9	8	8	8	8	8
6000											10	10	9	8	8	8	8	8

NOTES:

1. DIMENSIONS “A” AND “B” ARE THE EXTREME BOLT CENTER DISTANCES OF THE EQUIPMENT WITH DIMENSION “B” ALWAYS EQUAL TO OR GREATER THAN DIMENSION “A”.

2. THE APPROPRIATE NUMBER OF SUPPORTING CHANNELS SHALL BE SELECTED IN ACCORDANCE WITH THE WEIGHT AND DIMENSION “A” OF THE EQUIPMENT (SEE TABLE).

3. WHEN SELECTING SUPPORTING CHANNELS FOR WEIGHT AND DIMENSION “A” NOT LISTED IN TABLE, THE NEXT HIGHER WEIGHT VALUE AND THE SMALLER DIMENSION “A” SHALL BE USED.

4. WHEN SELECTING THE SUPPORTING CHANNELS FOR CASES 3 AND 4 LISTED IN THE TABLE, THE WEIGHT OF THE AUXILIARY CHANNELS OR PLATES SHOULD BE INCLUDED IN THE EQUIPMENT WEIGHT.

5. TWO STANDARD 4” BY 7.25# CHANNELS HAVE A COMBINED STRENGTH EQUIVALENT TO A SINGLE 4” BY 13.8# CAR BUILDING CHANNEL AND MAY BE USED IN PLACE OF, OR IN CONJUNCTION WITH, THE CAR BUILDING CHANNELS.

6. WHEN USING STANDARD OR CAR BUILDING CHANNELS BACK TO BACK, THE ENDS OF THE CHANNELS SHOULD BE CLAMPED WITH THE SPACER, PC 9, AND BOLTS SHOWN ON FIGURE 14, SH 1.

7. HOLES SHOULD NOT BE DRILLED THROUGH THE FLANGES OF THE SUPPORTING CHANNELS FOR THE PURPOSE OF BOLTING EQUIPMENT. EQUIPMENT SHOULD BE BOLTED TO THE SUPPORTING CHANNELS BY MEANS OF THE T CLAMP SHOWN ON FIGURE 14, SH 1.

8. THE SPACING OF THE SUPPORTING CHANNELS ON THE SHIPBUILDING CHANNELS SHOULD BE GOVERNED, WHEN PRACTICABLE, BY THE POSITION OF THE CG TO OBTAIN UNIFORM DISTRIBUTION OF LOAD.

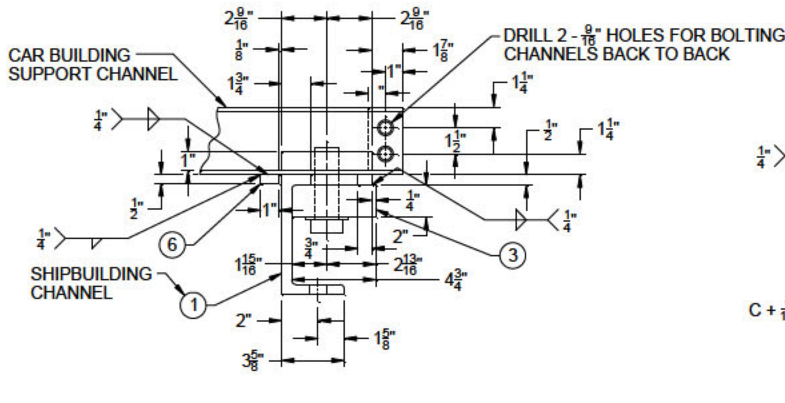
9. IF THE EQUIPMENT MOUNTING FEET ARE NOT SUBSTANTIALLY WIDER THAN DIMENSION “C”, A STEEL PAD SHOULD BE USED BETWEEN THE FEET AND SUPPORTING CHANNELS AT EACH MOUNTING BOLT AND CLAMP.

10. FOR EQUIPMENT REQUIRING TWO OR MORE CAR BUILDING SUPPORTING CHANNELS, ALL OR PART OF THE NUMBER OF CAR BUILDING CHANNELS AS INDICATED IN THE TABLE MAY BE REPLACED WITH STANDARD CHANNELS TO UTILIZE A BACK TO BACK CHANNEL ARRANGEMENT (SEE NOTE 7). IN THE EVENT THAT THE REQUIRED NUMBER OF SUPPORTING CHANNELS DOES NOT LEND ITSELF TO THIS METHOD, THE AUXILIARY CHANNEL ARRANGEMENT OF CASE 3 SHOULD BE USED.

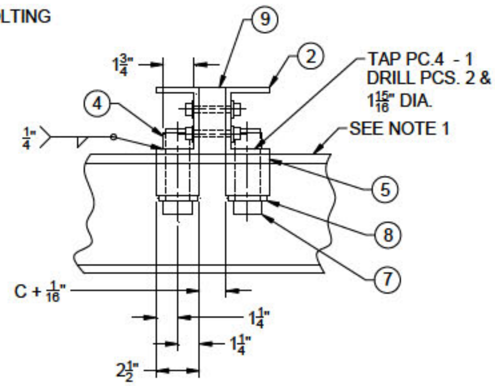
11. MIXED CHANNEL PAIRS (A CARBUILDING AND STANDARD CHANNEL PAIRED BACK-TO-BACK) SELECTED IN ACCORDANCE WITH NOTES 4, 7, AND 10 SHOULD BE USED TO ELIMINATE THE USE OF CARBUILDING CHANNEL PAIRS AND STANDARD CHANNEL PAIRS IN THE SAME MOUNTING ARRANGEMENT. MIXED CHANNEL PAIRS SHOULD BE PLACED WITH THE CARBUILDING CHANNEL OUTBOARD OF THE STANDARD CHANNEL SUCH THAT SYMMETRY IS ACHIEVED WHEREVER PRACTICABLE.

12. FOR EQUIPMENT HAVING AN IRREGULAR OR CIRCULAR MOUNTING BOLT HOLE PATTERN, UTILIZE T CLAMPS OF SUFFICIENT SIZE AND NUMBER TO PROVIDE TOTAL BOLTING STRENGTH AT LEAST 50 PERCENT GREATER THAN PROVIDED BY EQUIVALENT BOLTS.

FIGURE 13. Standard mounting platform for testing equipment on the MWSM. (Sheet 3 of 3)

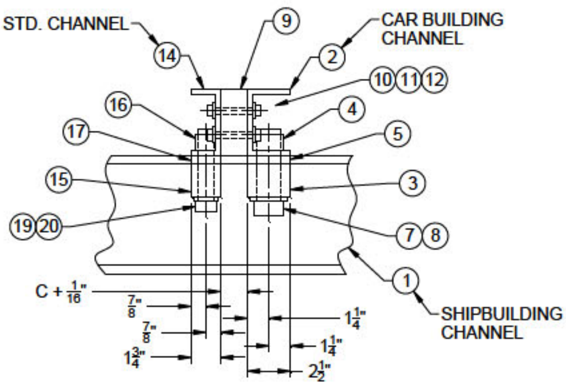


SECTION Y-Y



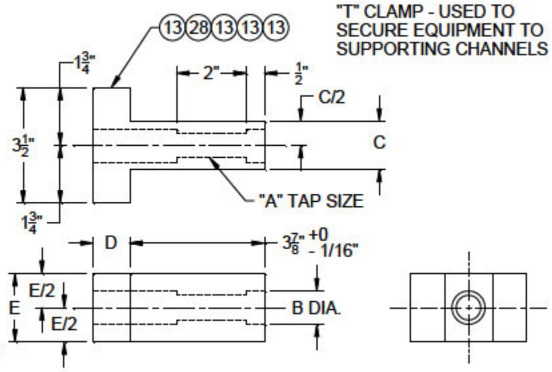
SECTION X-X

END CLAMP FOR 4" X 13.8# CAR BUILDING SUPPORTING CHANNELS



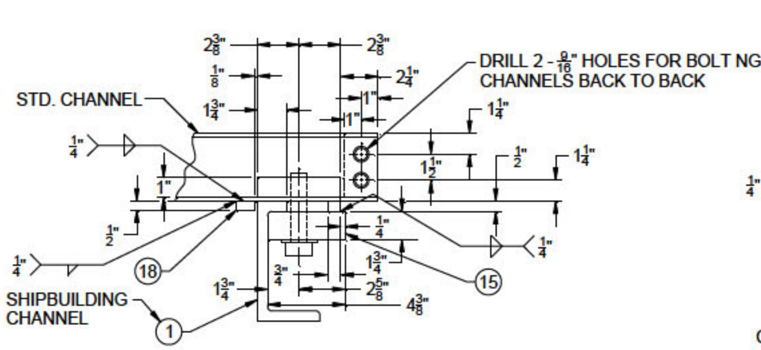
SECTION X-X

END CLAMP FOR CAR BUILDING SUPPORTING CHANNEL AND STANDARD CHANNEL COMBINED

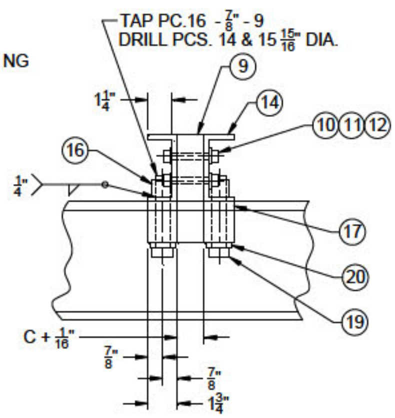


"T" CLAMP DIMENSIONS

PC. NO.	A	B	C	D	E
12	1/2"-13	9/16"	1 1/8"	3/4"	1 1/8"
28	5/8"-11	11/16"	1 1/8"	3/4"	1 1/8"
29	3/4"-10	13/16"	1 1/4"	7/8"	1 1/2"
30	7/8"-9	15/16"	1 3/8"	15/16"	1 3/4"
31	1"-8	1 1/16"	1 1/2"	1"	2"



SECTION Y-Y



SECTION X-X

END CLAMP FOR 4" X 7.25# STANDARD CHANNELS

FIGURE 14. Section details of standard mounting platform for testing equipment on the MWSM. (Sheet 1 of 3)

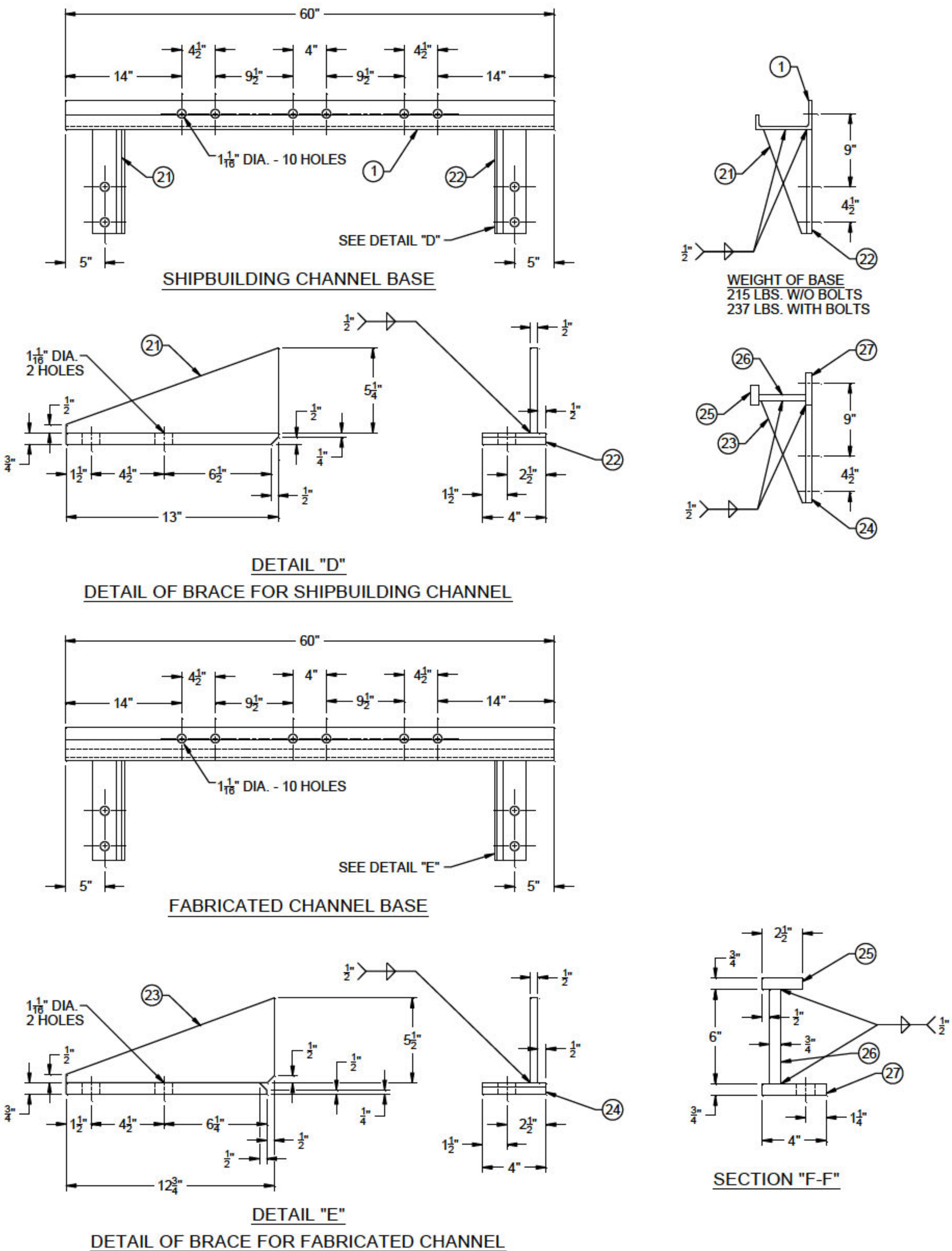


FIGURE 14. Section details of standard mounting platform for testing equipment on the MWSM. (Sheet 2 of 3)

PC. NO.	ITEM	SIZE	NO REQ'D	REMARKS
1	SHIPBUILDING CHANNEL	7" X 22.7#	2	MOD. – SEE NOTE 1
2	CARBUILDING CHANNEL	4" X 13.8#	A/R	
3	CLAMP	2" X 2-1/2" X 4-3/4"	A/R	
4	BLOCK	1" X 1-3/4" X 5-1/8"	A/R	
5	PAD	1/2" X 3/4" X 2-1/2"	A/R	
6	PAD	1/2" X 1" X 2"	A/R	
7	HEX. HD. BOLT *	1-1/4"-7 X 4-1/4" LG	A/R	HEAT TREATED STL.
8	WASHER	1-3/8" I.D. X 2-5/16" O.D.	A/R	
9	SPACER	2" X 4" X A/R	A/R	
10	HEX. HD. BOLT *	1/2"-13 X A/R	A/R	HEAT TREATED STL.
11	WASHER	9/16" I.D. X 1" O.D.	A/R	
12	HEX NUT	1/2"-13	A/R	
13	"T" CLAMP	SEE FIG. 14, SH. 1	A/R	
14	STANDARD CHANNEL	4" X 7.25#	A/R	
15	CLAMP	1-3/4' X 1-3/4" X 4-3/8"	A/R	
16	BLOCK	1" X 1-1/4" X 4-3/4"	A/R	
17	PAD	1/2" X 3/4" X 1-3/4'	A/R	
18	PAD	1/2" X 1" X 1-1/4"	A/R	
19	HEX HD. BOLT *	7/8"-9 X 3-5/8" LG.	A/R	HEAT TREATED STL.
20	WASHER	15/16" I.D. X 1-9/16" O.D.	A/R	
21	GUSSET	1/2" X 5-1/2" X 13"	A/R	
22	PLATE	3/4" X 4" X 13"	A/R	
23	GUSSET	1/2' X 5-1/2" X 12-3/4"	A/R	
24	PLATE	7/8" X 4" X 12-1/4"	A/R	
25	PLATE	7/8" X 2-1/2" X 60"	A/R	
26	PLATE	3/4" X 6" X 60"	A/R	
27	PLATE	3/4" X 4" X 60"	A/R	
28	"T" CLAMP	SEE FIG. 14, SH. 1	A/R	
29	"T" CLAMP	SEE FIG. 14, SH. 1	A/R	
30	"T" CLAMP	SEE FIG. 14, SH. 1	A/R	
31	"T" CLAMP	SEE FIG. 14, SH. 1	A/R	

MATERIAL SHALL BE STEEL

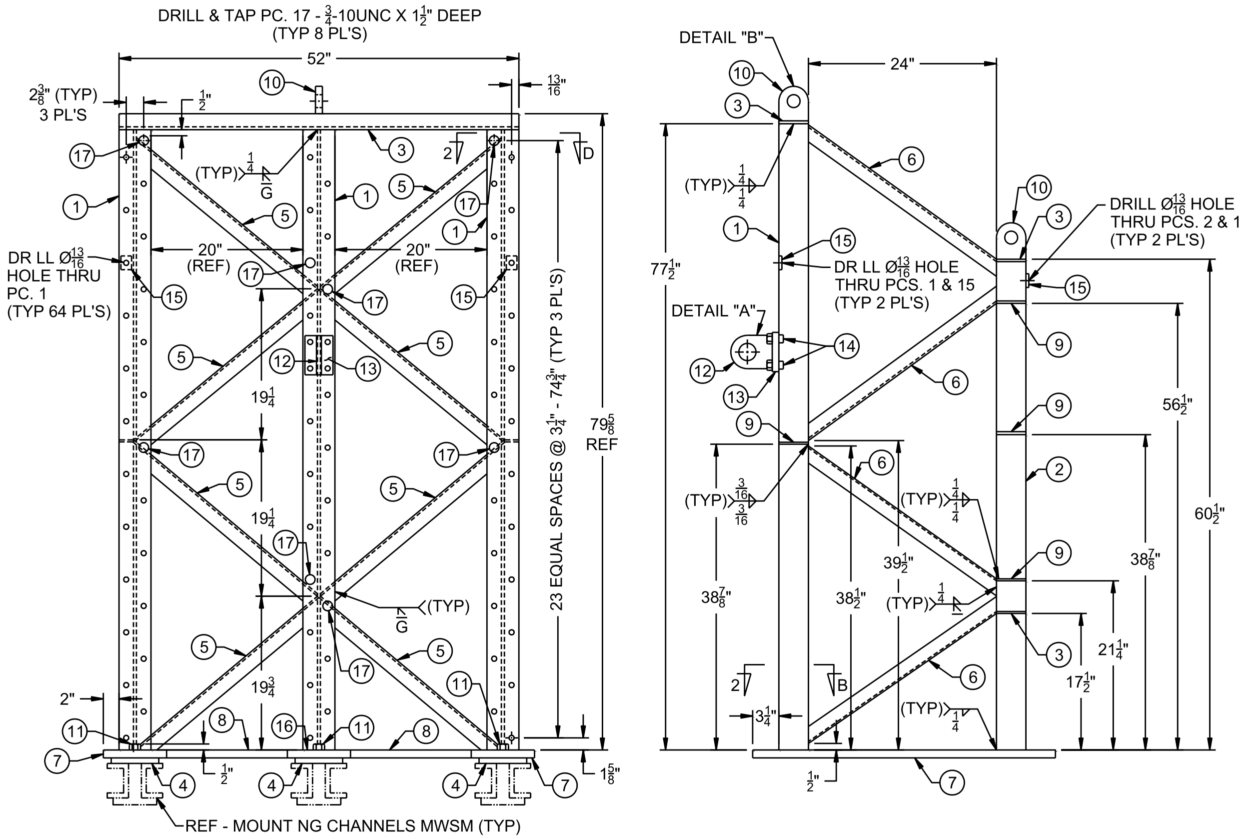
* HEAT TREATED STEEL

NOTES:

1. TOP FLANGE OF PC. NO.1 SHALL BE BURNED OR CUT OFF TO A WIDTH OF 1-3/4".
2. PC. NOS. 3 AND 4 SHALL BE SHAPED TO FIT INNER SURFACES OF PC. NOS. 1 AND 2, RESPECTIVELY (SEE NOTE 5).
3. PC. NOS. 15 AND 16 SHALL BE SHAPED TO FIT INNER SURFACES OF PC. NOS. 1 AND 14, RESPECTIVELY (SEE NOTE 5).
4. USE OF EITHER PC. NO. 1 OR THE FABRICATED CHANNEL, SECTION "F-F" OF FIGURE 14, SHEET 2, IS OPTIONAL DEPENDENT UPON AVAILABILITY OF MATERIAL OR EASE OF FABRICATION.
5. IF THE FABRICATED CHANNEL, SECTION "F-F", IS USED, PC. NOS. 3 AND 15 SHOULD BE SHAPED TO FIT THE INNER SURFACE OF THE FABRICATED CHANNEL, SECTION "F-F", RATHER THAN PC. NO. 1. PC NOS. 6 AND 18 SHALL BE SHIFTED INWARD 3/4".
6. USE OF BACK TO BACK SUPPORTING CHANNELS, WHICH ARE PERMANENTLY WELDED TOGETHER AT THE ENDS RATHER THAN BOLTED TOGETHER, IS OPTIONAL.

FOR ADDITIONAL DETAILS, SEE BUSHIPS DWG N0807-655947.

FIGURE 14. Section details of standard mounting platform for testing equipment on the MWSM. (Sheet 3 of 3)

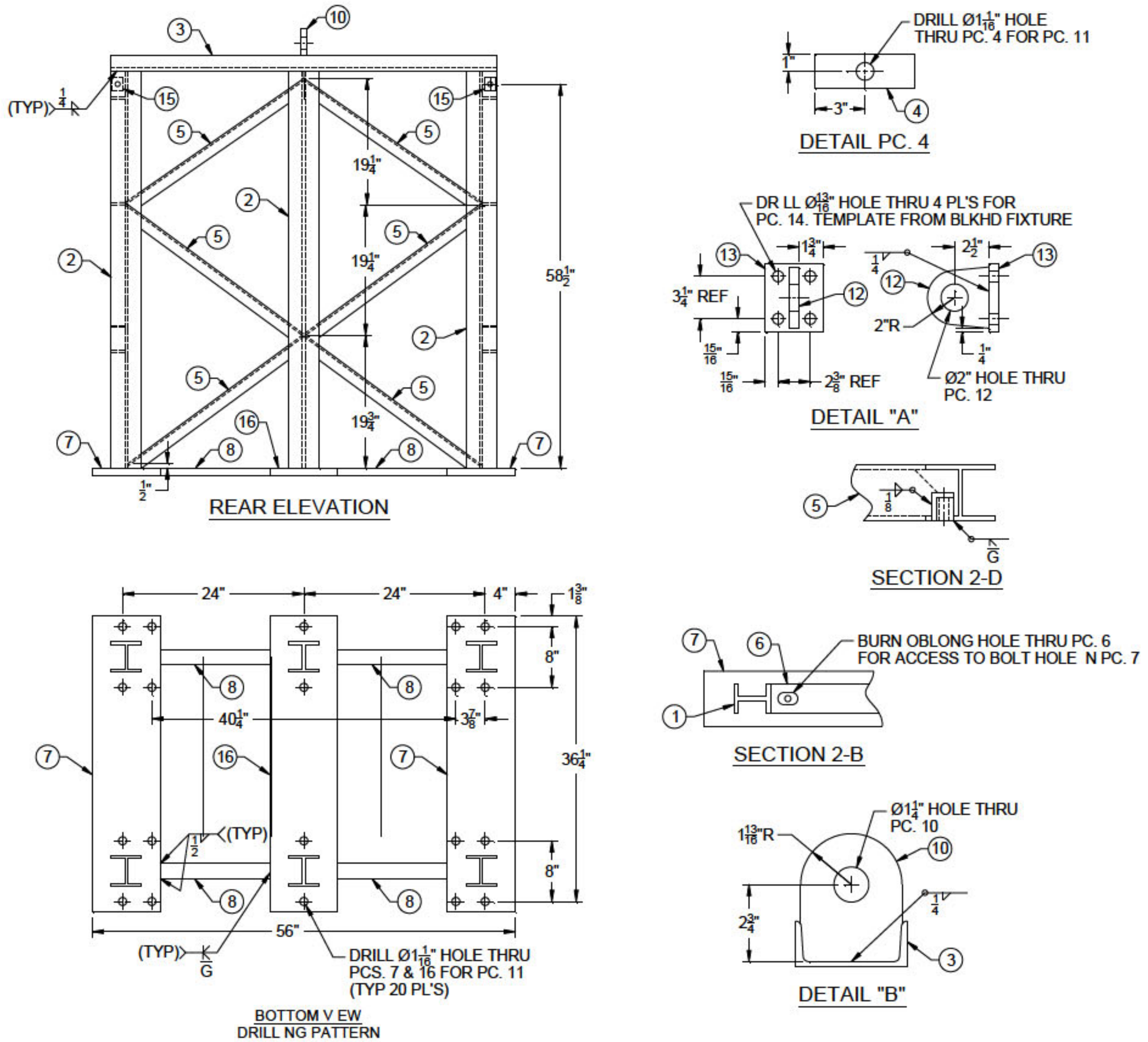


FRONT ELEVATION
OPTIONAL DRILLING DETAIL

RIGHT SIDE ELEVATION

17	12	1-¼" Φ Rd Bar x 2" Lg.	Steel	A36	6	8 Reqd for Optional Drilling Detail
16	1	1" PL 8" x 39"	"	A36	88	
15	4	⅜" PL 1-½" x 2"	"	A36	1	
14	2	¾-10UNC Hex Hd Bolt x 2" Lg.	"	Gr 5		w/ Hex Nuts
13	1	¾" PL 4-¼" x 5"	"	A36	5	
12	1	¾" PL 4-½" x 4-½"	"	A36	4	
11	12	1-8UNC Hes Hd Capscrew x 4" Lg.	"	Gr 5		
10	2	¾" PL 3-⅝" x 4-9/16"	"	A36	7	
9	10	¼" PL 1-⅞"x 3-3/16"	"	A36	4	
8	4	1" PL 2" x 15"	"	A36	34	
7	2	1" PL 9" x 39"	"	A36	188	
6	12	C 4" x 5.4 x 30-½" Lg.	"	A36	165	
5	14	C 4" x 5.4 x 30-½" Lg.	"	A36	192	
4	12	½" PL 2" x 6"	"	A36	20	
3	2	C 4" x 5.4 x 52" Lg.	"	A36	46	
2	3	W 4" x 13 x 60" Lg.	"	A36	195	
1	3	W 4" x 13 x 78" Lg.	"	A36	254	

FIGURE 15. Standard mounting platform for testing back mounted equipment on the MWSM. (Sheet 1 of 2)



NOTES:

1. THIS DRAWING PRESENTS FABRICATION DETAILS FOR MANUFACTURING THE STANDARD MOUNTING FIXTURE FOR TESTING BACK MOUNTED EQUIPMENT ON THE MEDIUM WEIGHT SHOCK MACHINE.
2. DIMENSIONS ARE IN INCHES.
3. FABRICATION, WELDING, AND INSPECTION SHALL BE IN ACCORDANCE WITH S9074-AR-GIB-010/278 OR OTHER APPROVED FABRICATION DOCUMENTS, INCLUDING MIL-STD-1689.
4. TOTAL WEIGHT OF STANDARD BULKHEAD TEST FIXTURE IS APPROXIMATELY 1,150 TO 1,200 POUNDS.

FIGURE 15. Standard mounting platform for testing back mounted equipment on the MWSM. (Sheet 2 of 2)

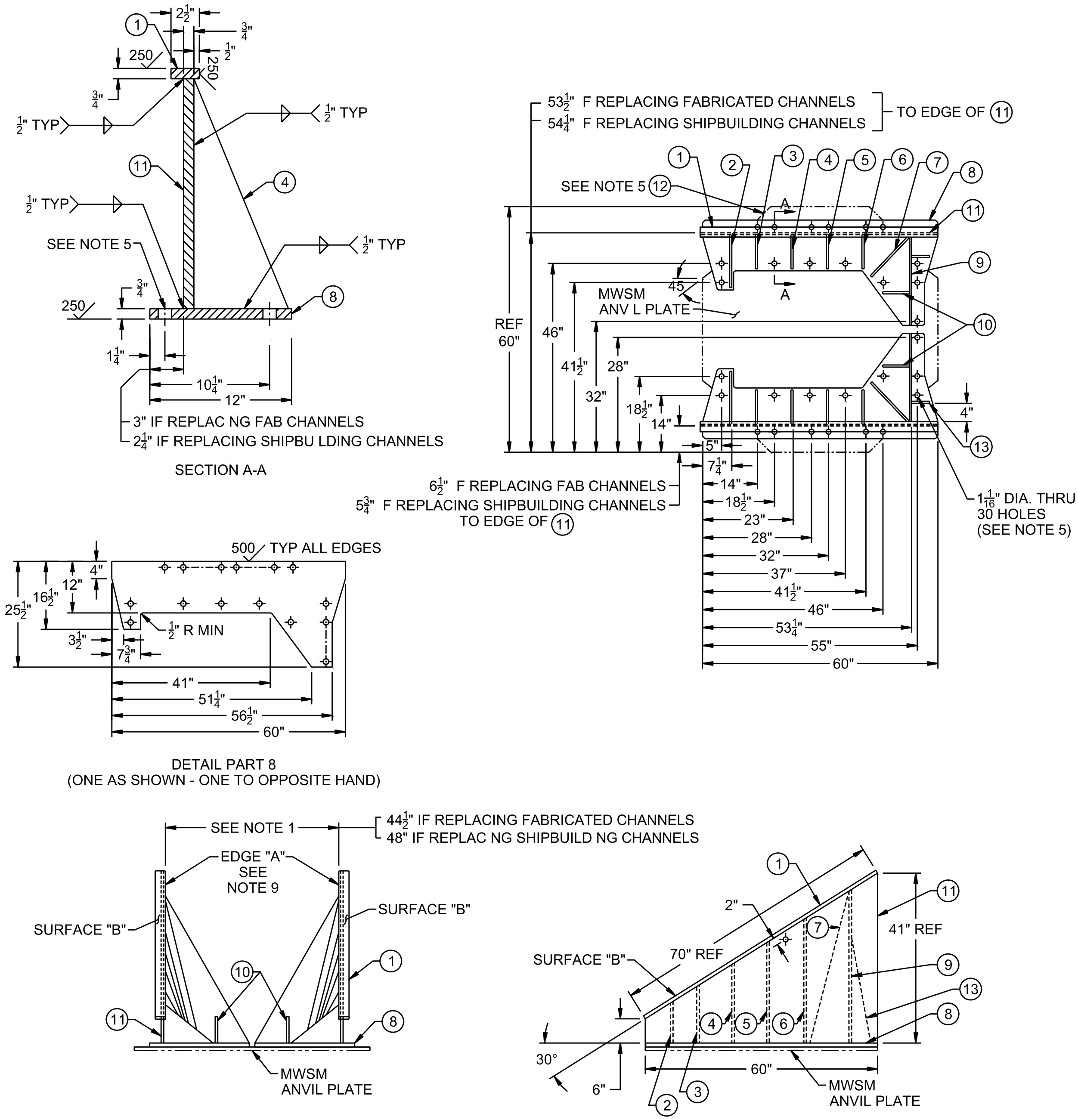


FIGURE 16. 30-degree mounting fixture for testing base mounted equipment on the MWSM. (Sheet 1 of 2)

PC. NO.	SIZE (INCHES)	MATERIAL	NO. REQ'D
1	1 X 4 X 70	HRS 1010	2
2	$\frac{1}{2}$ X 9-$\frac{1}{2}$ X 12-$\frac{1}{2}$		2
3	$\frac{1}{2}$ X 8 X 13-$\frac{1}{2}$		2
4	$\frac{1}{2}$ X 8 X 18-$\frac{1}{2}$		2
5	$\frac{1}{2}$ X 8 X 24-$\frac{1}{2}$		2
6	$\frac{1}{2}$ X 8 X 29		2
7	$\frac{1}{2}$ X 14 X 36		2
8	1 X 26 X 60		2
9	$\frac{1}{2}$ X 22 X 36		2
10	$\frac{1}{2}$ X 7 X 6-$\frac{1}{2}$		2
11	$\frac{3}{4}$ X 60 X 41	HRS 1010	2
12	$\frac{1}{4}$ X 60 X 60	61 ST	1
13	$\frac{1}{2}$ X 5 X 27	HRS 1010	2

MATERIAL: STEEL

WEIGHT OF FIXTURE (BOTH PIECES): 1400 LBS

NOTES:

1. THIS FIXTURE, WHEN USED, REPLACES THE SHIPBUILDING OR FABRICATED CHANNELS SHOWN ON FIGURES 13 AND 14. EQUIPMENT AND SUPPORTING CHANNELS ARE MOUNTED TO THIS FIXTURE AS SHOWN ON FIGURE 13.

2. THIS FIXTURE MAY BE USED TO TEST BACK MOUNTED EQUIPMENT AT 30-DEGREE INCLINATION BY ADDING BULKHEAD FIXTURE SHOWN ON FIGURE 15. SEE FIGURE 18 FOR ALTERNATE 30-DEGREE MOUNTING PLATFORM FOR BULKHEAD SUPPORTED EQUIPMENT.

3. FULLY ANNEAL ASSEMBLY AFTER WELDING.

4. FINISH MACHINE AFTER ANNEALING.

5. PC NO. 12 IS NOT PART OF THE FIXTURE. IT IS A TEMPLATE HAVING A HOLE PATTERN IDENTICAL TO THE SHOCK TEST MACHINE PLATFORM. LOCATE ALL 1-1/16-INCH DIAMETER HOLES FROM SHOCK MACHINE PLATFORM.

6. ALL WELDS TO BE 1/2 INCH COMPLETELY AROUND EACH EDGE.

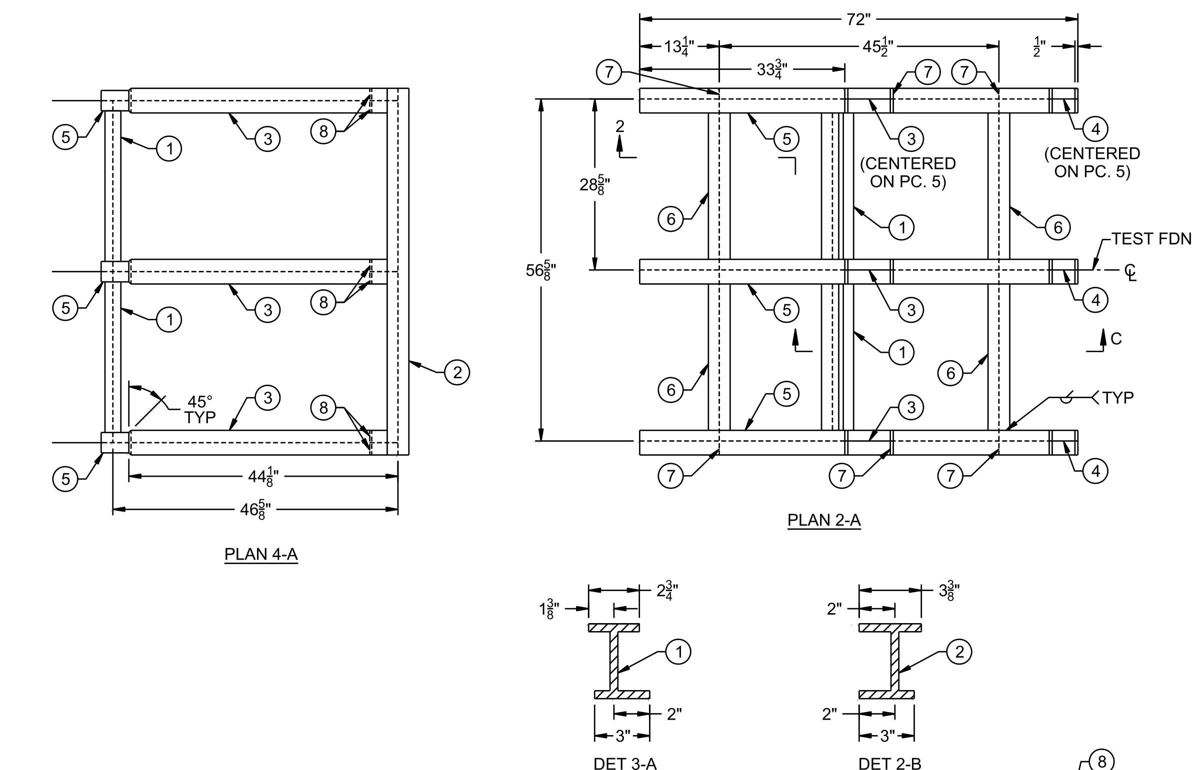
7. 2-INCH DIAMETER HOLE SHALL BE TORCH CUT AFTER WELDING. THE HOLE SHALL BE LOCATED NEAR THE CG.

8. ALL EDGES AND CORNERS SHALL BE BROKEN SUITABLE FOR HANDLING.

9. PARALLELISM SHALL BE MAINTAINED AT SURFACES “B” AND EDGES “A” WITHIN 1/32 INCH.

10. FOR ADDITIONAL DETAILS, SEE BUSHIPS DRAWING N0807-655947.

FIGURE 16. 30-degree mounting fixture for testing base mounted equipment on the MWSM. (Sheet 2 of 2)



ASSY MK	QTY	WT OR SIZE	CR/CL
1	2	C/F 4 WF 13	HT-TY A
2	1	C/F 4 WF 13	HT-TY A
3	3	4 WF 13	HT-TY A
4	3	4 WF 13	HT-TY A
5	3	6" X 3⅜" X 12.5#	HT-TY A
6	4	6" X 3⅜" X 12.5#	HT-TY A
7	24	10 2#	HT-TY I
8	6	10 2#	HT-TY I

NOTES:
1. THIS FIXTURE MAY BE USED N LIEU OF FIG. 16. IT PROV DES IMPROVED SUPPORT FOR NARROW-BASE EQUIPMENTS BY THE REORIENTED SUPPORT NG CHANNELS, AND DUE TO ITS REDUCED WEIGHT PERMITS TESTING HEAVIER EQUIPMENT WITHOUT EXCEED NG THE MAXIMUM WEIGHT LIMIT OF 7400 LBS.
2. WEIGHT OF FIXTURE IS 1250 LBS.
3. FOR ADDITIONAL DETAILS, SEE BUSH PS DWG. N0807-655947.

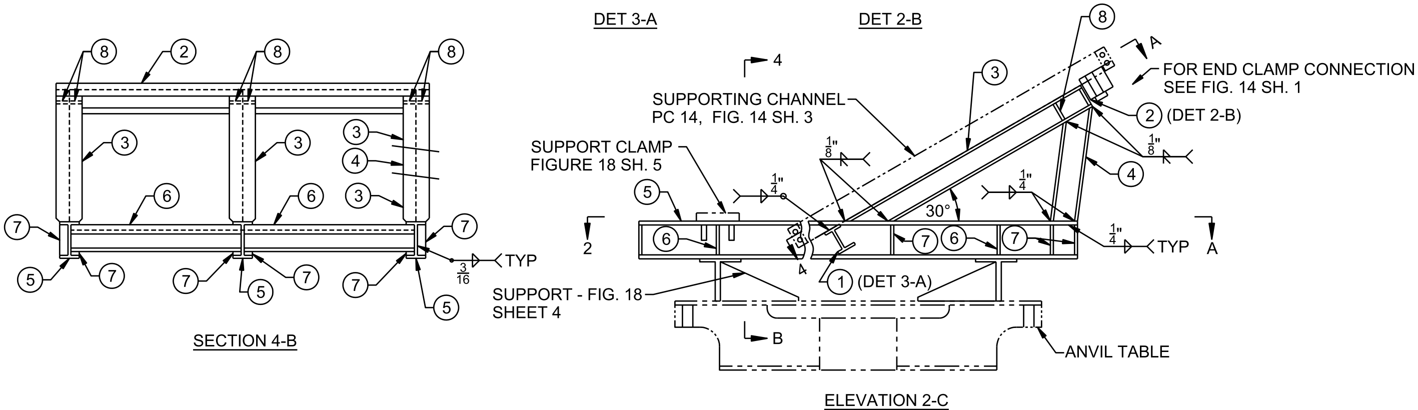


FIGURE 17. Alternate 30-degree mounting fixture for testing base mounted equipment on the MWSM.

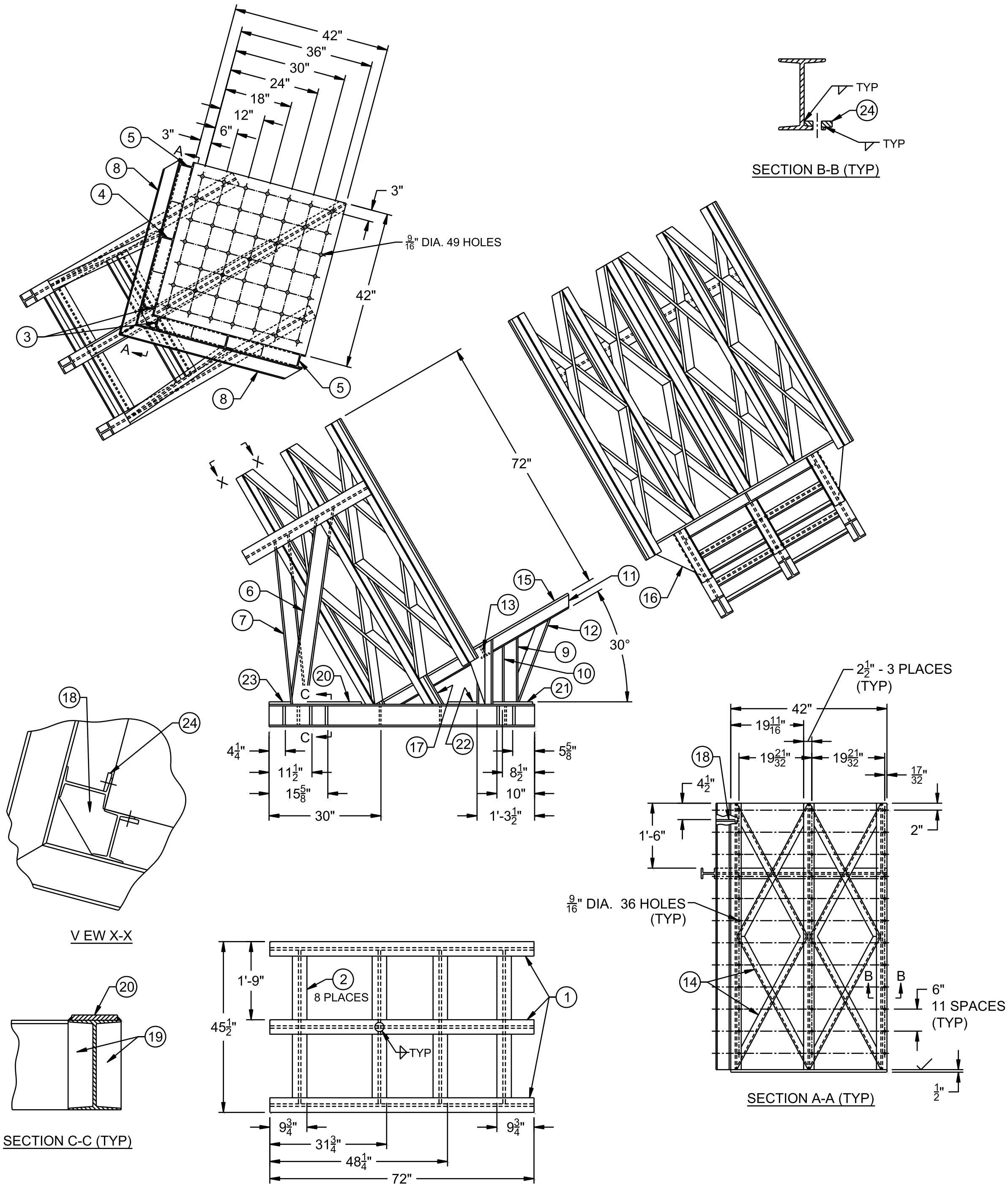


FIGURE 18. 30-degree mounting fixture for testing back mounted equipment on the MWSM. (Sheet 1 of 5)

LIST OF MATERIALS

PIECE NO.	ITEM	SIZE INCHES	LENGTH INCLES	NO. RQD.
1	H-BEAM	6.0 X 3-1/2 X 0.25 WEB	72	3
2	H-BEAM	6.0 X 3-1/2 X 0.25 WEB	20-3/4	8
3	H-BEAM	4.0 X 2-5/8 X 0.25 WEB	74	2
4	H-BEAM	4.0 X 2-5/8 X 0.25 WEB	82	2
5	H-BEAM	4.0 X 2-5/8 X 0.25 WEB	75	2
6	H-BEAM	4.0 X 2-5/8 X 0.25 WEB	52	2
7	H-BEAM	4.0 X 2-5/8 X 0.25 WEB	45	1
8	H-BEAM	4.0 X 2-5/8 X 0.25 WEB	50	2
9	H-BEAM	4.0 X 2-5/8 X 0.25 WEB	17-1/2	1
10	H-BEAM	4.0 X 2-5/8 X 0.25 WEB	16-3/4	2
11	T-BEAM	3.0 X 3.0 X 0.25 WEB	59	1
12	T-BEAM	3.0 X 3.0 X 0.25 WEB	24-3/4	1
13	T-BEAM	3.0 X 3.0 X 0.25 WEB	20-3/4	2
14	CHANNEL	4.0 X 1-3/4 X 0.25 WEB	41	16
15	PLATE	5/8 X 42	42	1
16	STIFFENER	3/8 X 8.0	15	2
17	STIFFENER	3/8 X 5-1/2	15	1
18	STIFFENER	3/8 X 5-1/4	5-1/4	4
19	STIFFENER	3/8 X 1-5/8	5-1/2	24
20	PAD	3/8 X 3.0	14-3/4	2
21	PAD	3/8 X 3.0	10-3/4	2
22	PAD	3/8 X 3.0	8-1/4	2
23	PAD	3/8 X 3.0	6	2
24	PAD	3/8 X 1-1/2	1-1/2	72

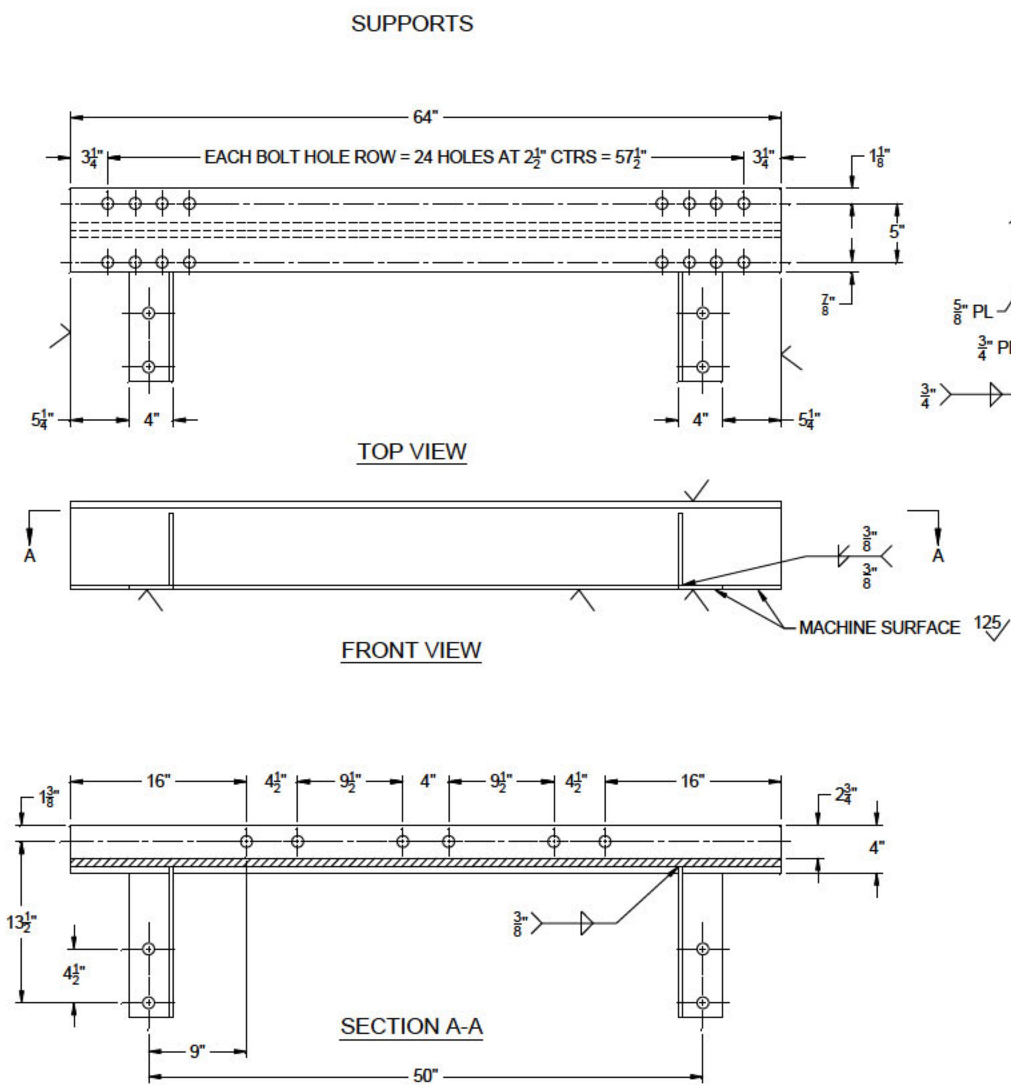
WEIGHT OF FIXTURE: 1733 LBS
MATERIAL: STEEL

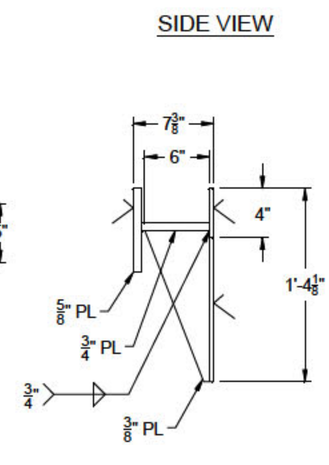
FIGURE 18. 30-degree mounting fixture for testing back mounted equipment on the MWSM. (Sheet 2 of 5)

NOTES:

1. UNLESS OTHERWISE SPECIFIED HEREIN OR IN THE INDIVIDUAL EQUIPMENT SPECIFICATION, SURFACE ROUGHNESS, AS ROLLED OR DRAWN, PUNCH CUT OR MACHINED, SHALL HAVE A 250 FINISH AND SHALL BE IN ACCORDANCE WITH ASME B46.1.
2. THREADS SHALL BE IN ACCORDANCE WITH FED-STD-H28 AND ASME Y14.6.
3. UNLESS OTHERWISE SPECIFIED HEREIN OR IN THE INDIVIDUAL EQUIPMENT SPECIFICATION, ALL FILLET WELDS SHALL BE 1/4 INCH.
4. MACHINED SURFACES SHALL BE PAINTED.
5. FABRICATION PROCEDURES AND INSPECTION STANDARDS FOR WELDING SHALL BE IN ACCORDANCE WITH CLASS 1 OF MIL-W-21157. WELD SHALL BE THE MANUAL SHIELDED ARC PROCESS USING WELDING ELECTRODE TYPE 7018 OF MIL-DTL-22200/1.
6. STRESS RELIEF SHALL BE AT 1175±25 °F FOR A MINIMUM OF 3 HOURS; THEN THE FURNACE SHALL BE COOLED.
7. WELDING SYMBOLS SHALL BE AS SPECIFIED IN AWS A2.4.
8. WELDING TERMS AND DEFINITIONS SHALL BE IN ACCORDANCE WITH AWS A3.0.
9. WELDED-JOINT DESIGNS SHALL BE AS SPECIFIED IN MIL-STD-22.
10. DIMENSIONS AND TOLERANCES SHALL BE AS SPECIFIED IN ASME Y14.5.
11. THIS FIXTURE IS ATTACHED TO THE ANVIL PLATE OF THE MWSM BY MEANS OF SUPPORTS AND CLAMPS SHOWN ON SHEETS 4 AND 5.
12. FOR ADDITIONAL DETAILS, SEE BUSHIPS DRAWING N0807-655947.

FIGURE 18. 30-degree mounting fixture for testing back mounted equipment on the MWSM. (Sheet 3 of 5)

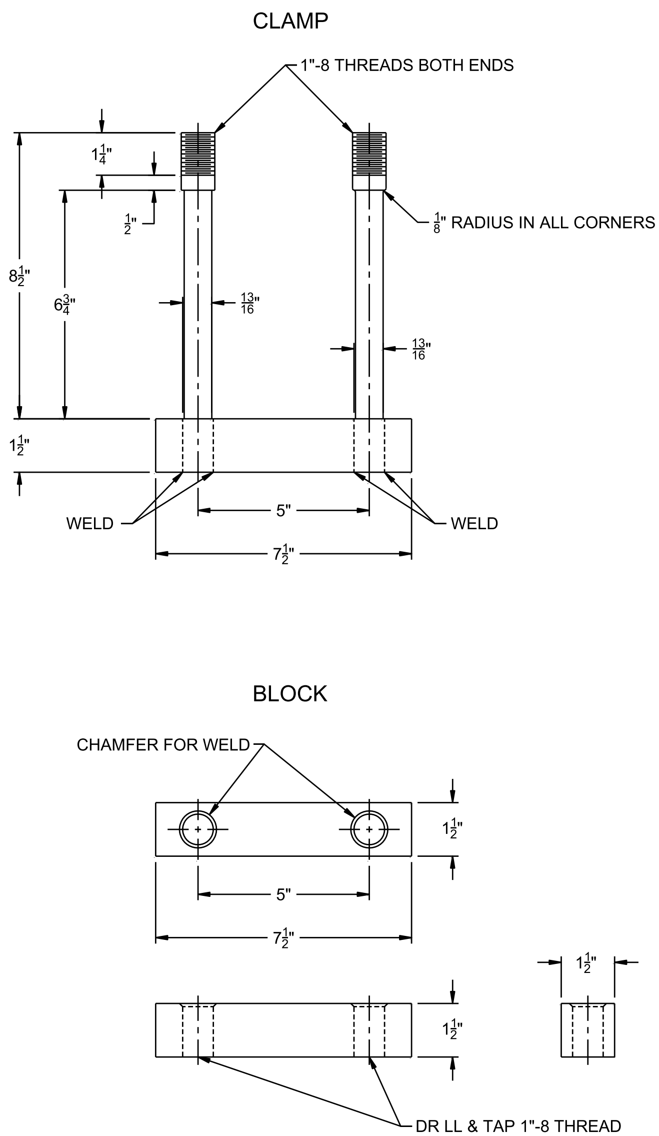


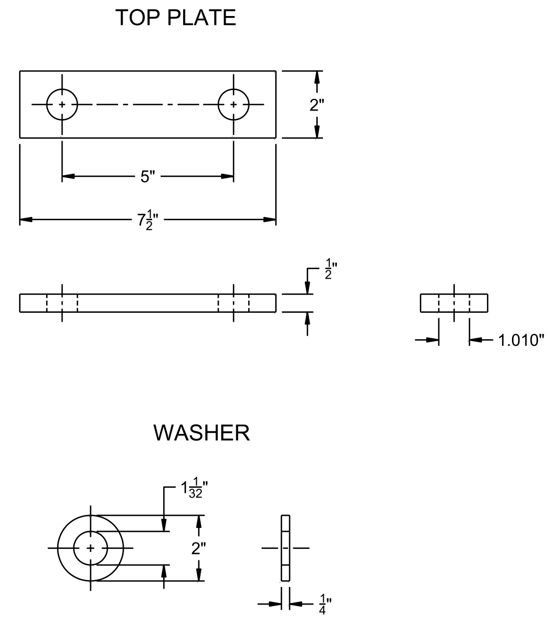


NOTES:

1. MATERIAL: STEEL.
2. ALL HOLES $1\frac{1}{16}$ INCH DIAMETER.
3. TWO SUPPORTS REQUIRED.
4. WHEN TESTING EQUIPMENT ON THE 30° MOUNTING FIXTURE (SHT. 1), THESE SUPPORTS ARE ATTACHED TO THE MWSM ANVIL PLATE IN PLACE OF THE SHIPBUILDING OR FABRICATED CHANNEL BASES SHOWN ON FIGURES 13 AND 14.
5. ATTACH THE 30° MOUNTING FIXTURE (SHT. 1) TO THESE SUPPORTS BY MEANS OF CLAMPS SHOWN ON SHEET 5.
6. WEIGHT OF SUPPORTS 225 LBS. PAIR.

FIGURE 18. 30-degree mounting fixture for testing back mounted equipment on the MWSM. (Sheet 4 of 5)





NOTES:
1. MATERIAL: 4340 STEEL.
2. NUMBEROF CLAMPS, WASHERS, STUDS, BLOCKS, TOP PLATES, AND NUTS REQUIRED ARE AS FOLLOWS:
   - 4 - CLAMPS
   - 8 - WASHERS
   - 8 - STUDS
   - 4 - BLOCKS
   - 4 - TOP PLATES
   - 8 - 1 INCH-8NC ESNA NUTS
3. WEIGHT PER ASSEMBLED CLAMP IS 10 LBS.
4. CLAMPS ARE USED FOR 30° MOUNTING FIXTURE (SHT. 1) AND SUPPORTS (SHT. 4).
5. TOLERANCES SHALL BE +0.010 INCH.

FIGURE 18. 30-degree mounting fixture for testing back mounted equipment on the MWSM. (Sheet 5 of 5)

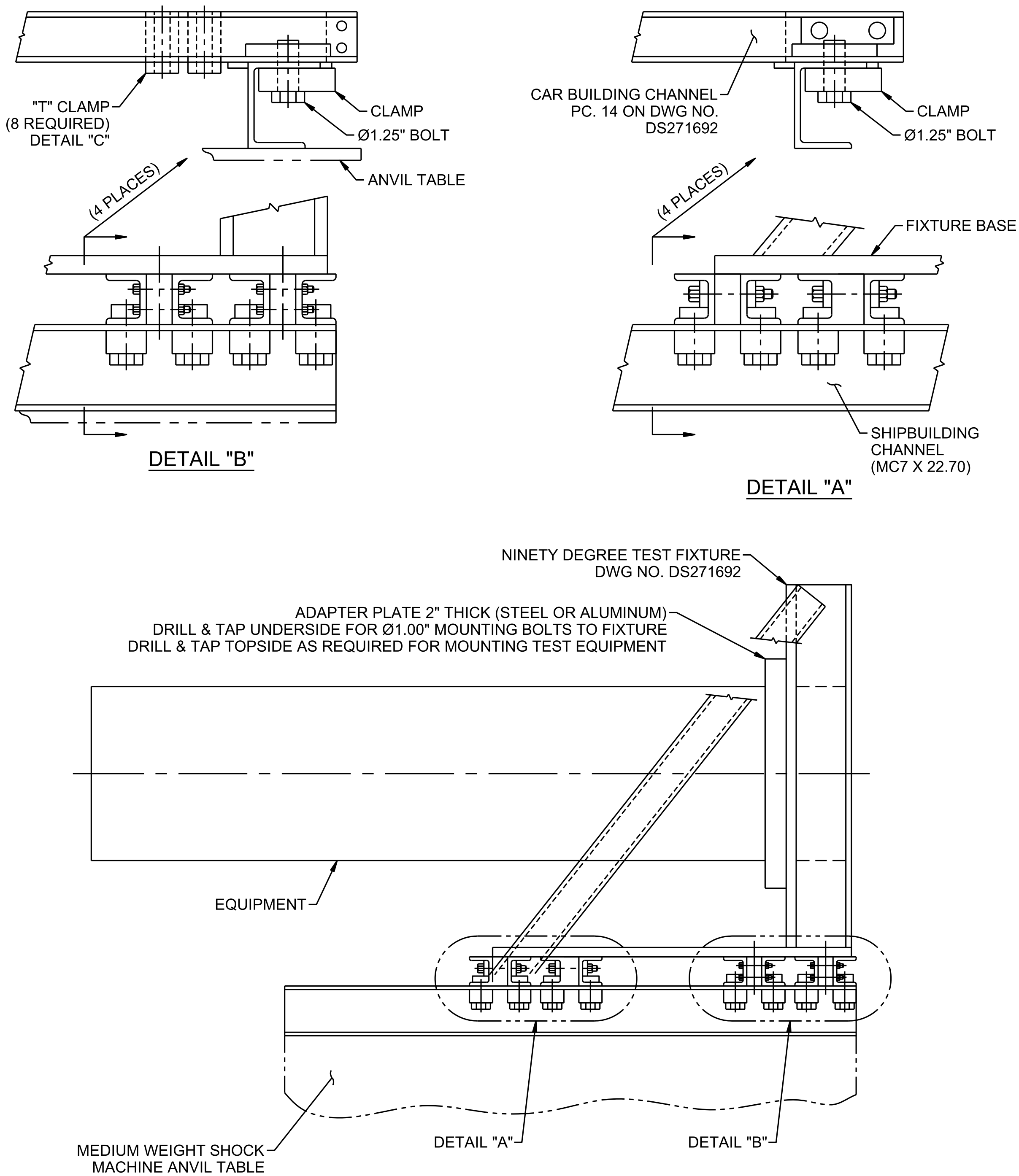


FIGURE 18a. 90-degree test fixture assembly. (Sheet 1 of 2)

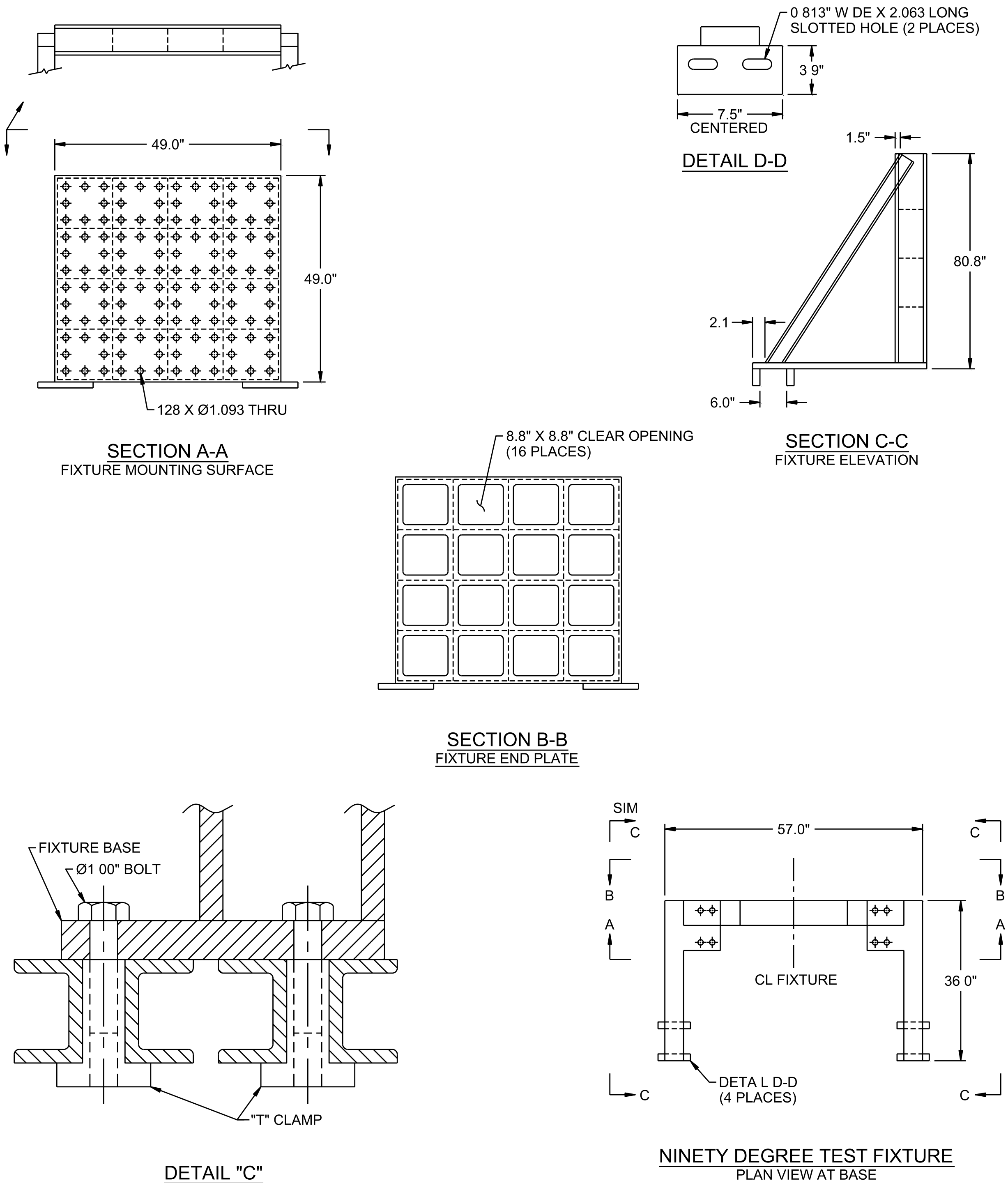


FIGURE 18a. 90-degree test fixture assembly. (Sheet 2 of 2)

SHOCK QUALIFICATION ACCEPTANCE FORM

1. The item identified below has met the requirements of MIL-DTL-901E, based upon:

   [ ] Shock testing
   [ ] Previous shock testing of a similar item (shock test extension)
   [ ] Previous shock testing of an identical item (shock test extension)

2. Item (Description): ____________________________________ 3. Part No.: _____________________

4. Manufacturer: _______________________________________ 5. Ship: _________________________

6. Model: _________________________________ 7. Contract No.: _________________

8. Size/Capacity: ______________________________

9. Drawing Number: ________________________ Revision and Date: _________________________

10. Military Specification: ____________________ Revision and Date: _________________________

11. Service: _________________________________

12. Shock Test Facility: ____

13. Shock Test Report No. & Date: ____

14. Previous shock test approval reference (if this form conveys shock test extension approval): _______
____

15. Test Category [ ] Lightweight [ ] Medium weight [ ] Heavyweight
[ ] Medium Weight Deck Simulating [ ] Alt. Vehicle

16. Shock Grade [ ] A [ ] B

17. Equipment Type [ ] Principal Unit [ ] Subsidiary Component [ ] Subassembly

18. Equipment Class [ ] I [ ] II [ ] I/II [ ] III

19. Shock Test Type [ ] A [ ] B [ ] C

20. Mounting Location [ ] Deck[1] [ ] Conventional Deck[2] [ ] Mitigated Deck[2]
[ ] Hull [ ] Shell [ ] Frame
[ ] Wetted-Surface [ ] End Closure/Closure Bulkhead[2] [ ] Mast[1]

[1] Surface ship only
[2] Submarine only

21. Shipboard mounting plane represented during shock test:
[ ] Base [ ] Back [ ] Combination
[ ] Front or face [ ] Top [ ] Other_____________

22. Mounting orientation of item (place limitations in Block 23): ______________________________
(e.g., Unrestricted, Vertical Axis Specified, Restricted)

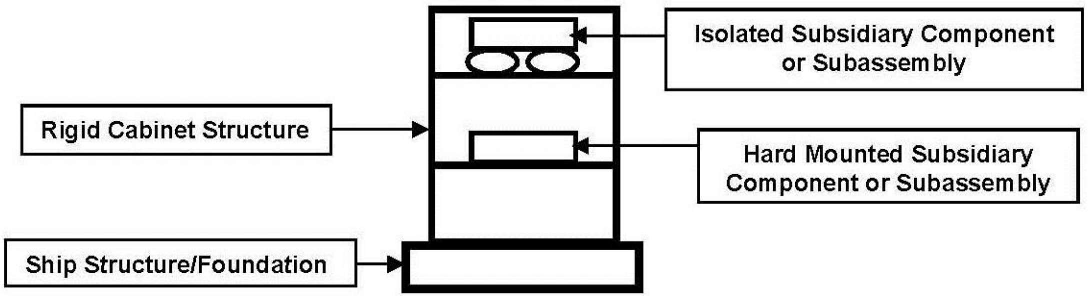
23. Remarks/Approval Limitations: ____
____
____

24. Approvals:

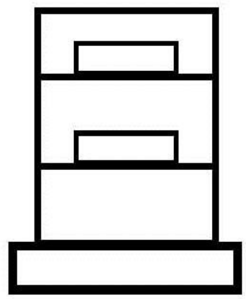
____________________________________ ______________________ ____________________
Technical Authority(ies) Activity Date

FIGURE 19. Shock qualification acceptance form.

The following are examples of the various classes of equipment mentioned in this document. The six cases shown on this figure are NOT intended to be exhaustive.

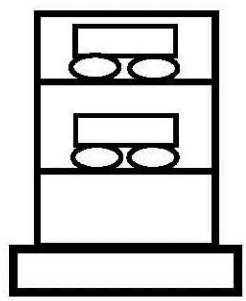


Case 1 is an example of **Class I** equipment. The rigid cabinet structure is hard mounted to the ship structure. All subsidiary components or subassemblies are hard mounted to the cabinet.



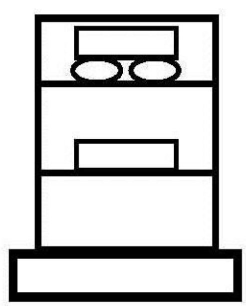
CASE 1

Case 2 is an example of **Class I/II** equipment. The rigid cabinet structure is hard mounted to the ship structure. All subsidiary components or subassemblies are mounted to the cabinet using isolation devices.



CASE 2

Case 3 is an example of **Class I/II** equipment. The rigid cabinet structure is hard mounted to the ship structure. Some subsidiary components or subassemblies are mounted to the cabinet using isolation devices, while other subsidiary components or subassemblies are hard mounted to the cabinet.



CASE 3

FIGURE 20. Examples of equipment classes. (Sheet 1 of 2)

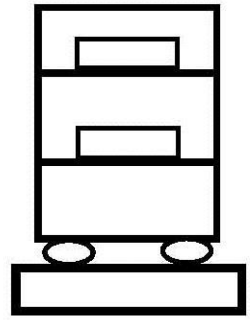
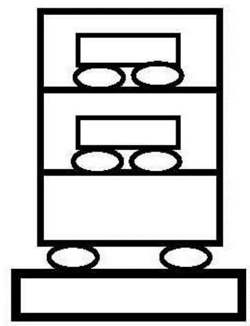
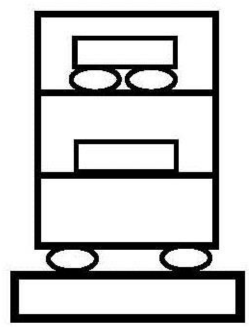
Case 4 is an example of **Class II** equipment. The rigid cabinet structure is mounted to the ship structure using isolation devices. The subsidiary components or subassemblies are hard mounted to the cabinet.	 CASE 4
Case 5 is an example of **Class II** equipment. The rigid cabinet structure is mounted to the ship structure using isolation devices. The subsidiary components or subassemblies are mounted to the cabinet using isolation devices.	 CASE 5
Case 6 is an example of **Class II** equipment. The rigid cabinet structure is mounted to the ship structure using isolation devices. Some subsidiary components or subassemblies are mounted to the cabinet using isolation devices, while other subsidiary components or subassemblies are hard mounted to the cabinet.	 CASE 6

FIGURE 20. Examples of equipment classes. (Sheet 2 of 2)

EXAMPLE	TESTING / MOUNTING DESCRIPTION (Note 1)
1. Class I equipment that falls within the lightweight, medium weight, or heavyweight shock test categories.	The equipment is tested, depending on weight and size limitations, on the lightweight or the medium weight shock machine, or on a floating shock platform, to the requirements for Class I equipment. • A single test on one of the testing platforms (lightweight shock machine, medium weight shock machine, or floating shock platform) is performed to qualify the equipment.
2. Equipment that is mounted on a submarine conventional deck or a submarine shock mitigated deck without isolation devices between the equipment and the deck. The equipment falls within the lightweight, medium weight, or heavyweight shock test categories. The principal unit does not contain isolation devices for subsidiary components or subassemblies.	In accordance with 1.2.4, the equipment is defined as Class I. The equipment is tested, depending on weight and size limitations, on the lightweight or the medium weight shock machine, or on a floating shock platform, to the requirements for Class I equipment. • A single test on one of the testing platforms (lightweight shock machine, medium weight shock machine, or floating shock platform) is performed to qualify the equipment. Note that if the deck mounted equipment contains isolation devices for subsidiary components or subassemblies, the equipment is classified (see 1.2.4) as Class I/II equipment (see examples 21 and 22).
3. Class II equipment that falls within the lightweight, medium weight, medium weight deck simulating, or heavyweight shock test categories. The principal unit does not contain isolation devices for subsidiary components or subassemblies.	The equipment is tested (depending on weight and size limitations, shipboard mounting location, and displacement limits on the isolation devices) on the lightweight or the medium weight shock machine, on a DSSM, or on a floating shock platform, to the requirements for Class II equipment (see 3.1.6.1.b, 3.1.6.4.a, and 3.1.6.4.c). • A single test on one of the testing platforms (lightweight shock machine, medium weight shock machine, DSSM, or floating shock platform) is performed to qualify the equipment.
4. Hull or frame mounted Class II equipment that falls within the lightweight shock test category. The principal unit contains isolation devices for subsidiary components or subassemblies. The isolation devices (including those between the principal unit and ship structure or foundation) have a deflection capability of less than 1.5 inches.	In accordance with 3.1.2.a, the equipment is tested on the lightweight shock machine to the requirements for Class II equipment (see 3.1.6.1.b). • A single test on the lightweight shock machine is performed to qualify the equipment. **WHY:** Table travel on the LWSM is sufficient to bottom isolation devices with less than 1.5 inches of travel; all parts of the equipment will receive a high-impact shock input.

FIGURE 21. Examples of testing requirements for classes of equipment. (Sheet 1 of 6)

EXAMPLE	TESTING / MOUNTING DESCRIPTION (Note 1)
5. Hull or frame mounted Class II equipment that falls within the lightweight shock test category. The principal unit contains isolation devices for subsidiary components or subassemblies. The isolation devices (including those between the principal unit and ship structure or foundation) have a deflection capability of greater than or equal to 1.5 inches, but less than 3 inches.	In accordance with 3.1.2.a and 3.1.2.b, the equipment is tested on the medium weight shock machine to the requirements for Class II equipment (see 3.1.6.1.b). • A single test on the medium weight shock machine is performed to qualify the equipment. **WHY:** Although the unit falls within LWSM weight limits, table travel on the LWSM is insufficient to bottom out isolation devices with more than 1.5 inches of travel, which may be bottomed out in the shipboard shock environment. Table travel on the MWSM is sufficient to bottom out isolation devices with less than 3 inches of travel; all parts of the equipment will receive a high-impact shock input.
6. Hull or frame mounted Class II equipment that falls within the medium weight shock test category. The principal unit contains isolation devices for subsidiary components or subassemblies. The isolation devices (including those between the principal unit and ship structure or foundation) have a deflection capability of less than 3 inches.	In accordance with 3.1.2.b, the equipment is tested on the medium weight shock machine to the requirements for Class II equipment (see 3.1.6.1.b). • A single test on the medium weight shock machine is performed to qualify the equipment. If the deflection capability of the isolation devices is greater than 3 inches, then the equipment is subject to heavyweight shock testing and is tested on a floating shock platform (see example 7). **WHY:** Table travel on the MWSM is sufficient to bottom out isolation devices with less than 3 inches of travel; all parts of the equipment will receive a high-impact shock input.
7. Hull or frame mounted Class II equipment that falls within the heavyweight shock test category.	In accordance with 3.1.6.4, the equipment is mounted in its shipboard configuration to the inner bottom of the floating shock platform.
8. Deck mounted Class II equipment that falls within the lightweight or medium weight shock test categories. The principal unit contains isolation devices for subsidiary components or subassemblies. The isolation devices (including those between the principal unit and ship structure or foundation) are LDCIDs.	In accordance with 3.1.2.a, 3.1.2.b, 3.1.2.d, 3.1.6.4.a, and 3.1.6.4.c, the equipment is tested on the lightweight or the medium weight shock machine to the requirements for Class I equipment (see 3.1.6.1.b). • A single test on the lightweight or the medium weight shock machine is performed to qualify the equipment. **WHY:** In the case of deck mounted equipment with only LDCIDs, the isolation devices are designed to snub, thus increasing the effective response frequency of the mounting system. 3.1.6.4.c notes that the shock machines produce a hull mounted, rather than deck mounted, shock input. For hard mounted equipment, the hull mounted shock environment is more severe. If LDCIDs with sufficiently high effective mounting frequency at qualification shock input amplitudes are used, the shock energy to the equipment at the item's SRF is not substantially different than if the equipment were hard mounted. Therefore, testing on the shock machines is acceptable.

FIGURE 21. Examples of testing requirements for classes of equipment. (Sheet 2 of 6)

EXAMPLE	TESTING / MOUNTING DESCRIPTION (Note 1)
9. Class III equipment that falls within the lightweight, medium weight, medium weight deck simulating, or heavyweight shock test categories. The principal unit does not contain isolation devices for subsidiary components or subassemblies.	Class III equipment is tested (depending on weight and size limitations, shipboard mounting location, and displacement limits on the isolation deices) on the lightweight or the medium weight shock machines, on the DSSM, or on a floating shock platform, to the requirements for both Class I and Class II equipment in accordance with 3.1.6.1.d and 3.1.6.4.c. • Two tests (non-isolated and isolated mounting configurations) are performed to qualify the equipment.
10. Hull or frame mounted Class III equipment that falls within the lightweight shock test category. The principal unit contains isolation devices for subsidiary components or subassemblies. The isolation devices (including those between the principal unit and ship structure or foundation) have a deflection capability of less than 1.5 inches.	Class III equipment is required to meet the requirements for both Class I and Class II equipment. 3.1.6.1.d requires testing in both the non-isolated and isolated shipboard mounting configurations. In accordance with 3.1.2.a, the equipment is tested on the lightweight shock machine. • Two tests (non-isolated and isolated mounting configurations) on the lightweight shock machine are performed to qualify the equipment. **WHY:** Two tests are performed to ensure that the equipment is qualified in both mounting configurations. In the isolated mounting configuration, the internal components may be sensitive to low-frequency deck inputs that may cause large responses due to resonance of the isolation devices.
11. Hull or frame mounted Class III equipment that falls within the lightweight shock test category. The principal unit contains isolation devices for subsidiary components or subassemblies. The isolation devices (including those between the principal unit and ship structure or foundation) have a deflection capability of greater than or equal to 1.5 inches, but less than 3 inches.	Class III equipment is required to meet the requirements for both Class I and Class II equipment. 3.1.6.1.d requires testing in both the non-isolated and isolated shipboard mounting configurations. In accordance with 3.1.2.a and 3.1.2.b, the equipment is tested on the medium weight shock machine. • Two tests (non-isolated and isolated mounting configurations) on the medium weight shock machine are performed to qualify the equipment. **WHY:** Two tests are performed to ensure that the equipment is qualified in both mounting configurations. In the isolated mounting configuration, the internal components may be sensitive to low-frequency deck inputs that may cause large responses due to the resonance of the isolation devices.

FIGURE 21. Examples of testing requirements for classes of equipment. (Sheet 3 of 6)

<table>
<tr><th>EXAMPLE</th><th>TESTING / MOUNTING DESCRIPTION (Note 1)</th></tr>
<tr><td>12. Hull or frame mounted Class III equipment that falls within the medium weight shock test category. The principal unit contains isolation devices for subsidiary components or subassemblies. The isolation devices (including those between the principal unit and ship structure or foundation) have a deflection capability of less than 3 inches.</td><td>Class III equipment is required to meet the requirements for both Class I and Class II equipment. 3.1.6.1.d requires testing in both the non-isolated and isolated shipboard mounting configurations. In accordance with 3.1.2.b, the equipment is tested on the medium weight shock machine.
• Two tests (non-isolated and isolated mounting configurations) on the medium weight shock machine are performed to qualify the equipment.
WHY: Two tests are performed to ensure that the equipment is qualified in both mounting configurations. In the isolated mounting configuration, the internal components may be sensitive to low-frequency deck inputs that may cause large responses due to the resonance of the isolation devices.</td></tr>
<tr><td>13. Hull or frame mounted Class III equipment that falls within the heavyweight shock test category.</td><td>In accordance with 3.1.6.4.f and 3.1.6.4.n, the equipment is mounted in its shipboard configuration to the inner bottom of a floating shock platform.
• Two tests (non-isolated and isolated mounting configurations) are performed to qualify the equipment.</td></tr>
<tr><td>14. Deck mounted Class III equipment that falls within the lightweight or medium weight shock test categories. The principal unit contains isolation devices for subsidiary components or subassemblies. The isolation devices (including those between the principal unit and ship structure or foundation) are LDCIDs.</td><td>Class III equipment is required to meet the requirements for both Class I and Class II equipment. Since the equipment contains only LDCIDs, 3.1.6.1.d allows testing in the non-isolated mounting configuration to Class I equipment requirements. In accordance with 3.1.2.a, 3.1.2.b, and 3.1.6.4.c, the equipment is tested on the lightweight or the medium weight shock machine.
• A single test (non-isolated mounting configuration) on the lightweight or the medium weight shock machine is performed to qualify the equipment.
WHY: For deck mounted equipment with LDCIDs that have a sufficiently high effective mounting frequency at qualification shock input amplitudes, the isolation devices are designed to reduce mount motions through portions of the response cycle, thus increasing the effective response frequency of the mounting system. The shock energy input to the system at the effective mounting frequency under these conditions is similar to the shock energy delivered to the equipment if it were hard mounted. Therefore, testing on the shock machines is acceptable.</td></tr>
</table>

FIGURE 21. Examples of testing requirements for classes of equipment. (Sheet 4 of 6)

EXAMPLE	TESTING / MOUNTING DESCRIPTION (Note 1)
15. Hull or frame mounted Class I/II equipment that falls within the lightweight shock test category. The isolation devices have a deflection capability of less than 1.5 inches.	3.1.6.1.c requires testing of Class I/II equipment in its shipboard mounting configuration. In accordance with 3.1.2.a, the equipment is tested on the lightweight shock machine. • A single test on the lightweight shock machine is performed to qualify the equipment. **WHY:** A single test is sufficient because isolation mounts with less than 1.5 inches of travel will bottom out on the LWSM; all parts of the equipment will receive a high-impact shock input.
16. Hull or frame mounted Class I/II equipment that falls within the lightweight shock test category. The isolation devices have a deflection capability of greater than or equal to 1.5 inches, but less than 3 inches.	3.1.6.1.c requires testing of Class I/II equipment in its shipboard mounting configuration. In accordance with 3.1.2.a and 3.1.2.b, the equipment is tested on the medium weight shock machine. • A single test on the medium weight shock machine is performed to qualify the equipment. **WHY:** Although the unit falls within LWSM weight limits, table travel on the LWSM is insufficient to bottom out isolation devices with more than 1.5 inches of travel, which may be bottomed out in the shipboard shock environment. Table travel on the MWSM is sufficient to bottom out isolation devices with less than 3 inches of travel.
17. Hull or frame mounted Class I/II equipment that falls within the medium weight shock test category. The isolation devices have a deflection capability of less than 3 inches.	3.1.6.1.c requires testing of Class I/II equipment in its shipboard mounting configuration. In accordance with 3.1.2.b, the equipment is tested on the medium weight shock machine. • A single test on the medium weight shock machine is performed to qualify the equipment. **WHY:** A single test is sufficient because isolation devices with less than 3 inches of travel will bottom out on the MWSM; all parts of the equipment will receive a high-impact shock input.
18. Hull or frame mounted Class I/II equipment that falls within the heavyweight shock test category.	In accordance with 3.1.6.4, the equipment is mounted in its shipboard configuration to a floating shock platform.

FIGURE 21. Examples of testing requirements for classes of equipment. (Sheet 5 of 6)

EXAMPLE	TESTING / MOUNTING DESCRIPTION (Note 1)
19. Deck mounted Class I/II equipment that falls within the lightweight or medium weight shock test categories. The isolation devices are LDCIDs.	In accordance with 3.1.2.a, 3.1.2.b, and 3.1.6.4.c, the equipment is tested on the lightweight or medium weight shock machine to Class I equipment requirements (see 3.1.6.1.c). • The equipment is tested in its shipboard mounting configuration on the lightweight or medium weight shock machine. **WHY:** For deck mounted equipment with only LDCIDs that have a sufficiently high effective mounting frequency at qualification shock input amplitudes, the isolation devices are designed to reduce mount motions through portions of the response cycle, thus increasing the effective response frequency of the mounting system. The shock energy input to the system at the effective mounting frequency under these conditions is similar to the shock energy delivered to the equipment if it were hard mounted. Therefore, testing on the shock machines is acceptable.
20. Submarine deck mounted (conventional or mitigated) Class I/II equipment that falls within the heavyweight shock test category. The isolation devices are not LDCIDs.	In accordance with 3.1.2.c, the equipment is tested on a floating shock platform. 3.1.6.1.c requires testing of Class I/II equipment in its shipboard mounting configuration. • If the submarine response frequency is known for the equipment, then a single test is performed with a deck fixture designed to have a similar fundamental response frequency in accordance with 3.1.6.4.c. • If the submarine response frequency is not known, then two tests are required in accordance with 3.1.6.4.c; one test with a 25-Hz deck fixture, and one test with a deck fixture frequency near the equipment SRF, as identified in 3.1.6.5.1.2. **WHY:** In the case of deck mounted equipment, the isolation devices are designed to mitigate the shock input through large-displacement, lower frequency responses. Therefore, if the submarine response frequency is not known, the test providing shock qualification of the Class II portion of the Class I/II equipment is conducted at the most limiting frequency, which is the equipment SRF. The portions of the equipment that are hard mounted may be more sensitive to a higher frequency input. Therefore, if the shipboard response frequency is not known, two tests are required.

Note 1: The examples in this figure are provided for convenience of the reader in interpreting the requirements of 3.1.2 and 3.1.6 and their subparagraphs. In case of any discrepancies between the contents of this figure and the text portions of 3.1.2 and 3.1.6 and their subparagraphs, the requirements of the text portions take precedence.

FIGURE 21. Examples of testing requirements for classes of equipment. (Sheet 6 of 6)

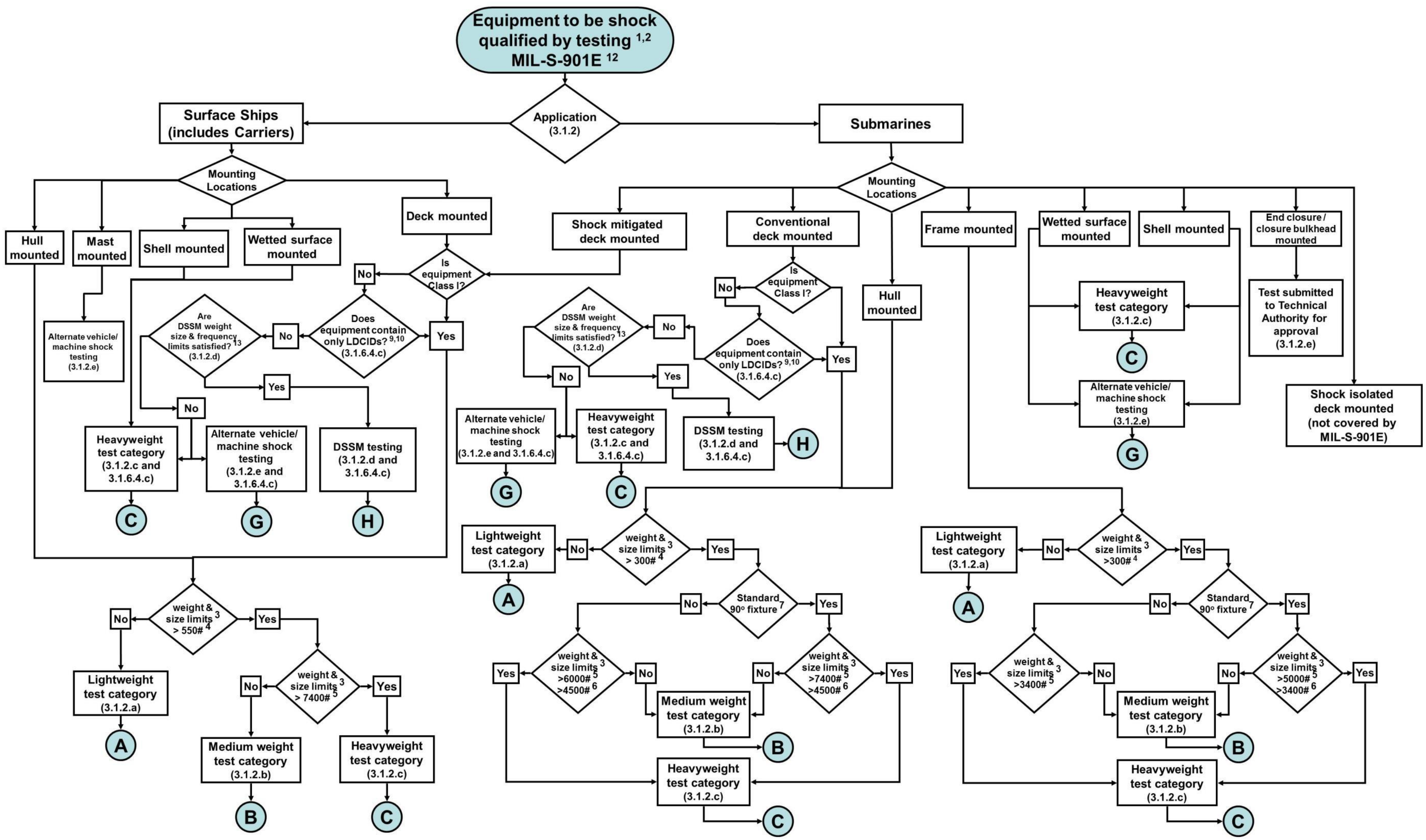


FIGURE 22. Flowcharts of testing requirements for qualification of equipment by shock testing. (Sheet 1 of 10)

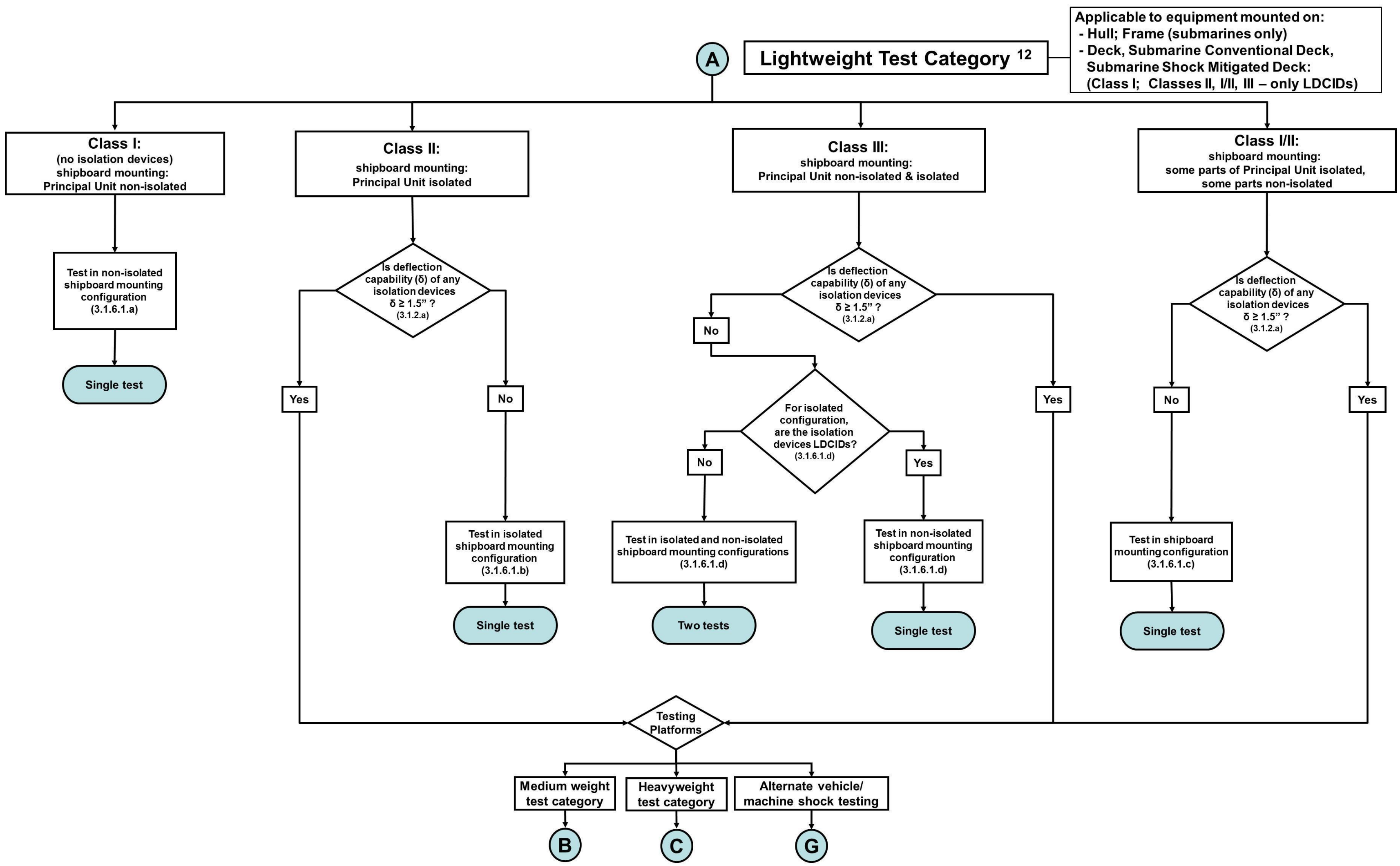


FIGURE 22. Flowcharts of testing requirements for qualification of equipment by shock testing. (Sheet 2 of 10)

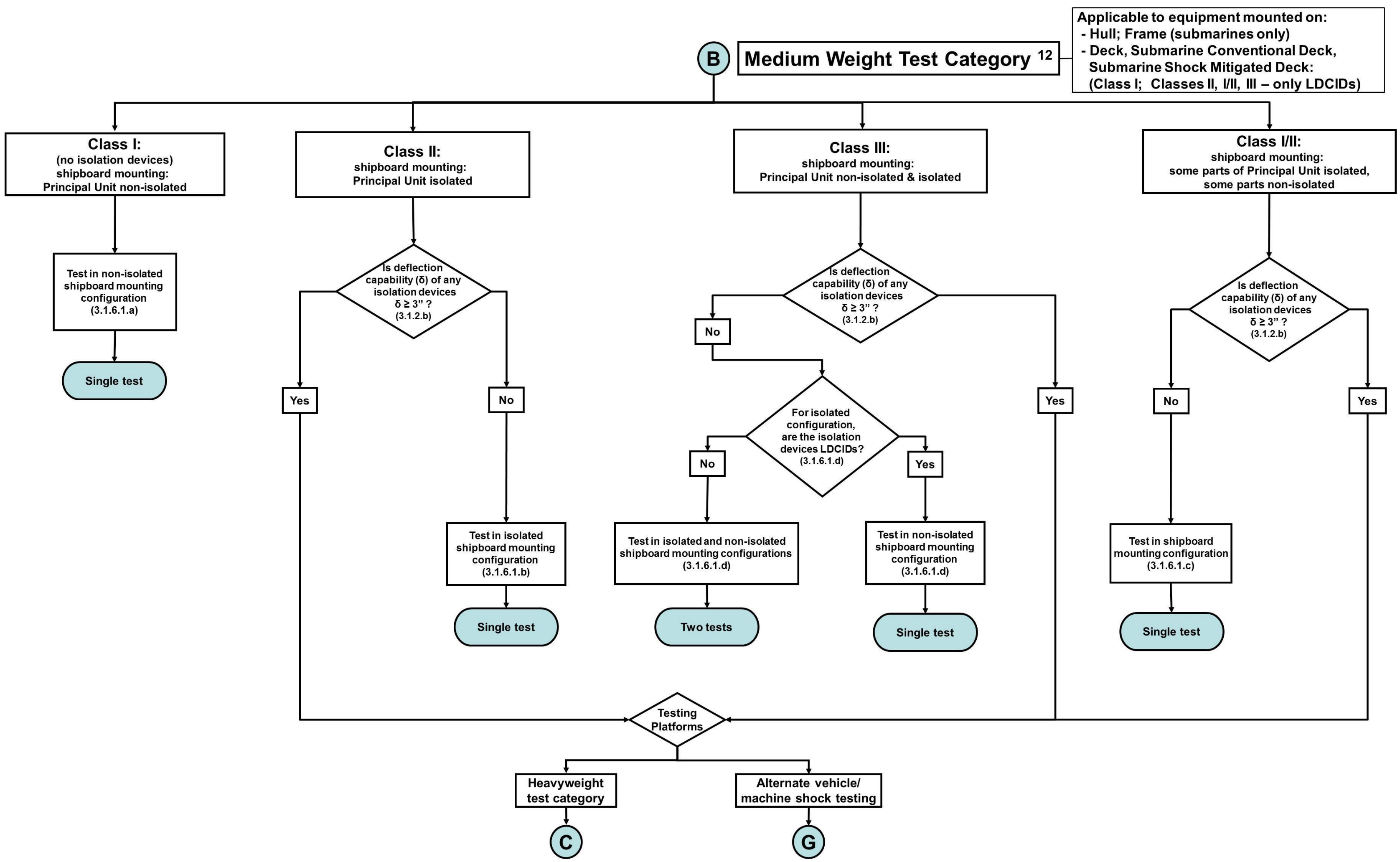


FIGURE 22. Flowcharts of testing requirements for qualification of equipment by shock testing. (Sheet 3 of 10)

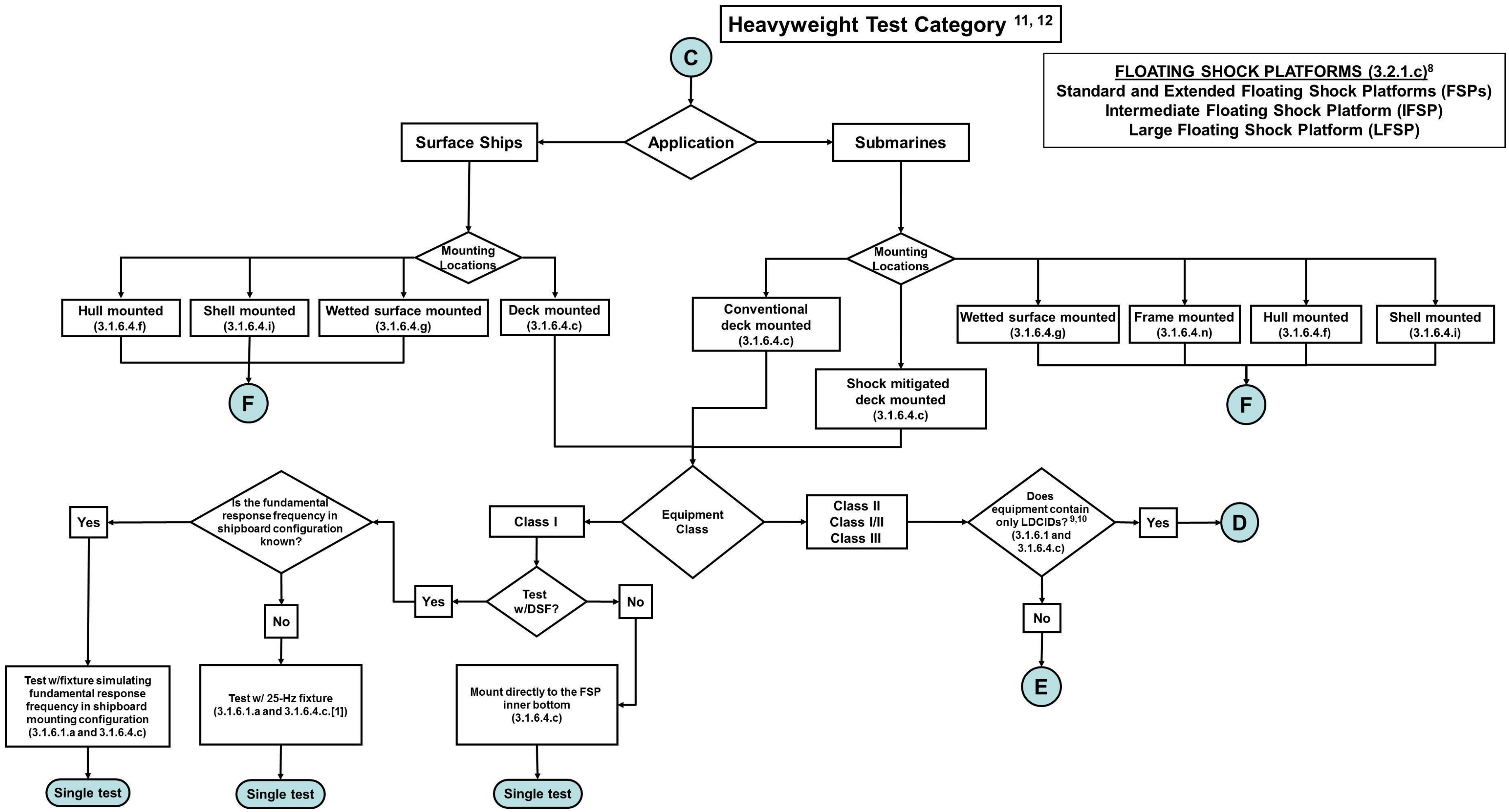


FIGURE 22. Flowcharts of testing requirements for qualification of equipment by shock testing. (Sheet 4 of 10)

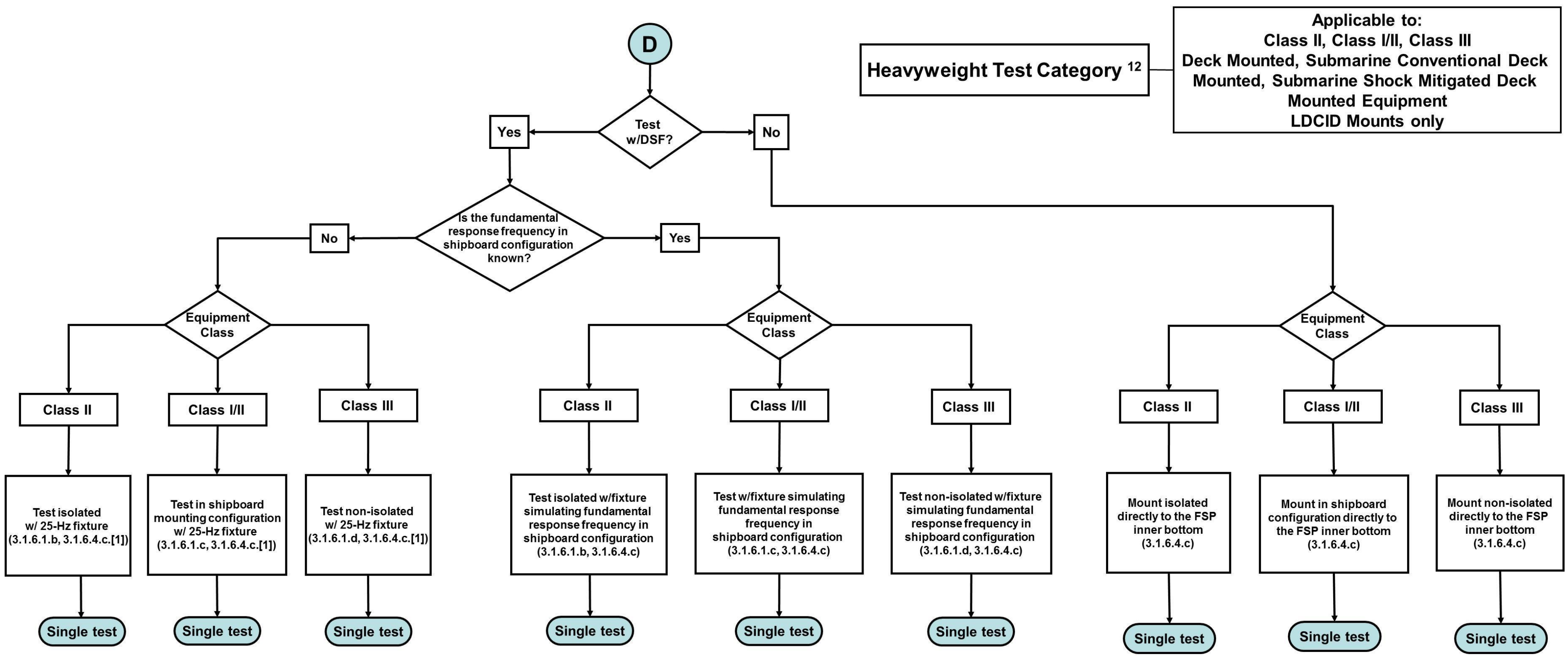


FIGURE 22. Flowcharts of testing requirements for qualification of equipment by shock testing. (Sheet 5 of 10)

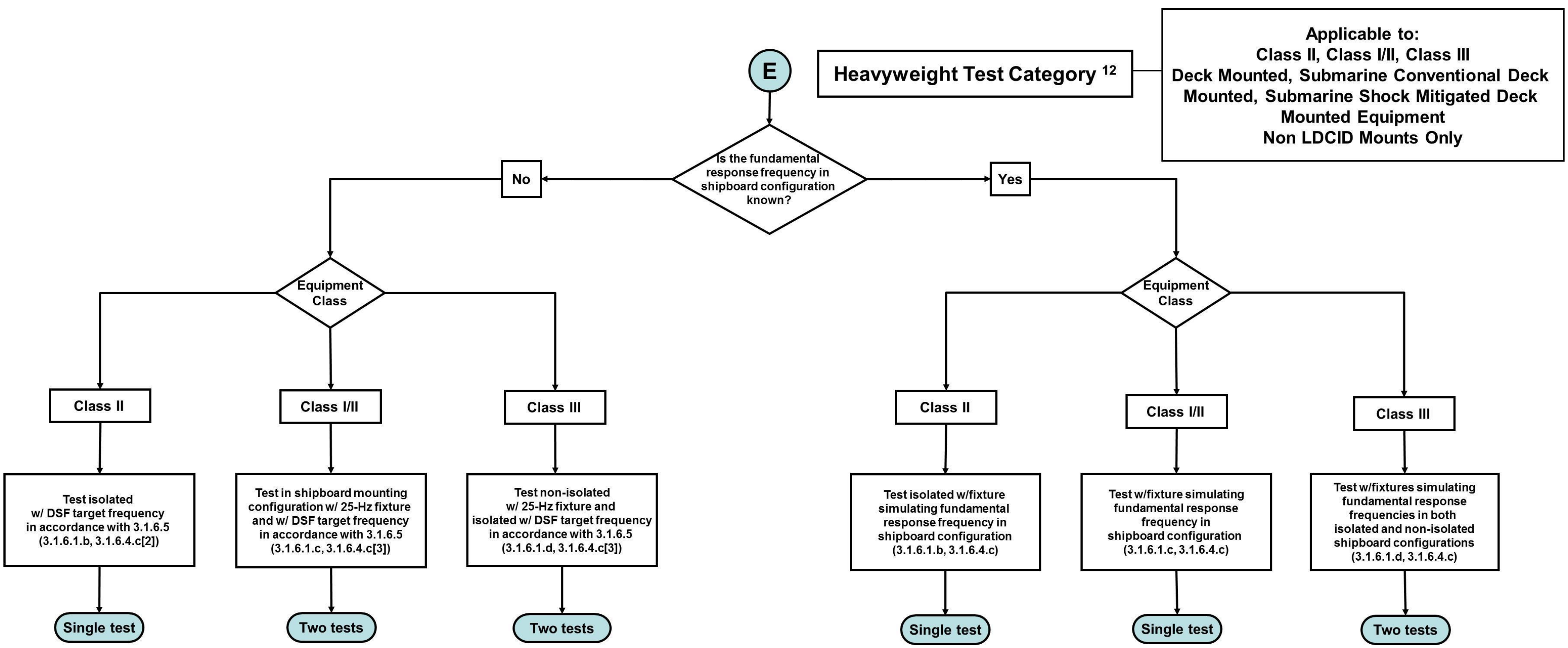


FIGURE 22. Flowcharts of testing requirements for qualification of equipment by shock testing. (Sheet 6 of 10)

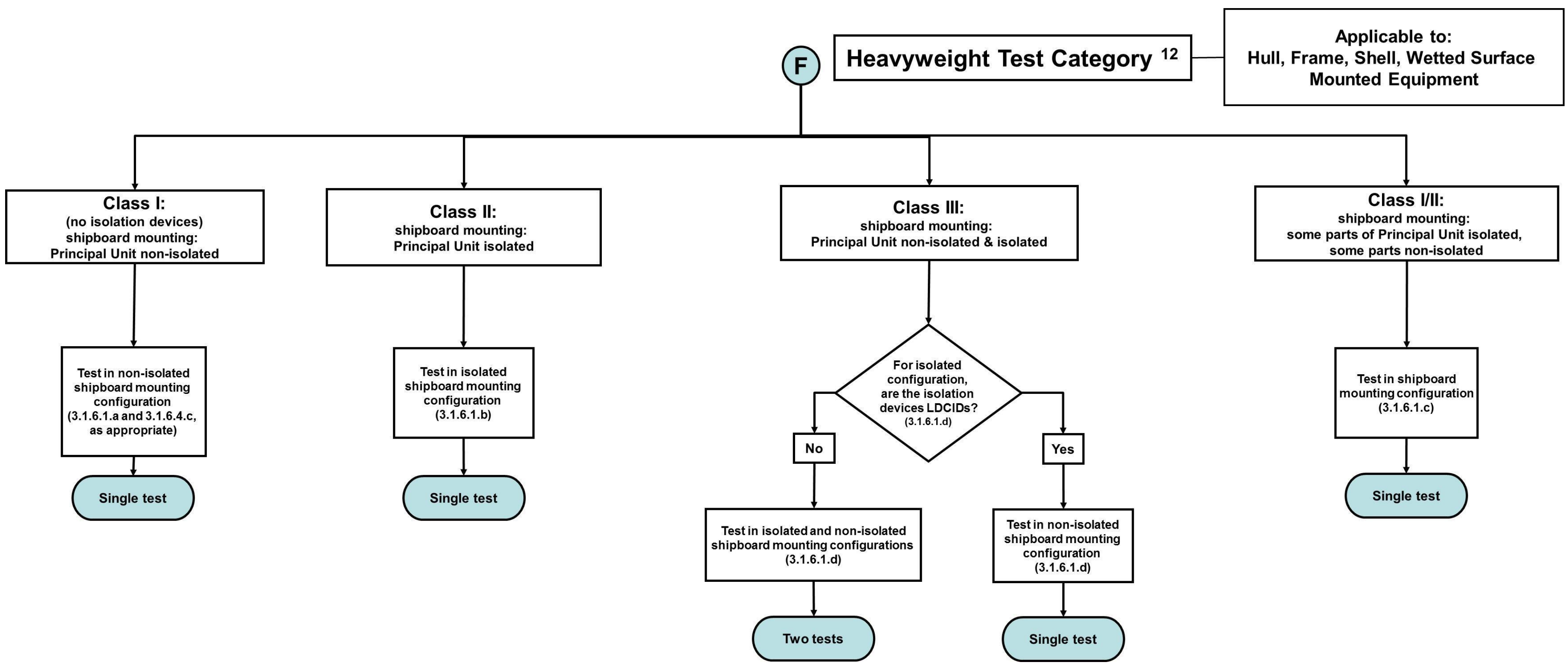


FIGURE 22. Flowcharts of testing requirements for qualification of equipment by shock testing. (Sheet 7 of 10)

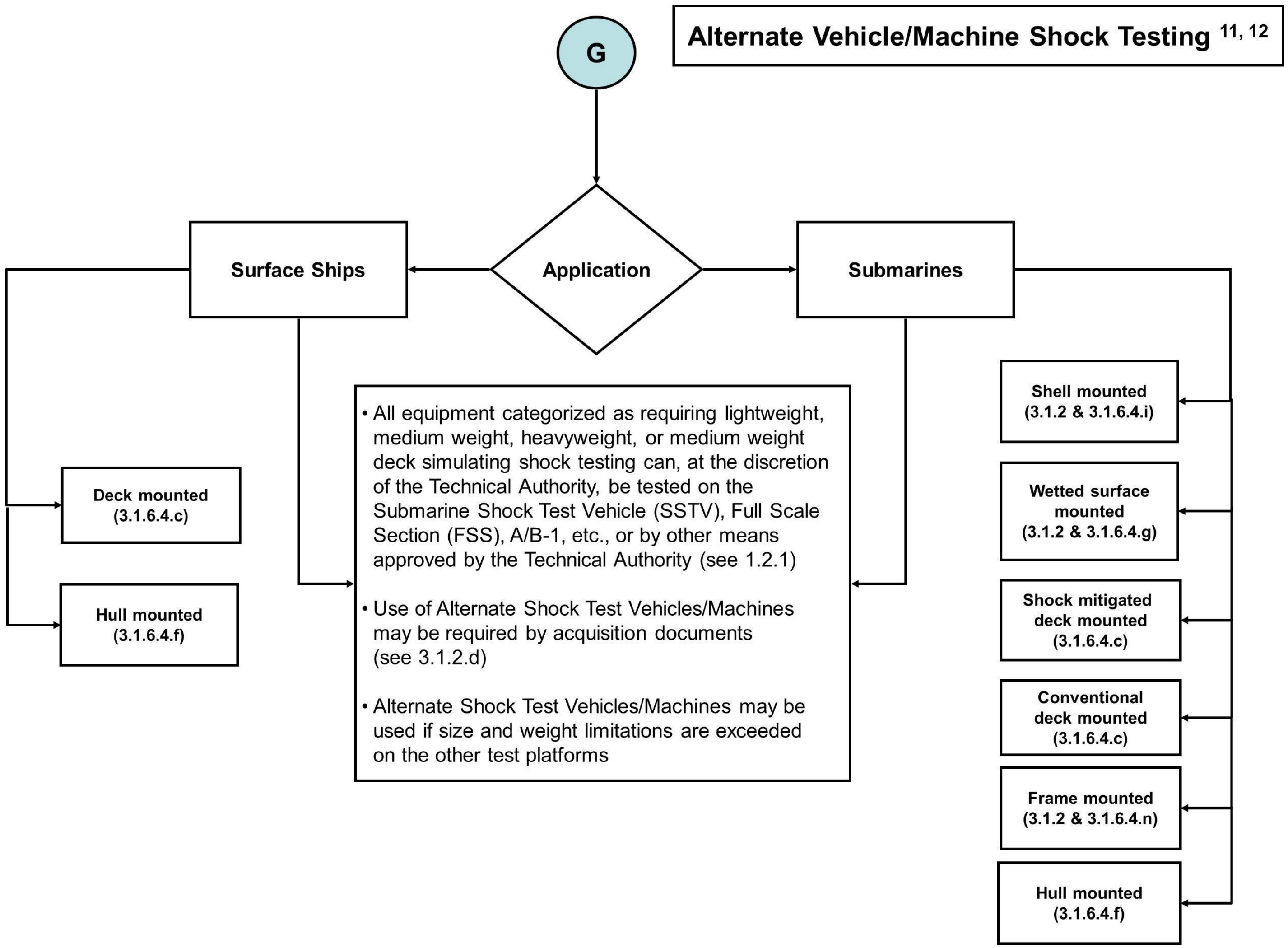


FIGURE 22. Flowcharts of testing requirements for qualification of equipment by shock testing. (Sheet 8 of 10)

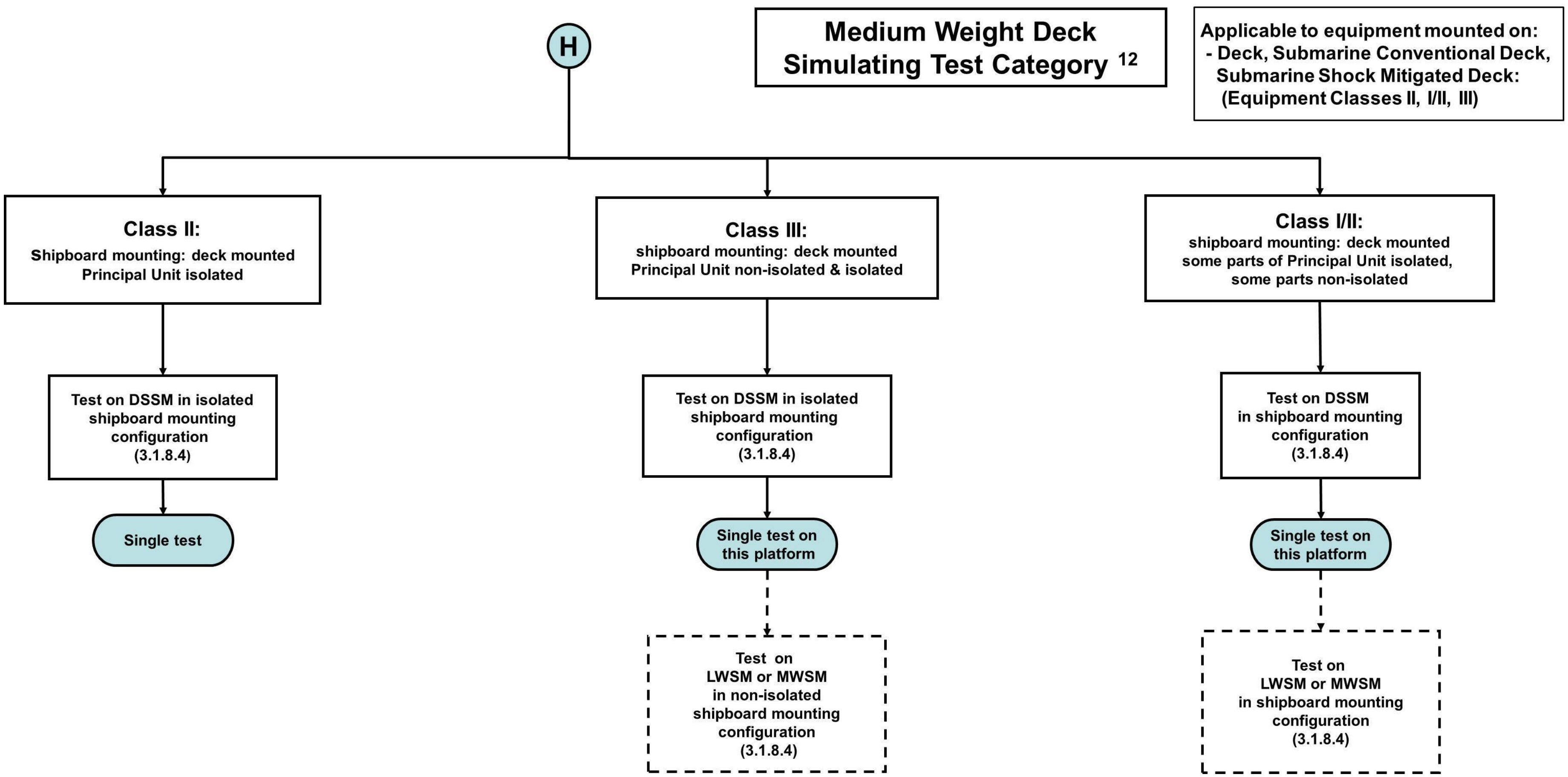


FIGURE 22. Flowcharts of testing requirements for qualification of equipment by shock testing. (Sheet 9 of 10)

NOTES

1. Acquisition documents may specify the shock test category, or may impose limitations upon the selection of the test category.
2. All equipment can be tested, at the discretion of the Technical Authority, on Alternate Test Vehicles, or by other means approved by the Technical Authority.
3. Practical size limitations shall not be exceeded.
4. Total weight supported by LWSM anvil plate.
5. Total weight supported by MWSM anvil table.
6. Item weight supported by MWSM anvil table.
7. Or approved non-standard 90 degree fixture.
8. For each FSP, 3.1.2.c identifies the maximum payload weight limit for all tested items (includes weight of item, fixture, ancillary equipment and fluids).
9. Choice of platform for testing deck mounted equipment is based on the frequency response characteristics of the isolation devices being employed (see 3.1.6.4.c).
10. Shock machine testing of deck mounted, submarine conventional deck mounted, or submarine shock mitigated deck mounted Class II, Class I/II, or Class III equipment, is acceptable only in cases where all the isolation devices have limited displacement capability (see 3.1.6.4.c).
11. Consideration shall be given to the orientation of the equipment aboard ship (see 3.1.6.1).
12. This figure is provided for convenience in interpreting the requirements of 3.1.2 and 3.1.6 and their subparagraphs. In case of any discrepancies between the contents of this figure and the text portion of 3.1.2 and 3.1.6 and their subparagraphs, the requirements of the text portion take precedence.
13. Payload weight limit (1500#) for testing with the DSSM. Size limitation: equipment needs to fit within 52″ X 52″ X 104″ cage structure interior. Deck and SRF frequency requirements apply. See 3.1.2.d and 3.1.8.4.

FIGURE 22. Flowcharts of testing requirements for qualification of equipment by shock testing. (Sheet 10 of 10)

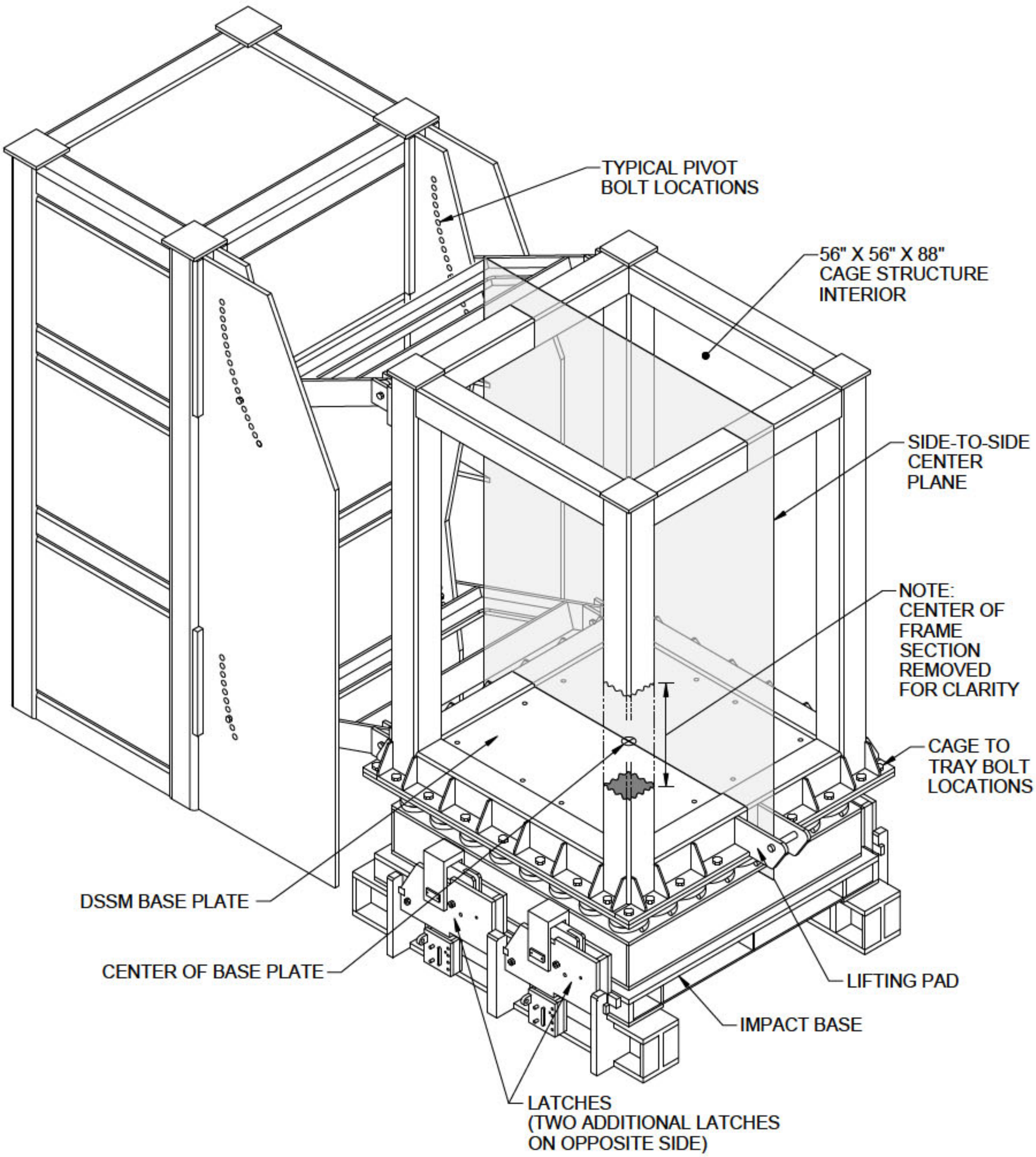


FIGURE 23. Deck simulating shock machine (DSSM).

DSSM TRAY Part Number: NNS Dwg DSSM 2010-103
DSSM SPRING Part Number: Item 2 on DSSM 2010-103
MAX SPRINGS AVAILABLE: 32

FIGURE 24: DSSM TRAY CONFIGURATION 1							
Number of Springs for Tray Configuration 1							
		Class II isolated payload weight (lbs; see 6.6.14.b)					
		0	500	1,000	1,500	2,000	2,400
Fixture weight + additional weight (lbs; see 6.6.14.c and 6.6.14.d)	0	8	8	8	6 [1/]	6 [1/]	6 [1/]
	500	8	8	8	8 [1/]	7 [1/]	7 [1/]
	1,000	10	10	10	8	8 [1/]	7 [1/]
	1,500	10	10	10	10	8 [1/]	8 [1/]
	2,000	10	10	10	10	10 [1/]	8 [1/]
	2,500	10	10	10	10	10 [1/]	10 [1/]
	3,000	10	10	10	10	10	10 [1/]
	3,500	10	10	10	10	10	10 [1/]
	4,000	10	10	10	10	10	10 [1/]
	5,500	10	10	10	10	12	12

Notes:

1. The DSSM shall be limited to testing Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment (see 3.1.8.4).
2. Test configuration pairs (fixture weight + additional weight, Class II isolated payload weight) not defined by this figure may be approved on a case basis, subject to review and approval by the Technical Authority.

DSSM Standard Test configuration:

1/ Non-standard DSSM test configuration (shaded): Test configurations in shaded cells are non-standard test configurations and require review and approval by the Technical Authority.

FIGURE 24. DSSM tray, spring, and spring number configuration selection – configuration 1.

DSSM TRAY Part Number: NNS Dwg DSSM 2010-103
DSSM SPRING Part Number: Item 2 on DSSM 2010-103
MAX SPRINGS AVAILABLE: 48

FIGURE 25: DSSM TRAY CONFIGURATION 2

Number of Springs for Tray Configuration 2

		Class II isolated payload weight (lbs; see 6.6.14.b)					
		0	500	1,000	1,500	2,000	2,400
Fixture weight + additional weight (lbs; see 6.6.14.c and 6.6.14.d)	0	24	24	24	24 1/	24 1/	24 1/
	500	30	30	30	26 1/	26 1/	28 1/
	1,000	30	30	30	30	30 1/	30 1/
	1,500	30	30	30	30	30 1/	32 1/
	2,000	30	30	30	30	30 1/	32 1/
	2,500	36	36	36	36	36 1/	36 1/
	3,000	36	36	36	36	36	36 1/
	3,500	40	40	40	40	40	40 1/
	4,000	40	40	40	40	40	40 1/
	5,500	44	44	44	44	44	44

Notes:
1. The DSSM shall be limited to testing Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment (see 3.1.8.4).
2. Test configuration pairs (fixture weight + additional weight, Class II isolated payload weight) not defined by this figure may be approved on a case basis, subject to review and approval by the Technical Authority.

DSSM Standard Test configuration:

1/ Non-standard DSSM test configuration (shaded): Test configurations in shaded cells are non-standard test configurations and require review and approval by the Technical Authority.

FIGURE 25. DSSM tray, spring, and spring number configuration selection – configuration 2.

DSSM TRAY Part Number: NNS Dwg DSSM 2010-102
DSSM SPRING Part Number: Item 2 on DSSM 2010-102
MAX SPRINGS AVAILABLE: 64

FIGURE 26: DSSM TRAY CONFIGURATION 3										
Number of DSSM Springs for Tray 3										
		Class II isolated payload weight (lbs; see 6.6.14.b)								
		0	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000
Fixture weight + additional weight (lbs; see 6.6.14.c and 6.6.14.d)	0	64	64	64	64	64	64 1/	64 1/	64 1/	64 1/
	500	64	64	64	64	64	64	64 1/	64 1/	64 1/
	1,000	64	64	64	64	64	64	64 1/	64 1/	64 1/
	1,500	64	64	64	64	64	64	64 1/	64 1/	64 1/
	2,000	64	64	64	64	64	64	64	64 1/	64 1/
	2,500	64	64	64	64	64	64	64	64 1/	64 1/
	3,000	64	64	64	64	64	64	64	64 1/	64 1/
	3,500	64	64	64	64	64	64	64	64	64 1/
	4,000	64	64	64	64	64	64	64	64	64 1/
	5,500	64	64	64	64	64	64	64	64	64

Notes:

1. The DSSM shall be limited to testing Class II deck mounted equipment and, if applicable, Class I/II and Class III deck mounted equipment (see 3.1.8.4).
2. Test configurations pairs (fixture weight + additional weight, Class II isolated payload weight) not defined by this figure may be approved on a case basis, subject to review and approval by the Technical Authority.

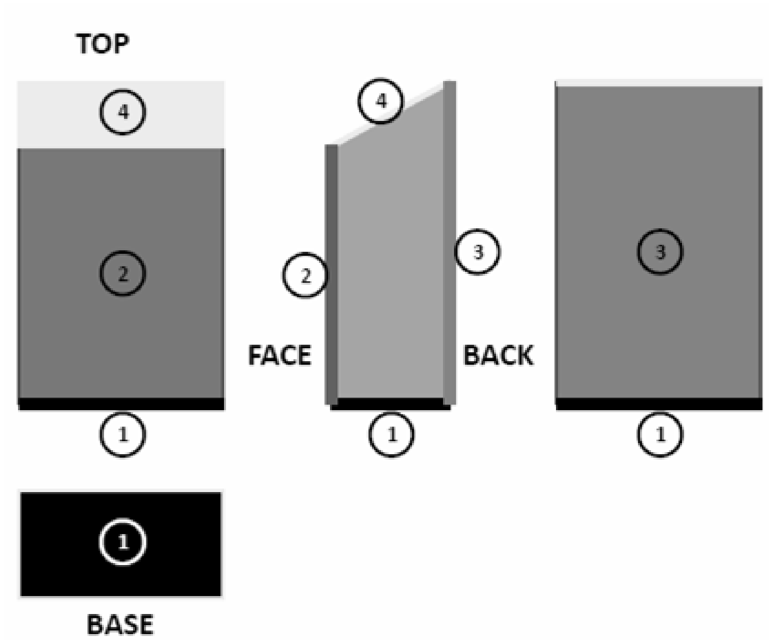
DSSM Standard Test configuration:

1/ Non-standard DSSM test configuration (shaded): Test configurations in shaded cells are non-standard test configurations and require review and approval by the Technical Authority.

FIGURE 26. DSSM tray, spring, and spring number configuration selection – configuration 3.

Mounting Plane

Mounting Plane Label	Foundation Interface #
Base (Bottom)	1
Front or Face	2
Back	3
Top	4
Combination	1 & 3 (Base and Back)
Other	Not Shown



Mounting Plane Aboard Ship:
See 1.2.7

FIGURE 27. Equipment mounting plane.

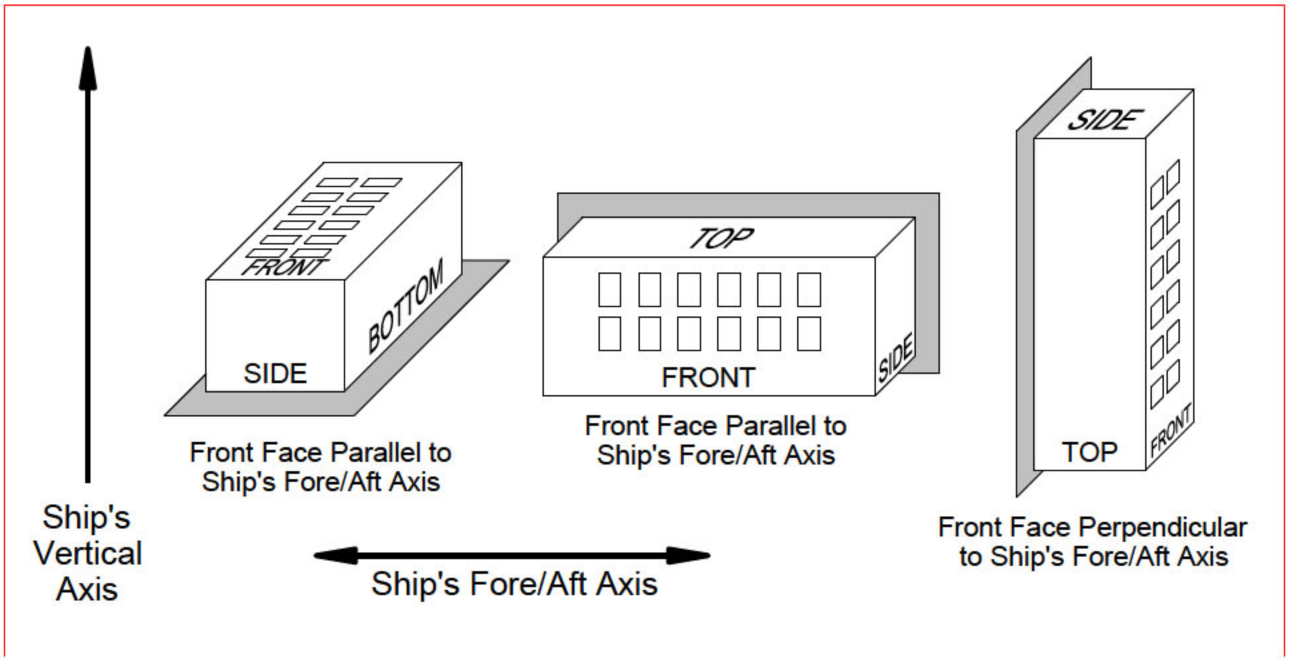


FIGURE 28. Representative examples depicting three unrestricted equipment mounting orientations.

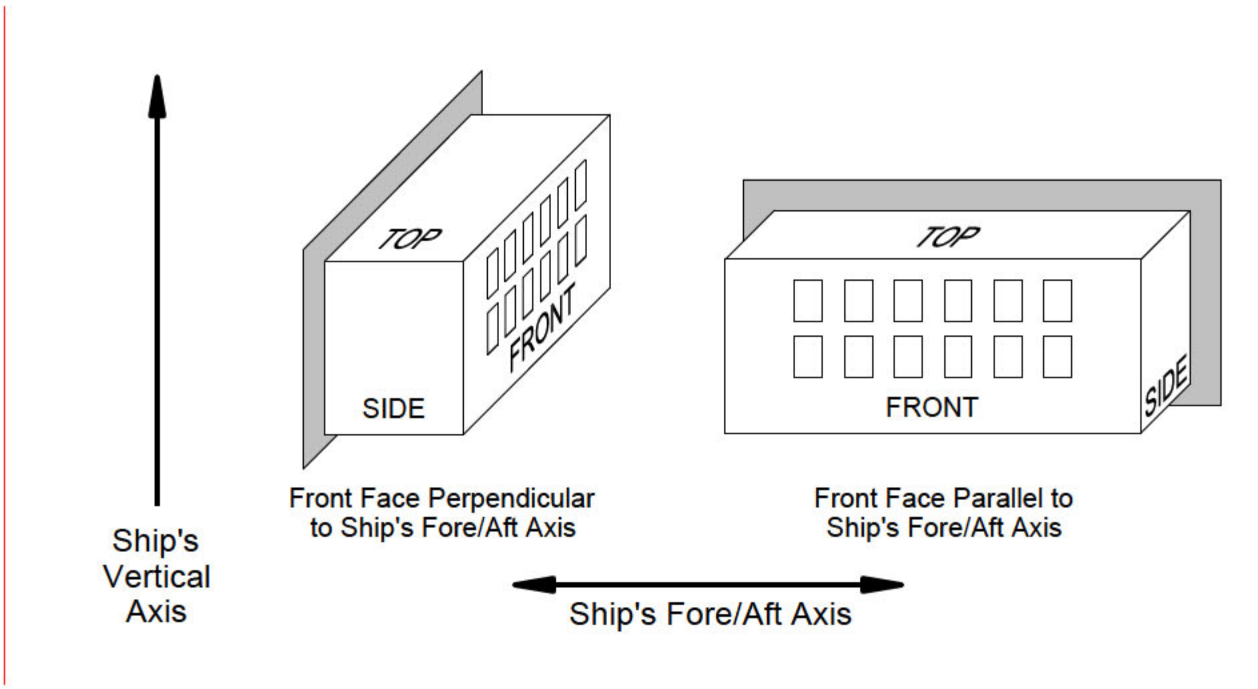


FIGURE 29. Representative examples depicting two vertical axis specified equipment mounting orientations.

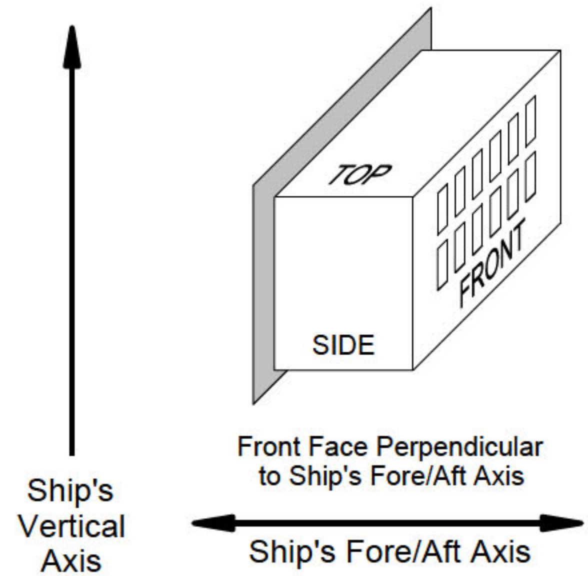


FIGURE 30. Representative example of restricted equipment mounting orientation.

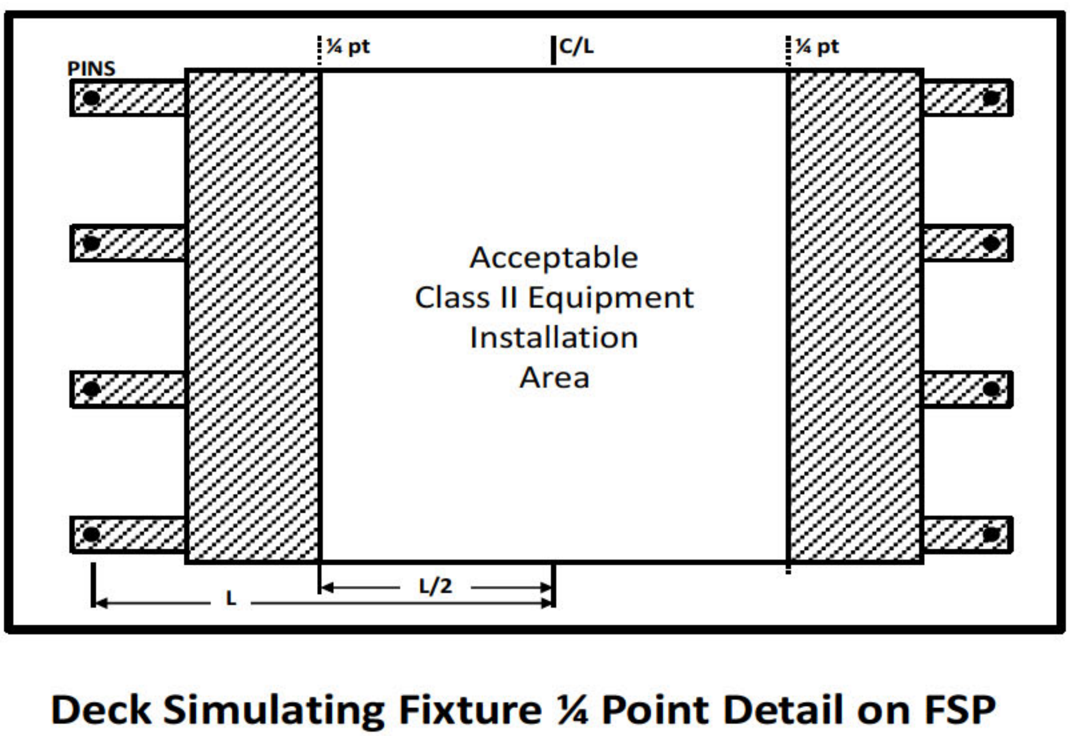
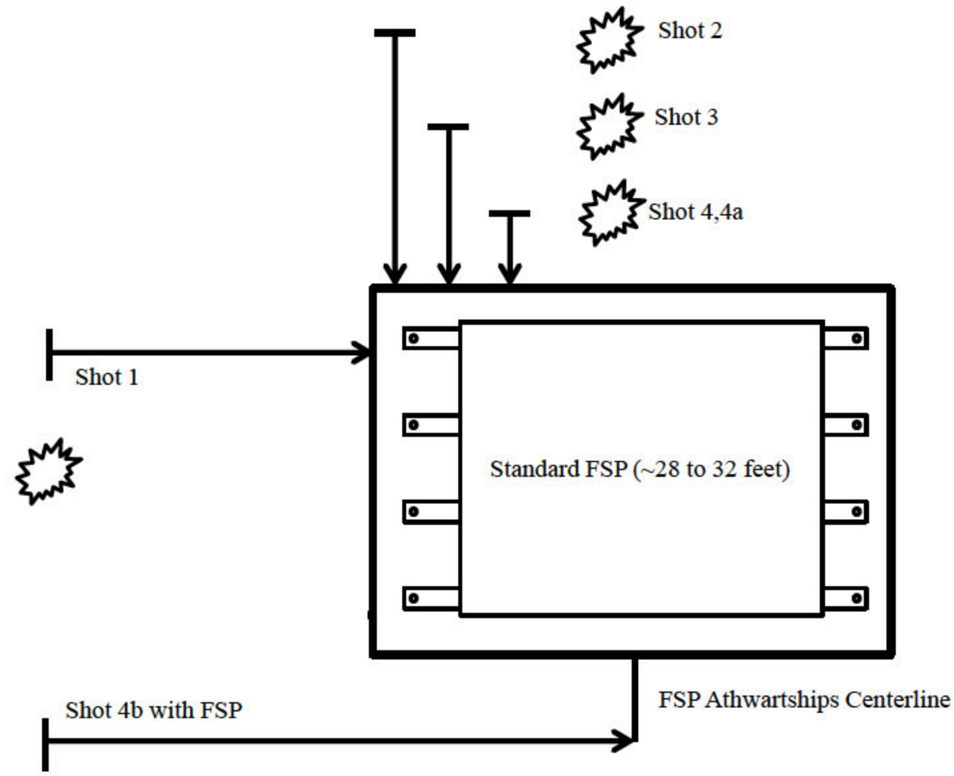


FIGURE 31. Deck simulating fixture (DSF) quarter point location.



S o			
		20	24

FIGURE 32. Shot geometry for standard FSP.

EXAMPLE OF SHOCK RESPONSE FREQUENCY (SRF) CALCULATION

A.1 SCOPE

A.1.1 Scope. This Appendix is not a mandatory part of the specification. The information contained herein is intended for guidance only.

A.2 GUIDANCE

A.2.1 Mounts. There are three categories of mounts, 1) nonlinear hardening, 2) linear, and 3) nonlinear softening. An example of a typical nonlinear hardening mount is provided below. The calculation for the shock response frequency (SRF) of a linear mount uses the same basic engineering principles used to calculate natural frequency. Response in the axial and lateral directions should be individually evaluated. The SRF for nonlinear softening mounts should be obtained from the manufacturer, if available.

A.2.2 Load-deflection curves. Some mounts are characterized by a single load-deflection curve (identified as Curve A), while others have separate load-deflection curves for the compression loading and extension loading directions (identified as Curve A and Curve B). The equations governing the mount response for this mount model assume bi-linear approximations of the load-deflection curves and neglect damping and hysteresis effects.

A.2.3 Definitions.

f_A = Acoustic frequency of mount with Curve A (i.e., linear frequency [*Hz*], given)

f_B = Acoustic frequency of mount with Curve B (i.e., linear frequency [*Hz*], given)

$\beta_A = \dfrac{k_{2A}}{k_{1A}} = \dfrac{F_{20A} - k_{1A}c_A}{k_{1A}(\delta_{2A} - c_A)}$ = Non-dimensional stiffness ratio of bi-linear load-deflection Curve A.

$\beta_B = \dfrac{k_{2B}}{k_{1B}} = \dfrac{F_{20B} - k_{1B}c_B}{k_{1B}(\delta_{2B} - c_B)}$ = Non-dimensional stiffness ratio of bi-linear load-deflection Curve B.

F_{20A} = A load sufficient to place the mount in the high stiffness region of its Curve A load-deflection relationship (*lbs*).

F_{20B} = A load sufficient to place the mount in the high stiffness region of its Curve B load-deflection relationship (*lbs*).

δ_{1A} = The deflection at the transition between the linear region and the nonlinear region of the load-deflection Curve A for the mount (*in*).

δ_{1B} = The deflection at the transition between the linear region and the nonlinear region of the load-deflection Curve B for the mount (*in*).

δ_{2A} = The Curve A deflection at load F_{20A} (*in*).

δ_{2B} = The Curve B deflection at load F_{20B} (*in*).

k_{1A} = The assumed linear stiffness of the mount in the Curve A low stiffness region (*lbs/in*).

k_{1B} = The assumed linear stiffness of the mount in the Curve B low stiffness region (*lbs/in*).

k_{2A} = The assumed linear stiffness of the mount in the Curve A high stiffness region (*lbs/in*).

k_{2B} = The assumed linear stiffness of the mount in the Curve B high stiffness region (*lbs/in*).

c_A = The break point of the assumed bi-linear load-deflection Curve A within the expected range of shock deflections (*in*), $\delta_{1A} \le c_A < \delta_{2A}$.

c_B = The break point of the assumed bi-linear load-deflection Curve B within the expected range of shock deflections (*in*), $\delta_{1B} \leq c_B < \delta_{2B}$.

V_0 = Input velocity (*in/sec*).

g = Acceleration due to gravity (*in/sec²*).

A.2.4 Shock response frequency (SRF). The following equations for the *SRF* are derived from first principles for a single degree of freedom mass-spring system, where the spring is assumed to have bi-linear load-deflection relationships, as shown on figures A-1 and A-2. The *SRF* equations are intended to provide expressions for determining if equipment can be tested to Class I equipment requirements (i.e., *SRF > 37 Hz*). The equations consider a response in a single direction only, and do not account for rotational motion.

Mounts characterized by a single load-deflection curve (identified as Curve A only):

$$SRF_{Curve\ A} = \frac{f_A\left(\frac{\pi}{2}\right)}{\sin^{-1}\left(\frac{2\pi f_A c_A}{V_0}\right) + \frac{(\pi - 2\alpha_A)}{2\sqrt{\beta_A}}} \tag{1}$$

Mounts with separate load-deflection curves for the compression loading and extension loading directions (identified as Curve A and Curve B):

$$SRF_{Curves\ A,B} = \frac{\pi}{\frac{1}{f_A}\left[Sin^{-1}\left(\frac{2\pi f_A c_A}{V_0}\right) + \frac{(\pi - 2\alpha_A)}{2\sqrt{\beta_A}}\right] + \frac{1}{f_B}\left[Sin^{-1}\left(\frac{2\pi f_B c_B}{V_0}\right) + \frac{(\pi - 2\alpha_B)}{2\sqrt{\beta_B}}\right]} \tag{2}$$

where

$$\alpha_A = Tan^{-1}\left(\frac{2\pi f_A c_A}{\sqrt{\beta_A}\, V_0 \sqrt{1 - \left(\frac{2\pi f_A c_A}{V_0}\right)^2}}\right) \tag{3}$$

and

$$\alpha_B = Tan^{-1}\left(\frac{2\pi f_B c_B}{\sqrt{\beta_B}\, V_0 \sqrt{1 - \left(\frac{2\pi f_B c_B}{V_0}\right)^2}}\right) \tag{4}$$

the parameters in Equations (1) through (4) are as described above.

A.2.4.1 Procedure for mounts characterized by a single load-deflection curve (identified as curve A only).

a. Determine a value for the initial velocity V_0 from table A-I. The velocities in the table are estimated from NRL report 7396, "Shipboard Shock and Navy Devices for its Simulation," by Clements, E.W., dated July 14, 1972.

TABLE A-I. Initial velocity for SRF calculation.

Machine	Total Test Weight (*lbs*)	V_0 (*in/sec*)
LWSM	< 300	120
	300-550	85
MWSM – external mounts	< 2000	75
	2000-3000	80
	3000-4000	85
	4000-5000	100
	> 5000	120
MWSM – internal mounts	0-7400	120

b. Determine the load-deflection curve, Curve A, for the mount. The curve can be obtained from data sheets, if it exists. Otherwise, the curve must be constructed.

c. From the data sheets for the desired mount: Retrieve values for the mount's rated vibration frequency, f_{rated}, the rated load per mount, W_{rated}.

d. For the particular application, determine the actual load per mount, W_{act}.

e. Calculate f_A for the value W_{act} using the rated isolation frequency, f_{rated}, and the rated load per mount, W_{rated}.

$$f_A = f_{rated}\sqrt{\frac{W_{rated}}{W_{act}}}$$

f. Compute the stiffness, k_{1A} (low stiffness region of the mount's load-deflection Curve A), from

$$k_{1A} = \frac{(2\pi f_A)^2 W_{act}}{g}$$

g. Determine the value for the deflection δ_{1A} (the transition between the linear region and the nonlinear region of the mount's load-deflection Curve A; see figure A-1). The load corresponding to δ_{1A} is $F_{10A} = k_{1A}\delta_{1A}$.

h. Determine the deflection and load (δ_{2A}, F_{20A}) at a point on the high stiffness portion of the load-deflection Curve A for the mount (normally $\delta_{2A} = x_{A\,\max}$).

i. The load-deflection Curve A is idealized as a bi-linear representation, whereby the break point between the low stiffness region and the high stiffness region is identified as (c_A, F_{1c_A}), where $\delta_{1A} \le c_A < \delta_{2A}$ (as shown on figure A-1). As c_A varies, the slope of the low stiffness region, k_{1A}, remains constant, while the slope of the high stiffness region, k_{2A}, varies. For each value of c_A, determine k_{2A} from (δ_{2A}, F_{20A}) and the break point (c_A, F_{1c_A}) using the equation:

$$k_{2A} = \frac{F_{20A} - F_{1c_A}}{\delta_{2A} - c_A} = \frac{F_{20A} - k_{1A}\, c_A}{\delta_{2A} - c_A}$$

j. For each value of c_A, calculate the ratio $\beta_A = (\frac{k_{2A}}{k_{1A}}) = \frac{F_{20A} - k_{1A} c_A}{k_{1A}(\delta_{2A} - c_A)}$

k. Compute the value of the SRF for the values of c_A, β_A using Equations (1) and (3).

l. Repeat steps (i) through (k) for the range of c_A desired.

The value chosen for the SRF corresponds to the minimum calculated value over the range of c_A. The bi-linear curve represented by this value of c_A should be plotted to ensure that it provides a reasonable representation of the actual nonlinear load-deflection curve.

A.2.4.2 Procedure for mounts characterized by separate load-deflection curves for the compression loading and extension loading directions (identified as curve A and curve B).

a. Determine a value for the initial velocity V_0 from table A-I.

b. Determine the load-deflection curves, Curve A and Curve B, for the mount. These curves can be obtained from data sheets, if they exist. Otherwise, the curves must be constructed.

c. From the data sheets for the desired mount: Retrieve values for the mount's rated vibration frequency, f_{rated}, the rated load per mount, W_{rated}.

d. For the particular application, determine the actual load per mount, W_{act}.

e. Calculate f_A for the value W_{act} using the rated isolation frequency, f_{rated}, and the rated load per mount, W_{rated}.

$$f_A = f_{rated}\sqrt{\frac{W_{rated}}{W_{act}}}$$

f. Compute the stiffness, k_{1A}, from

$$k_{1A} = \frac{(2\pi f_A)^2 W_{act}}{g}$$

g. Determine the value for the deflection (δ_{1A}) at the transition between the linear region and the nonlinear region of the mount's load-deflection Curve A (see figure A-1). The load corresponding to δ_{1A} is $F_{10A} = k_{1A}\delta_{1A}$.

h. Determine the deflection and load (δ_{2A}, F_{20A}) at a point on the high stiffness portion of the load-deflection Curve A for the mount (normally $\delta_{2A} = x_{A\,max}$).

i. Determine the values for the deflection and load (δ_{1B}, F_{10B}) at the transition between the linear region and the nonlinear region of the mount's load-deflection Curve B (see figure A-2).

j. Determine the deflection and load (δ_{2B}, F_{20B}) at a point on the high stiffness portion of the load-deflection Curve B for the mount (normally $\delta_{2B} = x_{B\,max}$).

k. Compute the stiffness, k_{1B}, from

$$k_{1B} = \frac{F_{10B}}{\delta_{1B}}$$

l. Calculate f_B from

$$f_B = \frac{1}{2\pi}\sqrt{\frac{k_{1B}g}{W_{act}}}$$

m. The load-deflection Curve A is idealized as a bi-linear representation, whereby the break point between the low stiffness region and the high stiffness region is identified as (c_A, F_{1c_A}), where $\delta_{1A} \le c_A < \delta_{2A}$ (as shown on figure A-1). As c_A varies, the slope of the low stiffness region, k_{1A}, remains constant, while the slope of the high stiffness region, k_{2A}, varies. For each value of c_A, determine k_{2A} from (δ_{2A}, F_{20A}) and the break point (c_A, F_{1c_A}) using the equation:

$$k_{2A} = \frac{F_{20A} - F_{1c_A}}{\delta_{2A} - c_A} = \frac{F_{20A} - k_{1A}\, c_A}{\delta_{2A} - c_A}$$

n. For each value of c_A, calculate the ratio $\beta_A = (\frac{k_{2A}}{k_{1A}}) = \frac{F_{20A} - k_{1A} c_A}{k_{1A}(\delta_{2A} - c_A)}$

o. The load-deflection Curve B is idealized as a bi-linear representation, whereby the break point between the low stiffness region and the high stiffness region is identified as (c_B, F_{1c_B}), where $\delta_{1B} \leq c_B < \delta_{2B}$ (as shown on figure A-2). As c_B varies, the slope of the low stiffness region, k_{1B}, remains constant, while the slope of the high stiffness region, k_{2B}, varies. For each value of c_B, determine k_{2B} from (δ_{2B}, F_{20B}) and the break point (c_B, F_{1c_B}) using the equation:

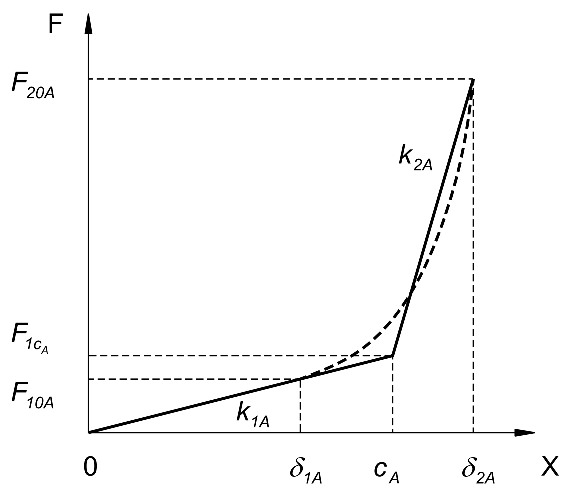
$$k_{2B} = \frac{F_{20B} - F_{1c_B}}{\delta_{2B} - c_B} = \frac{F_{20B} - k_{1B}\, c_B}{\delta_{2B} - c_B}$$

p. For each value of c_B, calculate the ratio $\beta_B = (\frac{k_{2B}}{k_{1B}}) = \frac{F_{20B} - k_{1B} c_B}{k_{1B}(\delta_{2B} - c_B)}$

q. Compute the value of the *SRF* for the values of c_A, c_B, β_A, β_B using equations (2), (3), and (4).

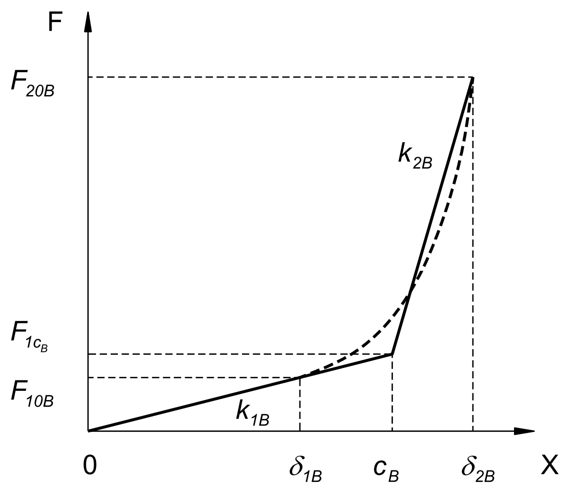
r. Repeat steps (m) through (q) for the ranges of c_A and c_B desired.

The value chosen for the SRF corresponds to the minimum calculated value over the range of c_A and c_B. The bi-linear curves represented by these values of c_A and c_B should be plotted to ensure that they provide reasonable representations of the actual nonlinear load-deflection curves.



$$\begin{array}{lll} Region\,1: & F_{1A}(x) = k_{1A}\, x & 0 \leq x \leq c_A \\ Region\,2: & F_{2A}(x) = k_{2A}(x - c_A) + k_{1A}\, c_A & c_A \leq x < \delta_{2A} \\ & where \quad \delta_{1A} \leq c_A < \delta_{2A} & \end{array}$$

FIGURE A-1. Curve A, assumed bi-linear mount load-deflection (F-X) relationship.
(Actual nonlinear relationship shown by dashed line.)



$$
\begin{aligned}
&\mathit{Region}\ 1: && F_{1B}(x)=k_{1B}\,x && 0\le x\le c_B \\
&\mathit{Region}\ 2: && F_{2B}(x)=k_{2B}(x-c_B)+k_{1B}\,c_B && c_B\le x<\delta_{2B} \\
& && \mathit{where}\quad \delta_{1B}\le c_B<\delta_{2B} &&
\end{aligned}
$$

FIGURE A-2. Curve B, assumed bi-linear mount load-deflection (F-X) relationship.
(Actual nonlinear relationship shown by dashed line.)

A.2.5 Sample method of calculation for nonlinear hardening mounts (e.g., typical Navy standard resilient mounts).

Published data, such as the Navy Standard Resilient Mount Handbook or Vendor catalogs, can be used to determine properties necessary for calculation of the *SRF*. In the following examples, the input velocity V_0 = 120 *in/sec*.

A.2.5.1 Example 1: 11M25 mount with load-deflection curve from the Navy Standard Resilient Mount Handbook. The calculated SRF is shown on figure A-3.

Mount 11M25:

$$f_A = 11.5\,Hz \quad W = 25\,lbs \qquad c_{A\,initial} = \delta_{1A} = 0.30\ in$$

$$(\delta_{1A}, F_{10A}) = (0.30,\ 101) \qquad (\delta_{2A}, F_{20A}) = (0.69,\ 2500)$$

$$k_{1A} = (2\pi f_A)^2 \frac{W}{g} = 338\ lbs/in$$

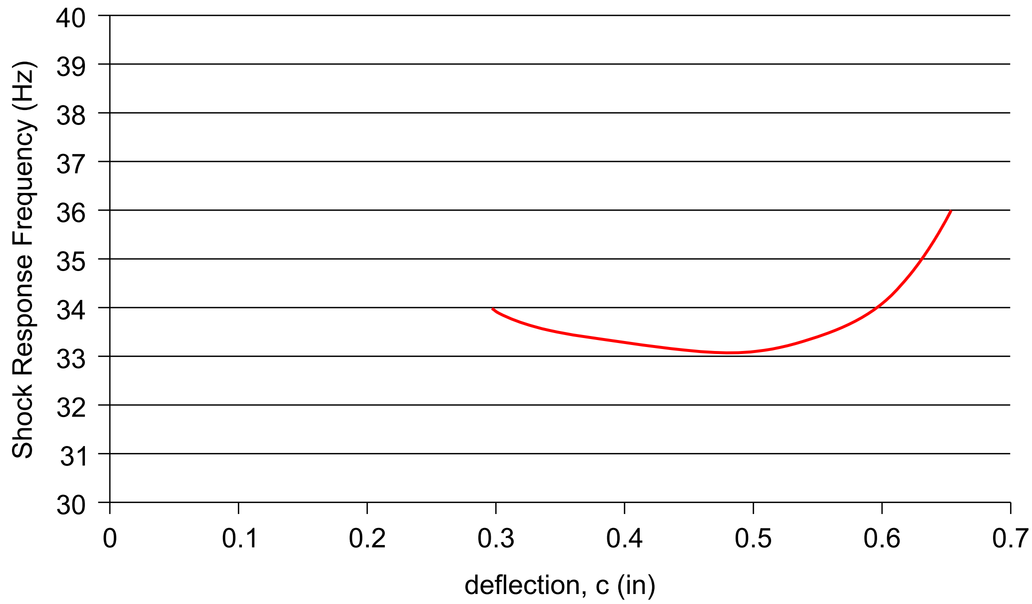


FIGURE A-3. 11M25 mount – SRF as a function of the break point, c_A.

For this example, for the assumed range of c_A, the minimum SRF for the mount without an external snubber is approximately 33.1 *Hz* at $c_A = 0.47$ *in*.

A.2.5.2 Example 2: 11M25 mount with an auxiliary snubber having a clearance of 0.125 inch. It is assumed that the load-deflection curve for this case can be represented by shifting the high stiffness region by (0.30 inch – 0.125 inch) = 0.175 inch to $(\delta_{2A}, F_{20A}) = (0.515, 2500)$. The nonlinear part of the curve begins at $\delta_{1A} = 0.125$ inch. The calculated *SRF* is shown on figure A-4.

Mount 11M25 w/snubber (clearance = 0.125 inch) :

$$f_A = 11.5\,Hz \quad W = 25\,lbs \qquad c_{A\,initial} = \delta_{1A} = 0.125\,in$$

$$(\delta_{1A}, F_{10A}) = (0.125,\ 39) \qquad (\delta_{2A}, F_{20A}) = (0.515,\ 2500)$$

$$k_{1A} = (2\pi f_A)^2 \frac{W}{g} = 338\,lbs/in$$

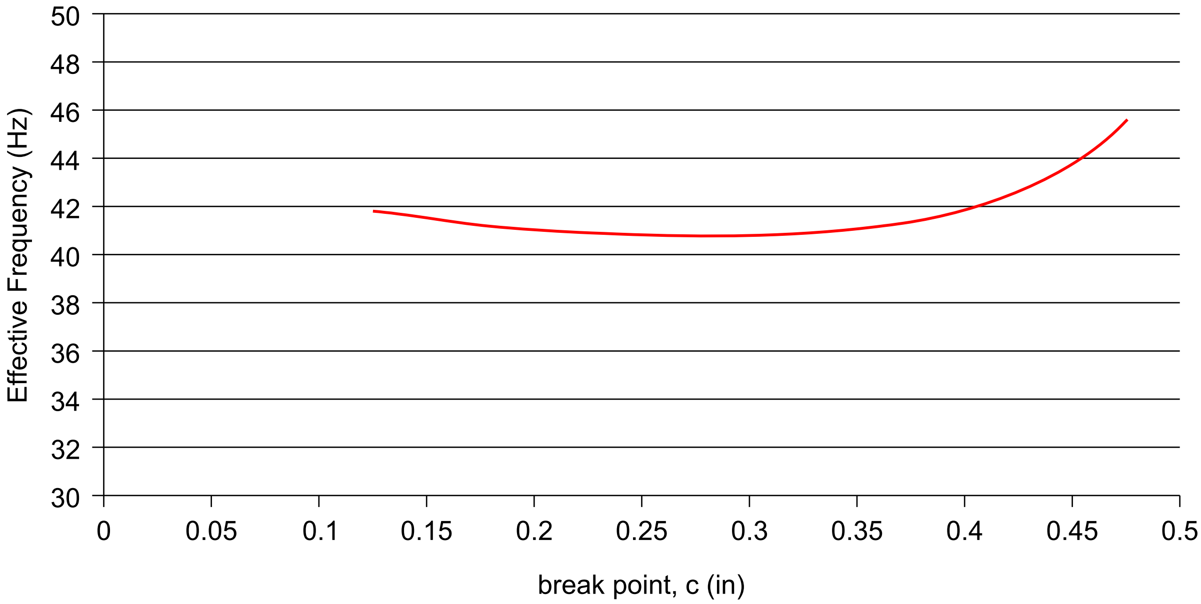


FIGURE A-4. 11M25 mount w/snubber (clearance 0.125 inch) – SRF as a function of the break point, c_A.

For this example of a mount with an external snubber, the calculated SRF is greater than 37 *Hz* over the entire assumed range of c_A, and the minimum value is $SRF = 40.9\ Hz$ at $c_A = 0.28\ in$. The 11M25 mount with the external snubber with clearance of 0.125 inch is considered a Limited Displacement Capability Isolation Device (LDCID) for the assumed shock conditions.

The above analysis estimates that the stiffness of the external snubber is equal to the high stiffness region of the mount for a range of break points c_A. If the actual stiffness of the external snubber, k_s, is known, then the parameter $\beta = \frac{k_s}{k_{1A}}$, and in this case $c_A = \delta_{1A}$ = the snubber clearance.

A.2.5.3 Example 3: 6E2000 Mount with separate load-deflection curves for the compression loading and extension loading directions from the Navy Standard Resilient Mount Handbook. The calculated SRF is shown on figure A-5.

Mount 6E2000:

$$f_A = 5.3\,Hz \quad W = 2000\,lbs \qquad c_{A\,initial} = \delta_{1A} = 0.6\,in \qquad c_{B\,initial} = \delta_{1B} = 0.18\,in$$

$$(\delta_{1A}, F_{10A}) = (0.60,\ 3447) \qquad (\delta_{2A}, F_{20A}) = (1.6,\ 35000)$$

$$(\delta_{1B}, F_{10B}) = (0.18,\ 4000) \qquad (\delta_{2B}, F_{20B}) = (0.56,\ 35000)$$

$$k_{1A} = (2\pi f_A)^2 \frac{W}{g} = 5746\,lbs/in \qquad k_{1B} = \frac{4000}{0.18} = 22,222\,lbs/in$$

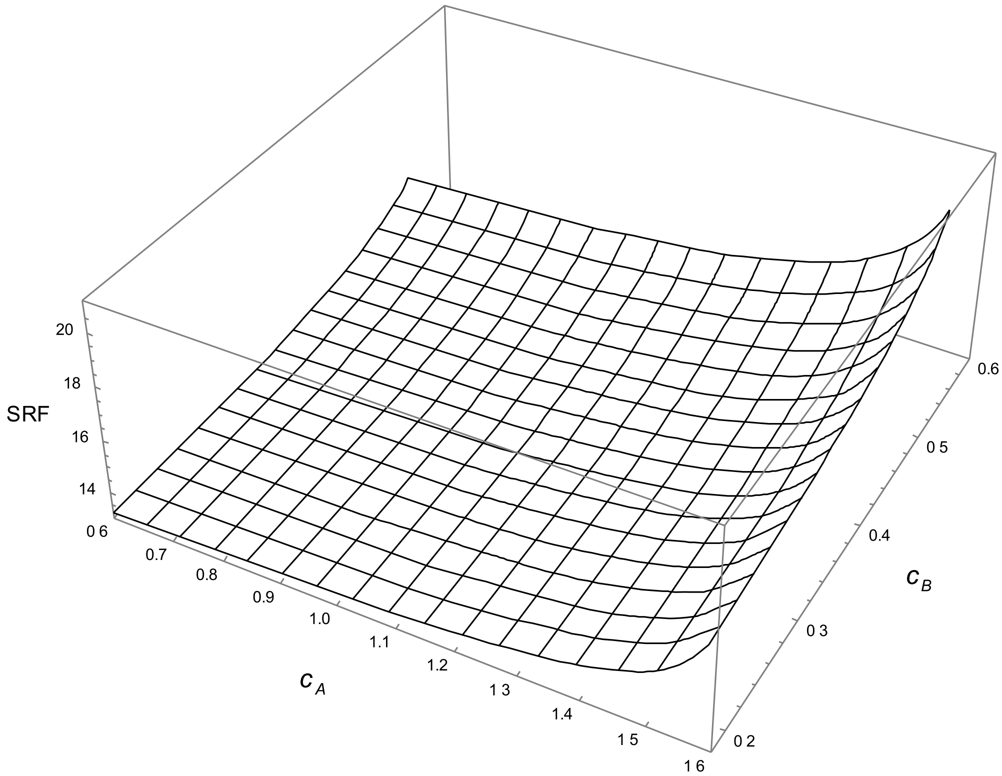


FIGURE A-5. <u>6E2000 mount – SRF as a function of the break points, c_A and c_B</u>.

For this example, for the assumed ranges of c_A and c_B, the minimum SRF for the mount is 13.2 Hz.

CONCLUDING MATERIAL

Custodians:
Army – TE
Navy – SH

Review activities:
Navy – AS, EC, MC, OS

Preparing activity:
Navy – SH
(Project ENVR-2015-005)

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.