

INCH-POUND

MIL-STD-2003-2B(SH)

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SUPERSEDING

MIL-STD-2003-2A(SH)

3 September 2009

**DEPARTMENT OF DEFENSE
STANDARD PRACTICE
ELECTRIC PLANT INSTALLATION
STANDARD METHODS FOR
SURFACE SHIPS AND SUBMARINES
(EQUIPMENT)**



MIL-STD-2003-2B(SH)

FOREWORD

1. This standard is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.
2. This standard disseminates up-to-date information detailing requirements for standard installation methods employed for electrical equipment for submarine and surface ship electrical distribution systems.
3. These criteria are for application to new construction, conversion, and alteration of existing ships.
4. 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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1. SCOPE

1.1 Scope. This standard covers standard installation methods for casualty power, shore power, electrical equipment, and switchboards.

1.1.1 Application. The installation methods in this document are intended to be used by all installing activities as required by contract, ship specifications, or similar implementing documents. These methods do not normally identify ship or type but do establish standards for electrical equipment installations in naval ships. The methods in this document are for new construction as well as for conversions, alterations, and repairs. It is the responsibility of the user activity to determine which method satisfies their requirements. This document provides methods and requirements for installation of electrical equipment in ships; not for maintenance or modifications interior to equipment enclosures. For maintenance and modifications inside equipment enclosures, see equipment drawings and equipment technical manuals.

2. APPLICABLE DOCUMENTS

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

COMMERCIAL ITEM DESCRIPTIONS

A-A-59004 - Anti-Galling Compound, Thread Lubricating, Seizing Resistant, and Calcium Hydroxide Containing

A-A-59313 - Thread Compound; Antiseize, Zinc Dust-Petrolatum

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-2036 - Enclosures for Electric and Electronic Equipment, Naval Shipboard

MIL-DTL-18240 - Fastener Element, Self-Locking, Threaded Fastener, 250 °F Maximum

MIL-DTL-45932 - Insert, Screw Thread, Thin Wall, Locked in: General Specification for

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-22 - Welded Joint Design

MIL-STD-763 - Locking Devices

MIL-STD-1310 - Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility, Electromagnetic Pulse (EMP) Mitigation, and Safety

MIL-STD-1689 - Fabrication, Welding, and Inspection of Ships Structure

MIL-STD-2042-2 - Fiber Optic Cable Topology Installation Standard Methods for Surface Ships and Submarines (Equipment)

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-290 - Standard Electrical Symbol List

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

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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 FACILITIES ENGINEERING COMMAND (NAVFAC) PUBLICATIONS

Naval Engineering Training and Operation - Shore-to-Ship Power Connect and Disconnect
Procedure and Standard (NETOPS) #29 Procedures

(Copies of this document are available online at www.navfac.navy.mil by searching for the title.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

803-6983506 - Electrical Enclosure, Composite Installation and Details

(Copies of this document are available from the applicable repositories listed in S0005-AE-PRO-010/EDM, which can be obtained online via Technical Data Management Information System (TDMIS) at <https://mercury.tdmis.navy.mil/>. Copies of this document may also be obtained from the Naval Ships Engineering Drawing Repository (NSED) online at <https://199.208.213.105/webjedmics/index.jsp>. To request an NSED account for drawing access, send an email to NNSY_JEDMICS_NSED_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

S9086-CJ-STM-010/075 - NSTM Chapter 075, Fasteners

S9086-KC-STM-010/300 - Naval Ships' Technical Manual Chapter 300, Electric Plant-General

S9300-A6-GYD-010 - Electrical Workmanship Inspection Guide for Surface Ships and Submarines

S9407-AB-HBK-010 - Handbook of Shipboard Electromagnetic Shielding Practices

SE000-01-IMB-010 - Navy Installation and Maintenance Book

T9070-AL-DPC-020/077-2 - NAVSEA Hazardous Material Avoidance Process

T9074-AD-GIB-010/1688 - Requirements for Fabrication, Welding, and Inspection of Submarine Structure

(Copies of these documents are available online via Technical Data Management Information System (TDMIS) at <https://mercury.tdmis.navy.mil/> by searching for the document number without the suffix. Refer questions, inquiries, or problems to: DSN 296-0669, Commercial (805) 228-0669. These documents are available for ordering (hard copy) via the Naval Logistics Library (NLL) at <https://nll.navsup.navy.mil/>. For questions regarding the NLL, contact the NLL Customer Service at nllhelpdesk@navy.mil, (866) 817-3130, or (215) 697-2626/DSN 442-2626.)

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

AEROSPACE INDUSTRIES ASSOCIATION (AIA)

NAS1352 - Screw, Cap, Socket Head, Undrilled and Drilled, Plain and Self-Locking, Alloy Steel, Corrosion-Resistant Steel and Heat-Resistant Steel, UNRC-3A and UNRC-2A

NASM8846 - Insert, Screw-Thread, Helical Coil

NASM16228 - Nut, Self-Locking, Hexagon, Thin, UNC-3B, Non Metallic Insert, Austenitic Corrosion Resistant Steel, Nonmagnetic, 250 °F

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- NASM17829 - Nut, Self-Locking, Hexagon, Regular Height, 250 °F, Non-Metallic Insert, Non-CRES Steel
- NASM17830 - Nut, Self-Locking, Hexagon-Regular, 250 °F and 450 °F, Non-Metallic Insert, 300 Series CRES
- NASM33540 - Safety Wiring, Safety Cabling, Cotter Pinning, General Practices for

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

- ASME B18.6.1 - Wood Screws (Inch Series)

(Copies of this document are available online at www.asme.org.)

ASTM INTERNATIONAL

- ASTM A342/A342M - Standard Test Methods for Permeability of Weakly Magnetic Materials
- ASTM A380/A380M - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
- ASTM A493 - Standard Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging
- ASTM D5363 - Standard Specification for Anaerobic Single-Component Adhesives (AN)
- ASTM F467 - Standard Specification for Nonferrous Nuts for General Use
- ASTM F468 - Standard Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use
- ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- ASTM F594 - Standard Specification for Stainless Steel Nuts
- ASTM F879 - Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws

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

SAE INTERNATIONAL

- SAE J429 - Mechanical and Material Requirements for Externally Threaded Fasteners
- SAE J995 - Mechanical and Material Requirements for Steel Nuts

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

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

3. DEFINITIONS

This section is not applicable to this standard.

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4. GENERAL REQUIREMENTS

4.1 Electrical equipment mounting. The installation of electrical equipment shall be in accordance with the figures in appendix 2A. Electrical equipment shall be secured in a manner that it does not come into direct contact with the outer shell plating or ballistic surfaces of the ship. A minimum clearance of 2 inches shall be maintained for inspection and painting. Composite electrical enclosures shall be mounted in accordance with Drawing 803-6983506.

4.1.1 Installation welding requirements. Unless otherwise specified on the individual figure, the welding of studs, step hangers, tapped pads, mounting pads, extension hangers, and top bracing supports for switchboards shall be in accordance with S9074-AR-GIB-010/278, T9074-AD-GIB-010/1688, MIL-STD-22, and MIL-STD-1689. Pads and studs shall be tapped or threaded before being welded to the ship's structure. Collar and weld studs shall be in accordance with MIL-S-24149.

4.1.2 Mounting fasteners. Unless otherwise approved by NAVSEA or allowed by the applicable ship specification, fasteners used to mount equipment to ship's foundation shall comply with the following requirements. See [figure 2A20](#) for locking devices used in electrical connections. In addition, 4.1.2.6 applies for electrical connections. [Table I](#) has requirements for fastener selection as well as for busbar electrical connections.

4.1.2.1 Fastener material and thread dimensions. Fastener materials shall be in accordance with [table I](#). Thread dimensions shall be of S9086-CJ-STM-010/075, class 2 unless class 3 is mandated by the applicable ship specification or in the figures included in this standard.

4.1.2.2 Washers and shims use.

- a. Washers are required between the bearing surface of any fastener or nut when the adjacent clearance hole is above what is allowed in accordance with the applicable ship specifications.
- b. Washers shall not be used for the sole purpose of reducing thread protrusion.
- c. Loose shims, washers, or liners may be stacked up to a thickness of $\frac{3}{8}$ inch for the alignment of electrical equipment. The washers may be used for hull environment (bulkhead) or deck environment (overhead or foundation) mounted equipment. Washers shall not be used as shims for any resiliently mounted equipment.
- d. Washers and shims are prohibited for alignment purposes on fasteners smaller than $\frac{3}{8}$ inch nominal diameter.
- e. NAVSEA approval is required for use of washers and shims for alignment purposes on fasteners larger than $\frac{3}{8}$ inch nominal diameter.
- f. Grounding and bonding shall be in accordance with 4.6.

The use of fasteners as shims with diameters equal to $\frac{3}{8}$ inch is allowed to secure equipment within the weight limits listed in tables [II](#) and [III](#). Fasteners shall have a yield strength of 65 kilo-pounds per square inch (KSI) or greater. NAVSEA approval is required if the weights limits in tables [II](#) and [III](#) are exceeded with $\frac{3}{8}$ -inch diameter fasteners.

4.1.2.3 Length of engagement for threaded holes. When a bolt, screw, or stud threads into a threaded tapped hole, the recommended length of engagement is 1.5 times the fastener diameter. The engagement length shall not be less than the fastener diameter.

4.1.2.4 Aluminum connections. See [table I](#) for material requirements unique to mechanical joints assembled with aluminum or aluminum alloys.

a. Where through bolting is not possible, corrosion resistant steel inserts that take fasteners shall be cast or threaded into the aluminum or aluminum alloys. The design of the insert shall include a method of locking the insert in place to prevent backing out. Providing strength, wear, shock, and vibration requirements can be met, either by solid wall bushings in accordance with MIL-DTL-45932 or by helical coil type inserts in accordance with NASM8846. Refer to S9086-CJ-STM-010/075 for further guidance on the use of threaded inserts.

b. No alloys of copper (brass, bronze, copper-nickel, or nickel-copper) shall be used in threaded contact with aluminum or aluminum alloys.

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c. Washers of the same material and coating as the bolts shall be fitted below all nuts and bolt heads that adjoin aluminum or aluminum alloys.

4.1.2.5 Thread protrusion. Thread lengths on male fasteners shall be selected to protrude the distance of at least one thread beyond the top of the nut or plastic locking element. When installed and tightened, protrusion of the male threads, as a minimum, shall be flush with the top of the nut or plastic locking element. Excessive protrusion shall be avoided particularly where necessary clearances, accessibility, shock, noise control and safety are important. Where practicable, the number of threads protruding shall not exceed five; however, this requirement shall not override the use of standard length fasteners. Standard length fasteners may result in protrusions greater than five threads. In no case shall thread protrusion exceed ten threads.

4.1.2.6 Thread lubricant or anti-seize. A thread lubricant shall be used on all threads. Zinc dust-petrolatum in accordance with A-A-59313 shall be used on aluminum threads unless otherwise specified in the applicable ship specification or in ship drawings. Thread lubricant paste in accordance with A-A-59004 shall be used for all other applications under 1,000 °F on carbon alloy steels or under 670 °F in all other applications.

- a. When NO-OX-ID is used as a lubricant, no other thread lubricants or sealants are allowed to be used.
- b. Thread lubricants containing molybdenum disulfide shall not be used.
- c. For all other applications of thread lubricant or anti-seize, contact NAVSEA for direction.

4.1.2.6.1 Thread lubricant application. To be effective, the lubricant should be applied to the complete thread area minus the 2 threads closest to the nut surface. Apply a light coat over all the external threads, and then fill the first one or two internal threads. The lubricant in the first threads will then be distributed over the remaining internal threads as the fastener is assembled. Apply the lubricant sparingly so blind holes are not filled with the compound. Use just enough lubricant to coat all of the threads.

4.1.2.7 Thread locking. Unless otherwise specified in applicable ship specifications, locking devices shall be provided on the following basis for electrical and mechanical connections into all switchboards, switchgear units, and in all equipment.

- a. Self-locking nuts should be used for stud mounting of Navy standard equipment covered in MIL-HDBK-290. Locking devices are not required for navy standard equipment up to symbol numbers 3012 in MIL-HDBK-290.
- b. Through bolts and self-locking nuts shall be used to mount equipment in gun mounts and in battery compartments.
- c. Unless shown differently in figures in this standard, self-locking fasteners should be used as the preferred thread locking devices.

4.1.2.7.1 Self-locking fasteners. Corrosion-resistant steel (CRES) self-locking nuts in accordance with NASM17830 or zinc-plated steel self-locking nuts in accordance with NASM17829 shall be used. CRES self-locking nuts in accordance with NASM16228 may be used as an alternative subject to NAVSEA approval. Users shall take into account that NASM16228 has lower strength requirements than NASM17830.

For electrical connections where a self-locking nut or jam nut cannot be used, a fastener with a self-locking pellet, in accordance with MIL-DTL-18240, type-N may be used as an alternative.

4.1.2.7.2 Jam nuts. Unless otherwise allowed in applicable ship specifications, jam nuts shall not be used as a primary locking mechanism. For many applications, self-locking nuts may replace jam nuts. If jam nuts must be used, refer to S9086-CJ-STM-010/075 for proper guidance. To prevent the bolt heads of a jam nut assembly from moving during the torquing process, a two-person process should be used when practical.

4.1.2.7.3 Lockwashers. Toothed or split-ring lockwashers are not allowed unless the lockwasher is a constituent or integrated element of a component such as a terminal board. For these cases where the lockwasher is a constituent or integrated element of a component, tooth lock washers in lieu of split type lock washers are preferred for #10 screws and smaller.

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4.1.2.7.4 Anaerobic thread locking compound. Anaerobic thread locking compound shall only be used in structural or mechanical applications. Anaerobic thread locking compound shall be in accordance with ASTM D5363.

4.1.2.7.5 Lockwire. Lockwiring or wiring in accordance with NASM33540 and locking cable in accordance with MIL-STD-763 are acceptable for use to prevent complete disassembly of a joint or complete loss of a joint. Examples of this include applications that prevent the fastener from coming adrift or to prevent tampering with a fastener after assembly by a controlled procedure. Lockwiring or wiring in accordance with NASM33540 and locking cable in accordance with MIL-STD-763 are not acceptable as a locking device when the clamping force in the joint is critical to the application. Lockwiring or wiring in accordance with NASM33540 and locking cable in accordance with MIL-STD-763 may be used as a retention device in addition to other locking methods.

4.1.2.7.6 Prohibited locking devices and methods. The following devices and thread locking methods shall not be used as locking devices unless allowed by applicable ship specifications or approved by NAVSEA.

- a. Anaerobic threadlocking compound shall not be used for electrical connections.
- b. Belleville washers (plain).
- c. Toothed and split ring lockwashers shall not be used except as described in 4.1.2.7.3.
- d. A fastener with a self-locking pellet, type N in accordance with MIL-DTL-18240 shall not be used in an electrical connection unless it is not feasible to use a self-locking nut or jam nut. See 4.1.2.7.1 and 4.1.2.7.2.
- e. Clip-on types of nuts.
- f. Single-thread engaging nuts formed by stamping a thread-engaging impression in a flat piece of metal.
- g. Setscrews.
- h. Pinning of fasteners shall not be used except with specific approval from NAVSEA. Pinning for linkage components does not require NAVSEA approval.
- i. Peening or thread upset after assembly.

4.1.2.8 Tightening sequences and incremental torque. For mechanical assemblies where more than one bolt is used, such as bolting of enclosure covers, the tightening sequence for nuts should be in accordance with S9086-CJ-STM-010/075. For joints with one bolt or more than one bolt, 10 percent of the specified torque should first be applied to all nuts in accordance with the tightening sequence to ensure the parts are solidly together. Torque should be then applied to all nuts at 25, 50, 75, and 100 percent of the specified torque in accordance with the tightening sequence. Finally, the tightening sequence should be reversed and 100 percent of required torque should be applied.

4.1.2.9 Installation torque. Fasteners shall be torqued to a specific value when required by the applicable drawing, maintenance standard, or technical manual. When an installation torque is not specified, refer to S9086-CJ-STM-010/075. Prevailing self-locking fasteners shall be torqued to 100 percent of the specified value plus the prevailing torque that is measured when the nut is turned on the bolt in its unloaded state. All full height nuts that are not prevailing torque self-locking fasteners shall be torqued to 100 percent of the specified value.

4.1.2.10 Torque seals. Torque seals shall be installed on all bus connections in power panels, load centers, switchboards, and power converters upon verification of torque using a calibrated torque wrench. Switchboards and load centers shall have torque seals on bus-to-bus connections as well as on cable connections to bus work upon verification of torque using a calibrated torque wrench.

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TABLE I. Fastener materials and fastener specifications for bolted joints.^{1/2/}

Application	Fastener Type, Specification, and Material Grade
Services interior to the ship joining steel components up to and including 650 °F.	<u>Hex head cap screws, and studs:</u> SAE J429, grade 5 or 8 ^{3/} ASTM F593, group 1 or 2, condition CW <u>Socket head cap screws:</u> NAS1352 alloy steel ^{3/} heat and corrosion resistant steel or corrosion resistant steel <u>Nuts:</u> SAE J995, grade 5 or 8 ^{3/} ASTM F594, group 1 or 2
Connections of steel, CRES, aluminum, and non-metallic components ^{4/ 5/}	<u>Screws and studs:</u> ASTM F593, group 2, condition CW <u>Nuts:</u> ASTM F594, group 2, condition CW
Attachment of aluminum alloys to aluminum alloys, both fittings and structure ^{4/ 5/}	<u>Screws and studs:</u> ASTM F593, group 1 or 2, condition CW <u>Nuts:</u> ASTM F594, group 1 or 2, condition CW
Applications where the bolt is designed to fail in a shock event (shear bolts in sway braces)	<u>Fasteners:</u> SAE J429, grade 2
Fasteners with diameters ¼ inch and smaller	<u>Socket head cap screws:</u> NAS1352 corrosion resistant steel <u>Flathead countersunk and button head cap screws:</u> ASTM F879
Countersunk fasteners	<u>Flathead countersunk screws:</u> ASTM F879
Attaching equipment to wooden structure ^{7/ 8/}	<u>Hex head lag screws:</u> ASTM F593, group 1, condition CW ^{8/} <u>Wood screws:</u> ASME B18.6.1 ^{7/ 8/}
Connections to copper alloys (for example, brass or bronze)	<u>Screws and studs:</u> ASTM F468, NiCu grade 400, condition, as formed or stress relieved <u>Nuts:</u> ASTM F467, NiCu grade 400, condition, as formed or stress relieved
Bus bar joints 4,000 amperes and above	<u>Screws and studs:</u> ASTM F468, copper alloys grade 651 and 655 <u>Nuts:</u> ASTM F467, copper alloys grade 651 and 655
Self-locking fasteners	<u>Screws and studs:</u> MIL-DTL-18240, type-N locking element <u>Nuts:</u> NASM 17829, carbon and alloy steel NASM 17830, CRES alloys

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TABLE I. Fastener materials and fastener specifications for bolted joints – Continued. ^{1/2/}

NOTES:	
^{1/}	Refer to S9086-CJ-STM-010/075 for a list of approved substitute materials.
^{2/}	MS part numbers listed in the figures in this standard supersede the guidance listed above.
^{3/}	Except where these materials constitute part of a galvanic (corrosion) couple, in which case proposals for alternate materials shall be submitted to NAVSEA for approval, the specific direction in this table applies.
^{4/}	Fasteners rated as SAE J429, grade 8 or stronger, having a tensile strength of 150 KSI or stronger, or having a hardness over HRC 34 shall not be zinc coated.
^{5/}	Aluminum and aluminum alloy parts in dry applications shall be assembled with 300 series CRES bolts, zinc coated steel bolts, or uncoated steel bolts.
^{6/}	When aluminum or CRES connections are in a wet space or are exposed to weather or salt spray, fasteners of 300 series CRES shall be used. Where connections are exposed to seawater, fasteners of type 316 shall be used.
^{7/}	Material for wood screws shall meet the requirements of 300 series CRES in accordance with ASTM A493 and shall be passivated in accordance with ASTM A380/A380M.
^{8/}	For nonmagnetic applications, fasteners shall be either annealed after manufacture or machined from annealed stock as to not change the properties of the original material. Fasteners shall not exceed a magnetic permeability of 1.5 at 100 oersteds when determined in accordance with the test methods of ASTM A342/A342M. Permeability indications shall be made on the threaded as well as unthreaded portions of the fasteners. Specify supplementary requirement S6 when procuring fasteners to ASTM F593.

TABLE II. Weight limits per 3/8 diameter fastener made of cold-worked 300 series CRES per ASTM F593 and grade 5 alloy steel per SAE J429 used to mount equipment with shims in surface ships.

0.065-inch thick washers used, m	Total thickness, d (in)	Deck environment mounted weight per fastener (lb)		Hull environment mounted weight per fastener (lb)	
		CW CRES	Grade 5	CW CRES	Grade 5
1	0.065	20.00	28.00	5.50	8.00
2	0.130	10.00	14.00	3.00	4.00
3	0.195	7.00	10.00	2.00	2.50
4	0.260	5.00	7.50	1.50	2.00
5	0.325	4.00	6.00	1.00	1.50
3/8-inch spacer	0.375	3.50	5.00	1.00	1.50

TABLE III. Weight limits per 3/8 diameter fastener made of cold-worked 300 series CRES per ASTM F593 and grade 5 alloy steel per SAE J429 used to mount equipment with shims in submarines.

0.065-inch thick washers used, m	Total thickness, d (in)	Deck environment mounted weight per fastener (lb)		Hull environment mounted weight per fastener (lb)	
		CW CRES	Grade 5	CW CRES	Grade 5
1	0.065	5.50	8.00	5.50	8.00
2	0.130	3.00	4.00	3.00	4.00
3	0.195	2.00	2.50	2.00	2.50
4	0.260	1.50	2.00	1.50	2.00
5	0.325	1.00	1.50	1.00	1.50
3/8-inch spacer	0.375	1.00	1.50	1.00	1.50

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4.1.3 Holes drilled in beams. Location of holes drilled in beams for passing cables or securing of supports or equipment shall be on or above the neutral axis.

4.1.4 Malleable iron castings. Malleable iron castings are not approved for any install except as may be noted on the individual figure.

4.1.5 Mounting electrical equipment on bulkheads subject to condensation and mounting to prevent galvanic corrosion. The mounting of electrical equipment on bulkheads subject to condensation, such as the outer surface of refrigerated space boundary bulkheads, shall be avoided. If no other location is feasible, the equipment shall be mounted at least 2 inches clear of such surfaces. Also, cable shall not be mounted in direct contact with such bulkheads, but shall use one of the wet location methods. When such surfaces are insulated, appropriate insulation methods shall be used for both equipment and cable. An air gap should be maintained between the mounting surface and the equipment enclosures to prevent galvanic corrosion.

4.1.6 Electrical equipment within gun and missile blast areas. Where necessary to attach electrical equipment to decks or bulkheads within gun and missile blast areas, such equipment shall be mounted to provide a 2-inch minimum clearance between the structure and equipment, and, moreover, such equipment shall be located clear of areas of maximum expected deflection or whip of bulkhead and deck plating in order to prevent breakage or pulling loose of mounting feet.

4.2 Switchboard mounting. Switchboard mounting and bracing shall be in accordance with figures [2B1](#) through [2B6](#). The base of each unit shall be adequately secured to the foundation and shall be in a level plane (with reference to ship's baseline) when secure. In order to ensure there is no warping of the switchboard framework or misalignment of component parts of the switchboard, the base of each section shall not be out-of-plane by more than 1/8 inch after installation, with all securing bolts tightened. Switchboards shall be located so that the base of the units can be bolted directly to the deck stiffeners or foundation and not bolted to a thin deck plate. Foundation bolts of the switchboard units shall be fastened to metal the thickness of which, in the immediate vicinity of the bolts, is at least equivalent to the bolt diameter. The addition of pads may be necessary to obtain the required thickness or to compensate for the lack of flanges on the deck stiffeners. The requirements regarding rigidity of the switchboard structure, the requirements for securing the units to the foundation, and for the foundation in the ship for mounting the switchboard are intended to ensure that the switchboard units after installation in the ship will not display unsatisfactory resonant vibrations. If the horizontal vibration of deck-mounted switchboard sections or switchboards exceeds 0.040-inch double amplitude, measured on the framework near the top of the structure, top bracing shall be provided. Rigidity of the braces and their attachments shall be adequate to prevent vibration of the top of the section. Shear bolts may be employed in the braces if provision is made to prevent the brace from striking the section or bulkhead after shearing of the bolt. Horizontal braces are preferred. The angle of inclination of braces shall not exceed 45 degrees from the horizontal. The braces shall possess inherent flexibility in the vertical direction. Top bracing and installation features shall conform to the methods shown in this section. Bolts, nuts, and washers used to fasten the braces to the switchboard frame shall be held captive by suitable means. Unless other means of bracing are provided, sway bracing shall be provided front-to-back on all switchboards and side-to-side on one-section and two-section switchboards.

4.3 Storage batteries and servicing facilities.

a. The requirements and guidance in this section and in appendix 2C apply to installation of storage batteries that are separate from equipment assemblies. For installation of equipment assemblies that include batteries, such as uninterruptable power supplies (UPS) or pre-fabricated battery racks, the installation procedures in the remaining sections of this standard apply.

b. This standard does not cover installation of submarine main storage batteries.

c. All lead-acid batteries shall be the sealed valve regulated lead-acid (VRLA) type unless otherwise approved by NAVSEA.

d. See appendix 2C for requirements and guidance on installation of batteries and battery servicing facilities.

e. See C.4.6 of appendix 2C for installation requirements for lithium-ion batteries and lithium-ion battery servicing facilities.

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4.4 Casualty power. The casualty power distribution system installation shall be in accordance with figures [2D1](#) through [2D7](#). These figures depict the installation requirements for horizontal bulkhead terminals, vertical risers, portable jumper cable, cable stowage racks, terminals mounted in equipment enclosures, terminal wiring, installation, and end preparation of casualty power cable. The following equipment and cable types shall be used for casualty power installments:

Bulkhead terminals	Symbol 1046 and 1048
Riser terminals	Symbol 1047
Plugs	Symbol 1049
Cable storage racks	Symbol 1040 and 1040.1
Permanent riser cable	TSGU-75 (LSTSGU-75)
Portable cable	THOF-42 (LSTHOF-42)

4.5 Shore power. Connecting and disconnecting shore power shall be conducted in accordance with NETOPS #29. Shore power installation precautions and limitations of [figure 2E1](#) shall be followed. Receptacles and cables associated with 450 volts AC (VAC) shore power facilities for surface ships shall be in accordance with the installation methods shown on figures [2E2](#) through [2E19](#). These figures depict the configuration of 450 VAC shore power stations inside and outside bulkheads, mounting of connection boxes, incline mounted 450 VAC shore power receptacles in protected areas, free standing shore power stations, details of in-line connectors on alongside 450 VAC power cables, portable cable jumper assemblies, termination and potting of plugs, termination and heat shrink boot requirements for in-line connectors, installation details for receptacles, typical 450 VAC shore power cable supports, repair and mounting of terminal boxes, and the repair and preparation of 450 VAC shore power cables.

4.6 Grounding of electrical equipment. The methods for grounding electrical equipment, enclosures, and supports shall be in accordance with MIL-STD-1310. Methods for equipment grounding are included on figures [2A29](#) through [2A33](#). Any metallic component exposed to operators shall be grounded. Removable and hinged enclosure access panels with mounted energized components shall be grounded in accordance with MIL-STD-1310, MIL-DTL-2036, and S9086-KC-STM-010/300.

4.7 Switchboard entry enclosures. A switchboard entry enclosure is a welded or bolted enclosed structure below or above switchboards or load centers to allow cabling for the switchboards or load centers to be separated for connection to the switchboard or load center. Switchboard entry enclosures may be used when necessary to remove cable jackets from electrical cables prior to entering electrical equipment such as switchboards and load centers. Removal of cable jackets may be required to meet cable bend radius requirements or for convenience of handling due to the large number of cables involved. Conductors and cables shall be supported within the first 16 inches of coming out of the collar or transit upon entering the switchboard entry enclosure and every 16 to 32 inches thereafter. Support shall be provided using a fire-resistant, non-magnetic material, such as aluminum or phenolic. Clearance of conductors and cables shall maintain 1.5 inches from sides, bottom, top, and beams inside the switchboard entry enclosure. There shall be no duct work, piping, or any other foreign objects in the switchboard entry enclosure. Switchboard entry enclosure shall be constructed by welding and shall be painted for corrosion protection. Cable entry into switchboard entry enclosures shall be in accordance with MIL-STD-2003-1 requirements for switchboard cable entry.

4.8 Or equal. MIL-STD-2003 uses the term “or equal” to permit the use of parts, components, or tools that are equivalent and can perform the same function as the specified products. The use of the equivalent product is allowed as long as the same functional characteristics, performance, equipment safety, personnel safety, suitability for marine service, life cycle cost, maintenance cost, and supportability are attained, and agreement is obtained from NAVSEA. The request for agreement for the use of “equal” products shall include data that supports that functional and performance equivalence is retained.

4.9 Consideration of electromagnetic shielding. For equipment cable entries where electromagnetic shielding is required to be considered, the shielding practices of S9407-AB-HBK-010 shall be used.

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4.10 Junction boxes to extend incoming power or signal cables. A junction box may be used to avoid replacement of ship cables by extending incoming power or signal cables if a replacement component is equipped with incoming terminals in a different location than the original component. In this case, the cabling between the extension junction box and the replacement component shall meet all requirements of the original power or signal cables.

4.11 Inactive for new design documents. Some of the documents referenced in MIL-STD-2003-2 have been declared as inactive for new design by decision of the Department of Defense. Where replacement documents are designated, the replacement document is normally substituted for the inactive for new design document. Methods that reference inactive for new design documents shall not be used for new ship design unless approved by NAVSEA. Components and products produced in accordance with the inactive for new design documents shall not be used for new design of systems or equipment; however, this does not prohibit use for maintenance, repair, or resupply purposes.

4.12 Workmanship and inspection guidance. For workmanship and inspection guidance associated with equipment installation, see S9300-A6-GYD-010. For any conflict between this standard and S9300-A6-GYD-010, the requirements of this standard take precedence.

4.13 Installation of fiber optic cable topology (FOCT) equipment. For installation of FOCT equipment, see MIL-STD-2042-2.

4.14 Guidance for installation of electronic equipment. For installation of electronic equipment, follow the guidance of SE000-01-IMB-010. If there are conflicts between the installation requirements in SE000-01-IMB-010 and this standard, the requirements in this standard take precedence.

4.15 Hazardous materials. Materials and products utilized to execute installation methods in this standard should avoid chemicals listed on the NAVSEA List of Targeted Chemicals (N-LTC) contained within T9070-AL-DPC-020/077-2. These chemicals pose significant risk to the user, environment, or both, and are deemed both undesirable and unsustainable by NAVSEA. NAVSEA is minimizing the use of hazardous materials in procedures such as those covered by this standard. Alternative materials should be considered for applications covered in this document to minimize the use of targeted chemicals. NAVSEA should be informed of the need for the use of any of the targeted chemicals prior to procedure execution.

4.16 The terms agreement or approval. Wherever such terms as “approved” or “agreement” are used without further qualification, it is the approval or agreement of the Supervising Authority or NAVSEA, as applicable, that is intended. In these cases, the approval request and the response shall be formal, in writing, and traceable. Existing methods allowed by applicable ship specifications, such as departures from specifications, are acceptable. The Supervising Authority, also referred to as the Supervisor, is defined in the applicable ship specifications.

5. DETAILED REQUIREMENTS

(See figures.)

6. NOTES

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

6.1 Intended use. This standard specifies the requirements for equipment mounting, switchboard mounting, battery equipment, casualty power, and shore power methods to be employed both on surface ships and submarines. Standard methods identified for electric plant installation are intended for new construction, conversion, and alteration of existing ships. The use of this standard will be specified in the contract, ship specifications, and similar implementing documents (such as COMUSFLTFORCOMINST 4790.3, Joint Fleet Maintenance Manual (JFMM) and S9086-KC-STM-010/300, Naval Ships' Technical Manual Chapter 300, Electric Plant-General).

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this standard.

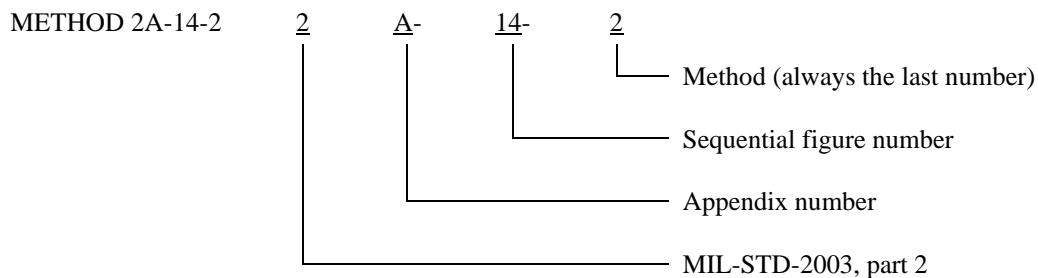
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6.3 Designation of electric plant installation standard methods figures. The electric plant installation standard method MIL-STD-2003-2 contains drawings that depict standard methods that are applicable for general electric plant installation on both surface ships and submarines. The methods shown on the figures are grouped together in the following appendices to this standard. Each appendix provides requirements for similar functions.

MIL-STD-2003-2 (Equipment)

- A. Standard methods for Mounting Equipment (Appendix 2A)
- B. Switchboard Mounting (Appendix 2B)
- C. Battery Rack Mounting (Appendix 2C)
- D. Casualty Power (Appendix 2D)
- E. Shore Power (Appendix 2E)

The methods shown on the figures are identified by the following alphanumeric designation system:



Thus, method 2A-14-2 identifies method 2, figure number 14, Appendix 2A of MIL-STD-2003-2.

6.4 Subject term (key word) listing.

Battery equipment
 Battery rack
 Bulkhead
 Casualty power
 Deck
 Fastener
 Foundation
 Ground
 Lithium-ion
 Mounting
 Shield
 Shore power
 Switchboard
 Thread
 Torque seal
 VRLA
 Washer
 Watertight
 Weld

6.5 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.

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APPENDIX 2A

APPENDIX 2A – STANDARD METHODS FOR MOUNTING EQUIPMENT

A.1 SCOPE

A.1.1 Scope. This appendix describes standard methods and procedures for the installation and mounting of equipment. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

A.2 APPLICABLE DOCUMENTS

A.2.1 General. The documents listed in this section are specified in this appendix. This section does not include documents cited in other sections of this standard 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 this appendix, whether or not they are listed.

A.2.2 Government documents.

A.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.

COMMERCIAL ITEM DESCRIPTIONS

A-A-59125 - Terminal Boards, Molded, Barrier Screw and Stud Types and Associated Accessories

DEPARTMENT OF DEFENSE SPECIFICATIONS

- MIL-DTL-917 - Electric Power Equipment, Basic Requirements for
- MIL-I-3064 - Insulation, Electrical, Plastic-Sealer
- MIL-PRF-15624 - Gasket Material, Rubber, 50 Durometer Hardness (Maximum)
- MIL-PRF-23236 - Coating Systems for Ship Structures
- MIL-S-24149 - Studs, Welding, and Arc Shields (Ferrules), General Specification for
- MIL-DTL-24231/1 - Connector, Plug, Type I, Molded, Three-, Four-, and Five-Conductor
- MIL-DTL-24231/10 - Connectors, Single Cable, Type III, 14-, 24-, 30-, or 40-Conductor
- MIL-DTL-24231/25 - Connector, Hull Inserts, Type VII
- MIL-S-24235 - Stuffing Tubes, Metal, and Packing Assemblies for Electric Cables, General Specification for
- MIL-DTL-24441/20 - Paint, Epoxy-Polyamide, Green Primer, Formula 150, Type III
- MIL-DTL-24749 - Grounding Straps and Studs, Electrical Bonding
- MIL-PRF-32273 - Battery Cells and Modules, Valve Regulated Lead-Acid, Main Storage, Submarine; General Specification for
- MIL-PRF-32273/1 - Battery Cell, Valve Regulated Lead-Acid, Main Storage, Submarine, Classification Type B
- MIL-PRF-32273/2 - Battery Cell, Valve Regulated Lead-Acid, Main Storage, Submarine, Classification Type C

DEPARTMENT OF DEFENSE STANDARDS

- MIL-STD-1310 - Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility, Electromagnetic Pulse (EMP) Mitigation, and Safety

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- MIL-STD-2003-3 - Electric Plant Installation Standard Methods for Surface Ships and Submarines (Penetrations)

DEPARTMENT OF DEFENSE HANDBOOKS

- MIL-HDBK-290 - Standard Electrical Symbol List
MIL-HDBK-2036 - Preparation of Electronic Equipment Specifications

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

A.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

- 815-1853069 - Bearing Circle and Compass Holder for Portable Gyro Repeater
815-1853085 - Portable Ship Control Unit, Type IC/29A40 SYM2945, Type IC/29A40-M SYM 2945- M, Type IC/ 29A40- T SYM 2945- T, Submarine Bridge

(Copies of these documents are available from the applicable repositories listed in S0005-AE-PRO-010/EDM, which can be obtained online via Technical Data Management Information System (TDMIS) at <https://mercury.tdmis.navy.mil/>. Copies of these documents may also be obtained from the Naval Ships Engineering Drawing Repository (NSED) online at <https://199.208.213.105/webjedmics/index.jsp>. To request an NSED account for drawing access, send an email to NNSY_JEDMICS_NSED_HELP_DESK@navy.mil.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

- S9086-CJ-STM-010/075 - NSTM Chapter 075, Fasteners
S9086-KC-STM-010/300 - Naval Ships' Technical Manual Chapter 300, Electric Plant-General

(Copies of these documents are available online via Technical Data Management Information System (TDMIS) at <https://mercury.tdmis.navy.mil/> by searching for the document number without the suffix. Refer questions, inquiries, or problems to: DSN 296-0669, Commercial (805) 228-0669. These documents are available for ordering (hard copy) via the Naval Logistics Library (NLL) at <https://nll.navsup.navy.mil>. For questions regarding the NLL, contact the NLL Customer Service at nllhelpdesk@navy.mil, (866) 817-3130, or (215) 697-2626/DSN 442-2626.)

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

ASTM INTERNATIONAL

- ASTM A36/A36M - Standard Specification for Carbon Structural Steel
ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes

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ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

ASTM F1836M - Standard Specification for Stuffing Tubes, Nylon, and Packing Assemblies (Metric)

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

SAE INTERNATIONAL

SAE-AS23190 - Wiring, Positioning, and Support Accessories

(Copies of this document are available online at www.sae.org.)

A.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.

A.3 REQUIRED EQUIPMENT AND MATERIALS

A.3.1 Required equipment and materials. Equipment and materials for the installation and mounting of equipment shall be as specified on figures [2A1](#) through [2A33](#).

A.4 NOTES AND PROCEDURES

A.4.1 Dimensions. For figures and tables in this appendix, all dimensions are in inches unless otherwise noted.

A.4.2 Figures. [Table 2AI](#) provides information for the figures in this appendix.

TABLE 2AI. Figures for equipment mounting.

Figure number	Equipment mounting	Page
2A1	Equipment secured to watertight and non-watertight steel decks or bulkheads	17
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2A3	Bracket fans supported on steel bulkheads	21
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2A6	Equipment mounted on aluminum watertight and non-watertight decks and bulkheads	26
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2A9	Equipment mounted on aluminum stanchions	31
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2A14	Equipment mounted on cabling racks	38
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TABLE 2AI. Figures for equipment mounting – Continued.

Figure number	Equipment mounting	Page
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2A20	Locking devices on electrical connections	49
2A21	Portable ship control unit submarine bridge type	50
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2A24	Electrical equipment mounting to glass reinforced plastic (GRP) bulkheads/panels	54
2A25	Clip mounting of electrical equipment	56
2A26	Sealing holes in electrical equipment	65
2A27	Stool mounting of electrical equipment	69
2A28	Deck to deck support of electrical equipment	75
2A29	Grounding of isolated equipment using bond straps	77
2A30	Grounding of welded or bolted equipment	79
2A31	Grounding of electrical equipment box covers	80
2A32	Grounding of electrical equipment mounted on ungrounded surfaces	81
2A33	Grounding of slide mounted equipment	82

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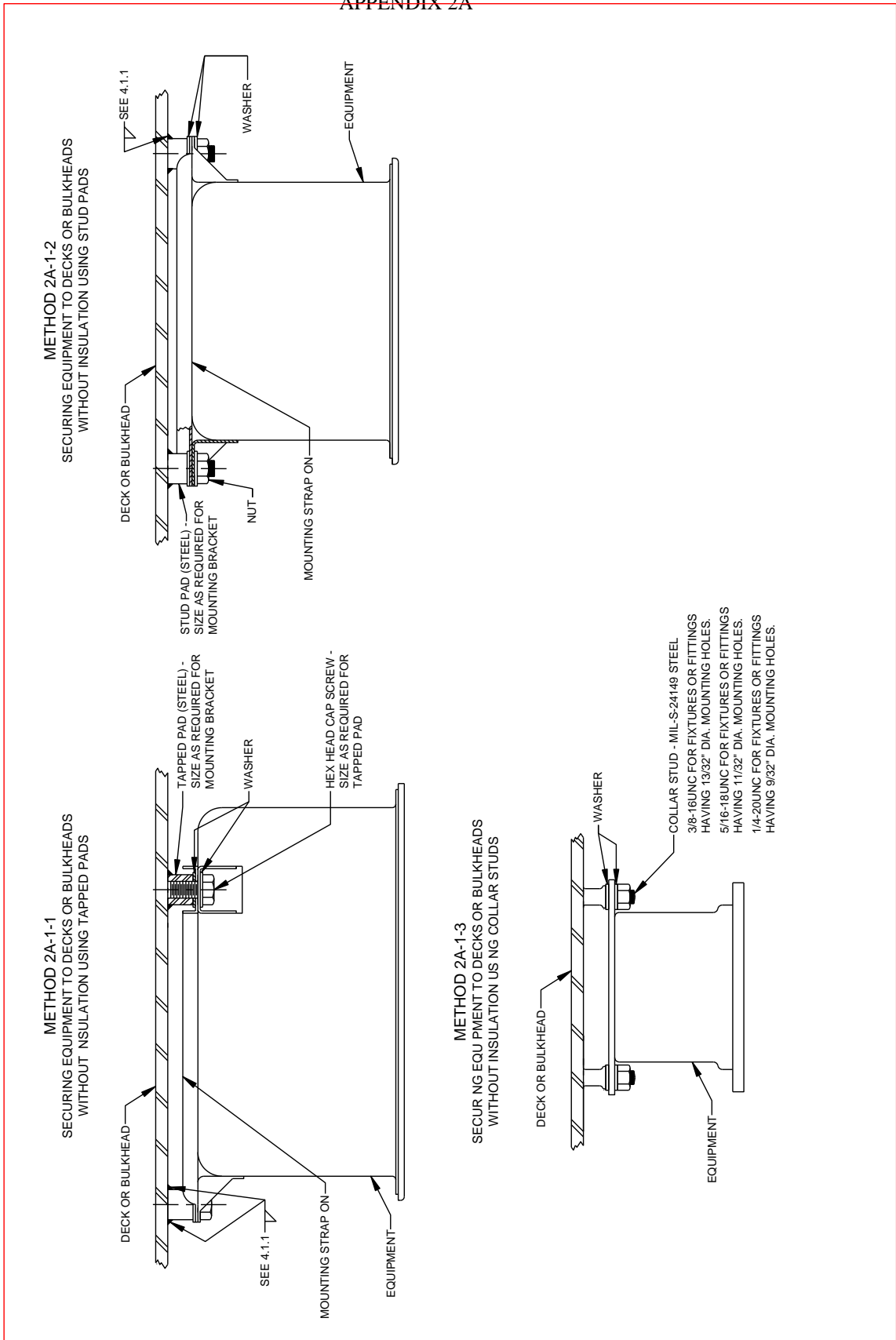
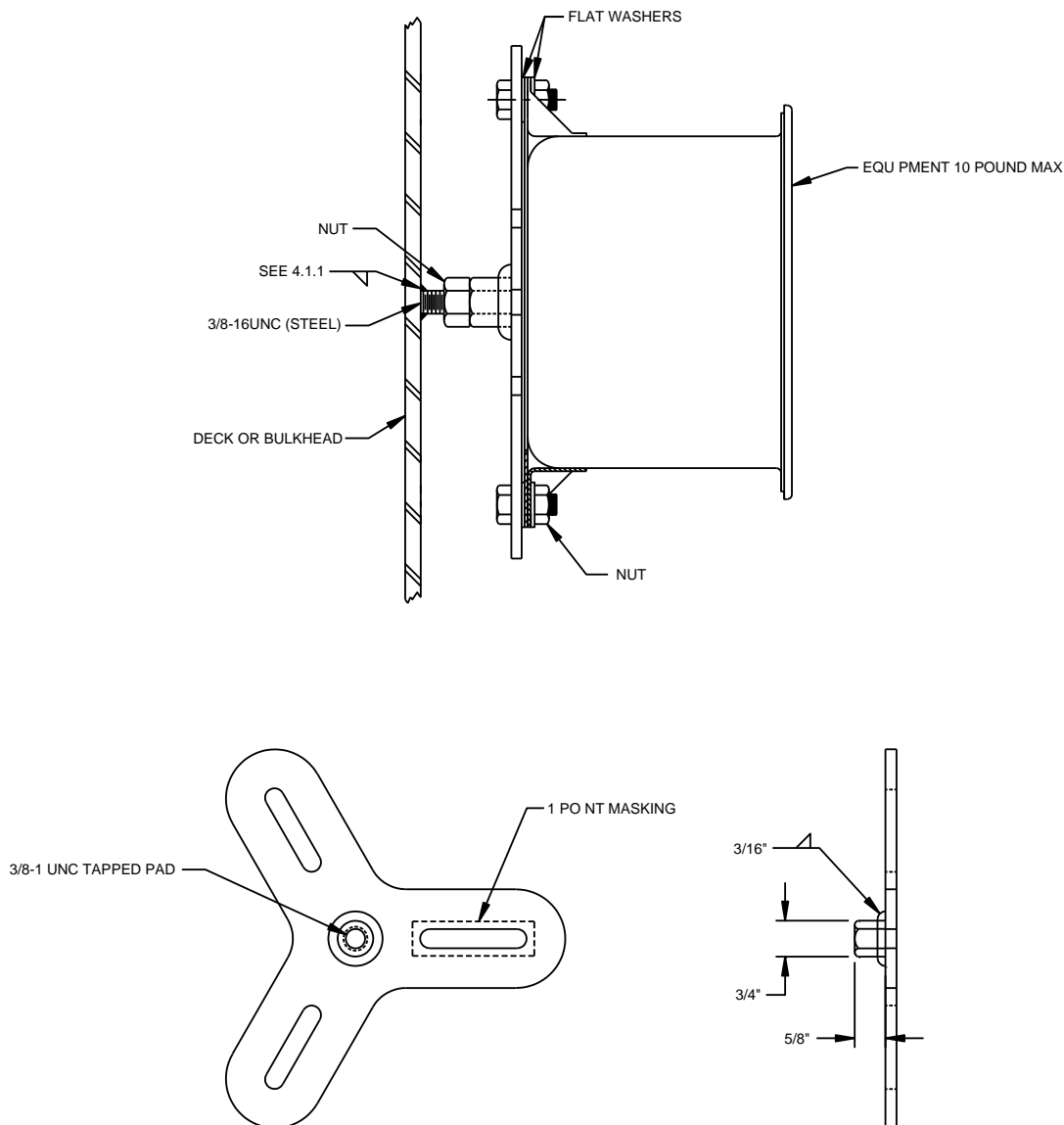


FIGURE 2A1. Equipment secured to watertight and non-watertight steel decks or bulkheads.

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METHOD 2A-1-4
SECURING EQUIPMENT TO DECKS OR BULKHEADS
WITHOUT INSULATION USING STUD



NOTES:

1. See 4.1.2 for mounting fastener requirements.
2. Methods shown are for use on interior decks or bulkheads when not subjected to moisture or high temperature (125 °F [51.6 °C]). Not to be used for decks or bulkheads insulated or exposed to weather.
3. For stud mounting, equipment with $\frac{5}{8}$ - or $\frac{3}{4}$ -inch diameter mounting holes may be mounted with $\frac{1}{2}$ -inch studs.
4. For stud mounting, collar studs with $\frac{3}{4}$ - or 1-inch thread length should be used for mounting commercial boxes using existing knock-out holes.
5. See 4.1.1 for welding and stud requirements.

FIGURE 2A1. Equipment secured to watertight and non-watertight steel decks or bulkheads – Continued.

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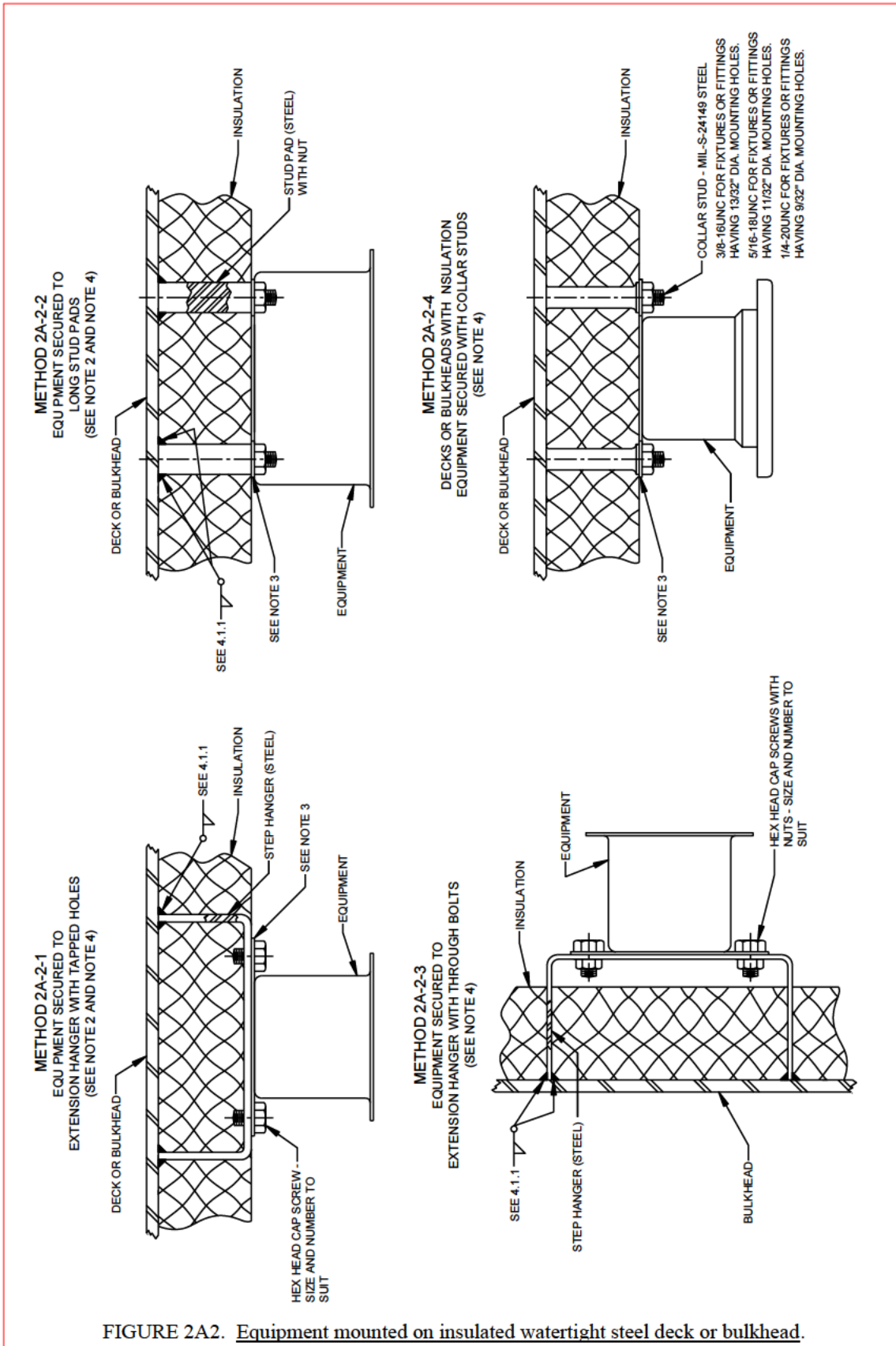


FIGURE 2A2. Equipment mounted on insulated watertight steel deck or bulkhead.

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NOTES:

1. See 4.1.2 for mounting fastener requirements.
2. Methods 2A-2-1 and 2A-2-2 may be used when bulkheads or decks are ballistic or type A protective plate.
3. Step hangers shall be flush with surface of insulation and threads shall extend ½ inch above insulation or equipment to properly mount equipment. See 4.1.2.5 for requirements for thread protrusion.
4. Methods 2A-2-1, 2A-2-2, 2A-2-3, and 2A-2-4 are for use on interior decks or bulkheads not subjected to moisture or high temperature (125 °F [51.6 °C]).
5. For stud mounting, equipment with 5/8- or ¾-inch diameter mounting holes may be mounted with ½-inch studs.
6. For stud mounting, collar studs with ¾- or 1-inch thread length should be used for mounting commercial boxes using existing knock-out holes.
7. See 4.1.1 for welding and stud requirements.

FIGURE 2A2. Equipment mounted on insulated watertight steel deck or bulkhead – Continued.

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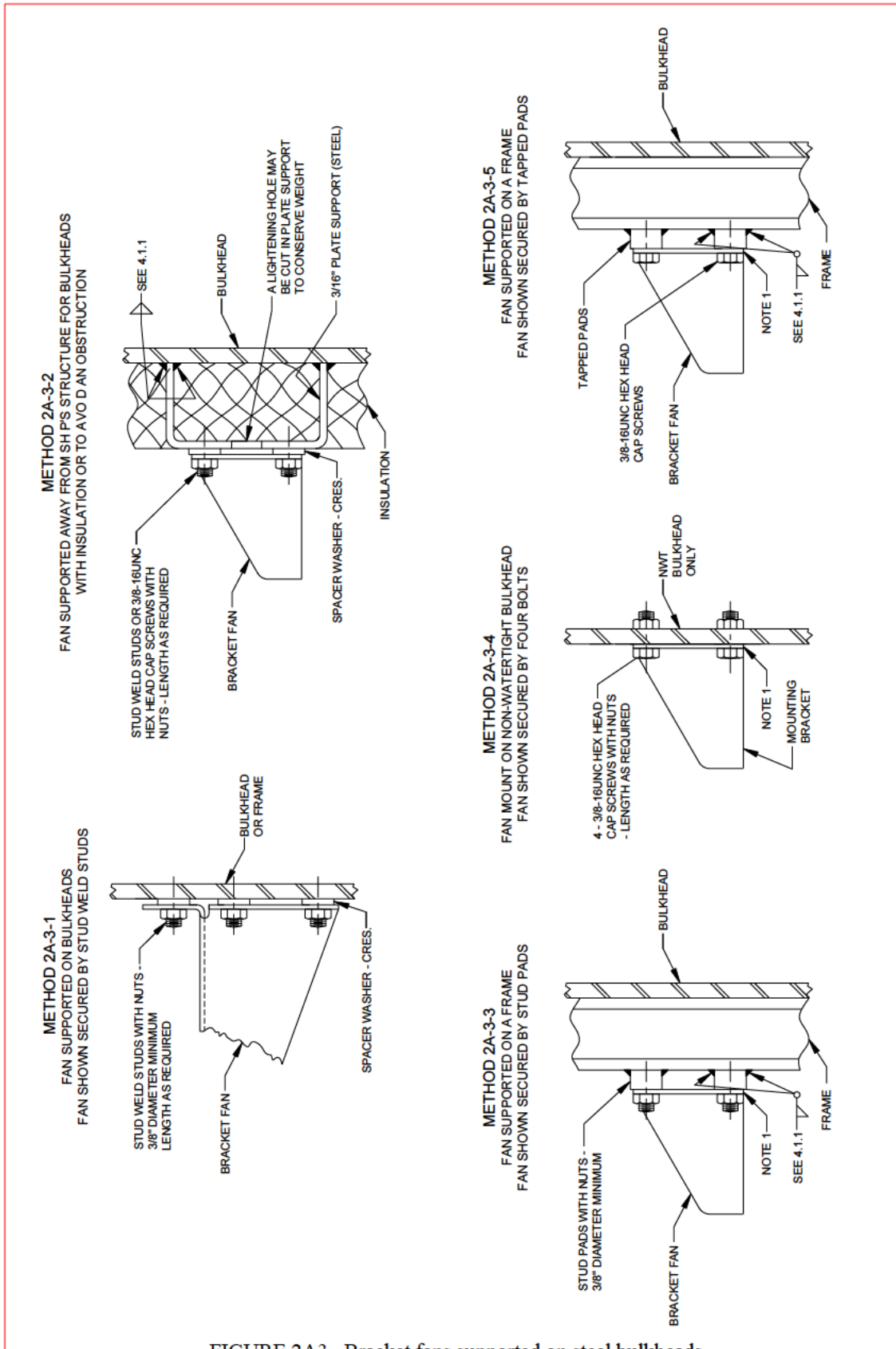


FIGURE 2A3. Bracket fans supported on steel bulkheads.

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NOTES:

1. See 4.1.2 for mounting fastener requirements.
2. Methods shown are for use on interior bulkheads not subjected to moisture or high temperature (125 °F [51.6 °C]).
3. See 4.1.1 for welding and stud requirements.

FIGURE 2A3. Bracket fans supported on steel bulkheads – Continued.

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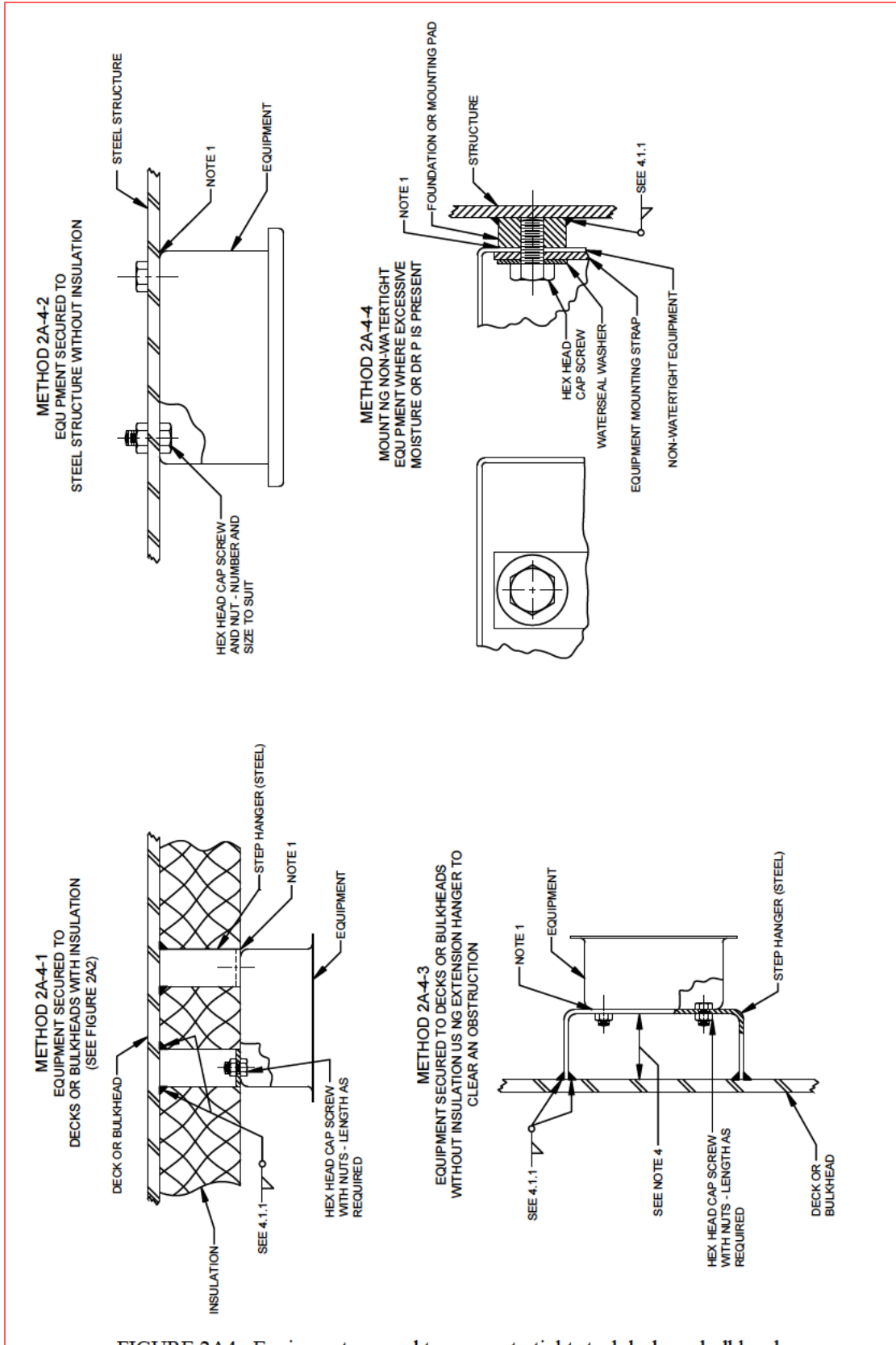


FIGURE 2A4. Equipment secured to non-watertight steel decks or bulkheads.

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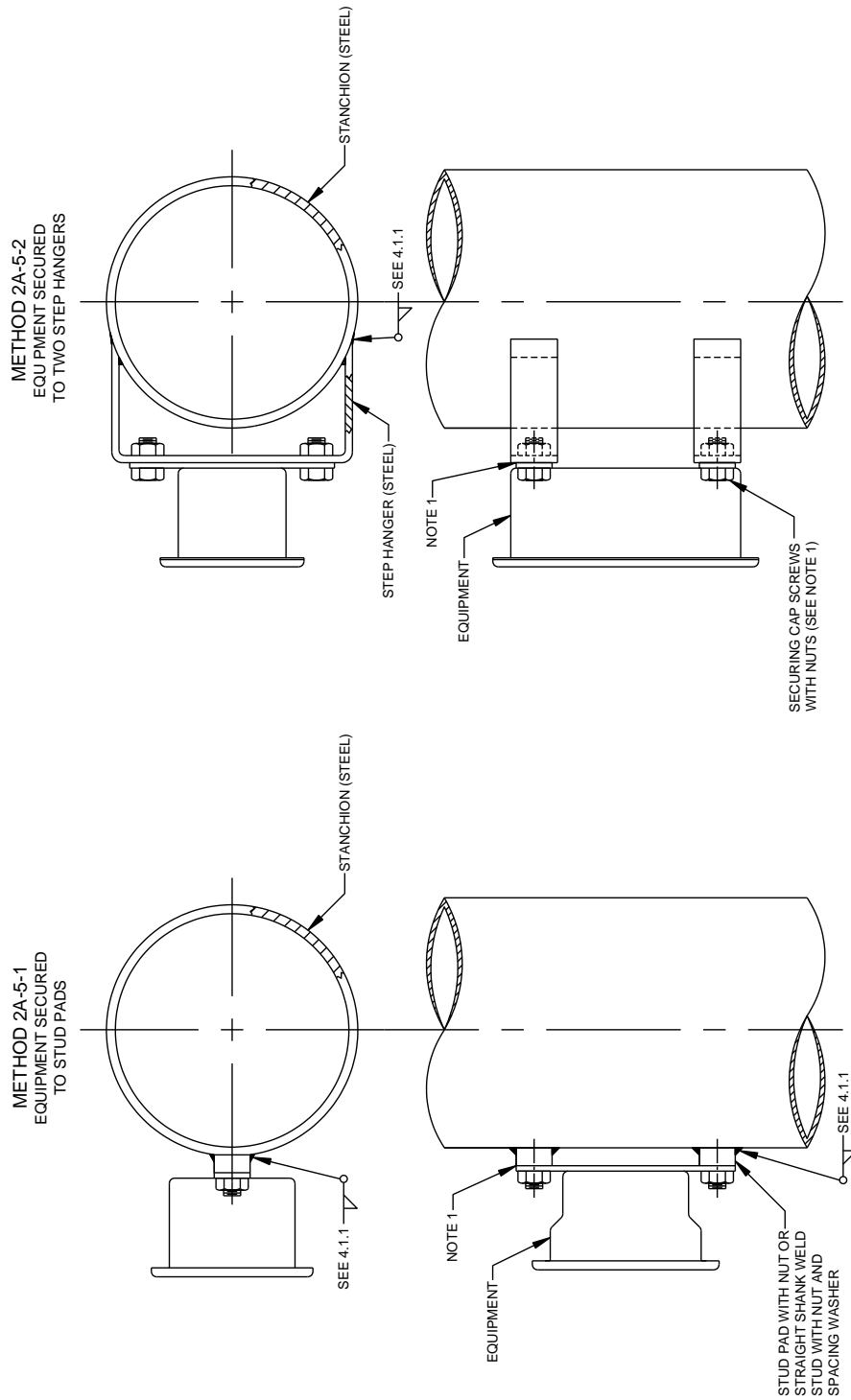
TABLE 2A4-I. Waterseal washer table.

Mounting	Metal portion – stainless steel			Rubber portion - neoprene			
	Bolt	Outside diameter (O.D.)	Inside diameter (I.D.)	Thickness	Outside diameter (O.D.)	Inside diameter (I.D.)	Thickness
	¼	0.729	0.3593	0.0299	0.8125	0.1875	0.0625 to 0.0937
	⅜	0.875	0.50	0.0299	0.9375	0.2812	0.0625 to 0.0937
	½	1.1875	0.5468	0.0299	1.250	0.4062	0.0625 to 0.0937
	⅝	1.5625	0.750	0.0359	1.625	0.50	0.0625 to 0.0937
	¾	1.090625	0.962	0.0359	2.0312	0.625	0.0625 to 0.0937

NOTES:

1. See 4.1.2 for mounting fastener requirements.
2. Suitable corrosion protection shall be used for dissimilar metals.
3. Methods 2A-4-1, 2A-4-2, and 2A-4-3 are for use on interior decks and bulkheads not exposed to weather, moisture, or high temperature (125 °F+ [51.6 °C+]).
4. This dimension shall be sufficient to clear the obstruction.

FIGURE 2A4. Equipment secured to non-watertight steel decks or bulkheads – Continued.

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NOTES:

1. See 4.1.2 for mounting fastener requirements.
2. For use in interior of ships where not exposed to weather, moisture, or high temperature (125 °F+ [51.6 °C+]).
3. See 4.1.1 for welding and stud requirements.

FIGURE 2A5. Equipment secured to steel stanchions.

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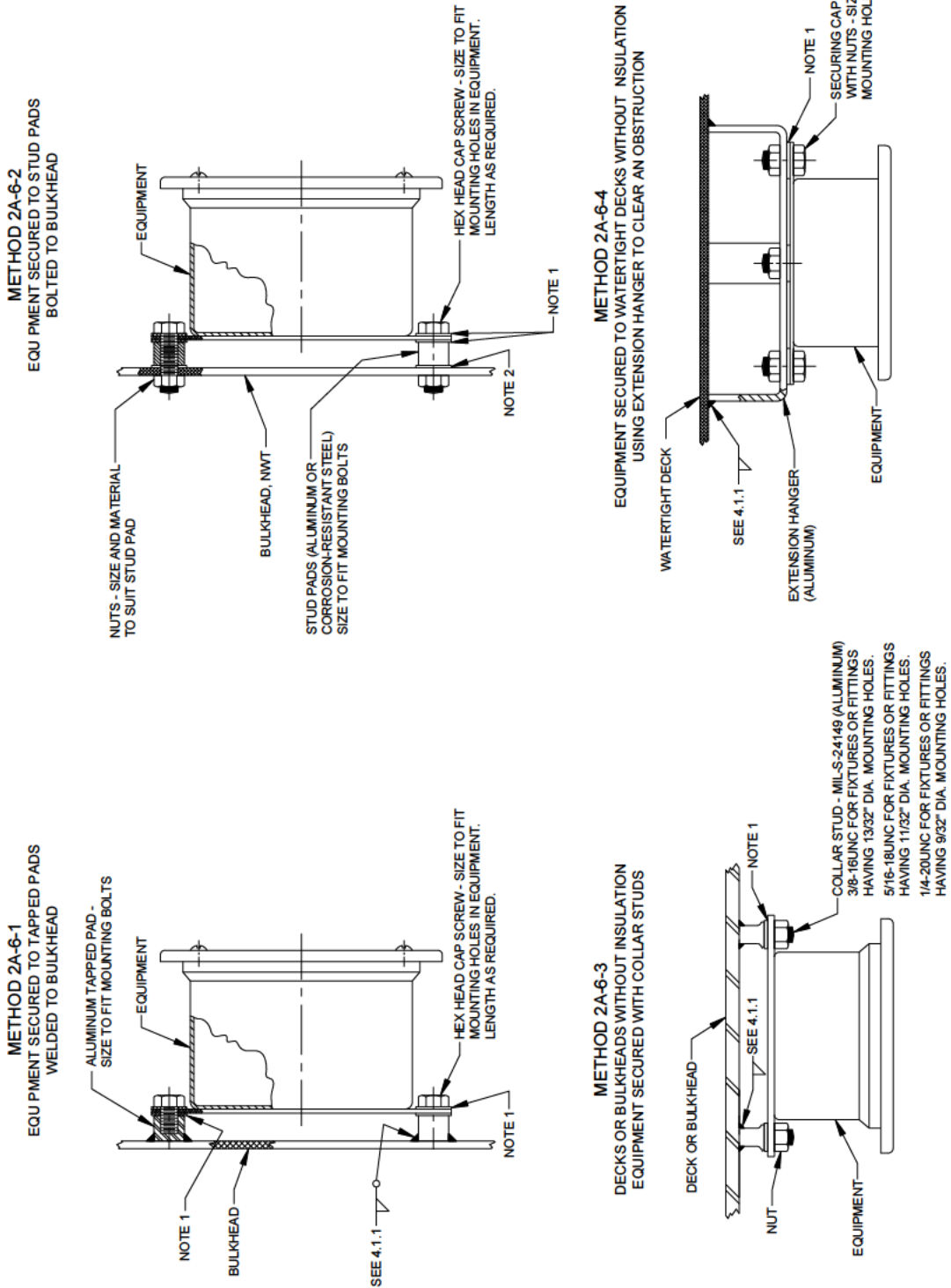


FIGURE 2A6. Equipment mounted on aluminum watertight and non-watertight decks and bulkheads.

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NOTES:

1. See 4.1.2 for mounting fastener requirements.
2. Apply gasket joint sealing packing material on watertight bulkheads.
3. See 4.1.1 for welding and stud requirements.

FIGURE 2A6. Equipment mounted on aluminum watertight and non-watertight decks and bulkheads – Continued.

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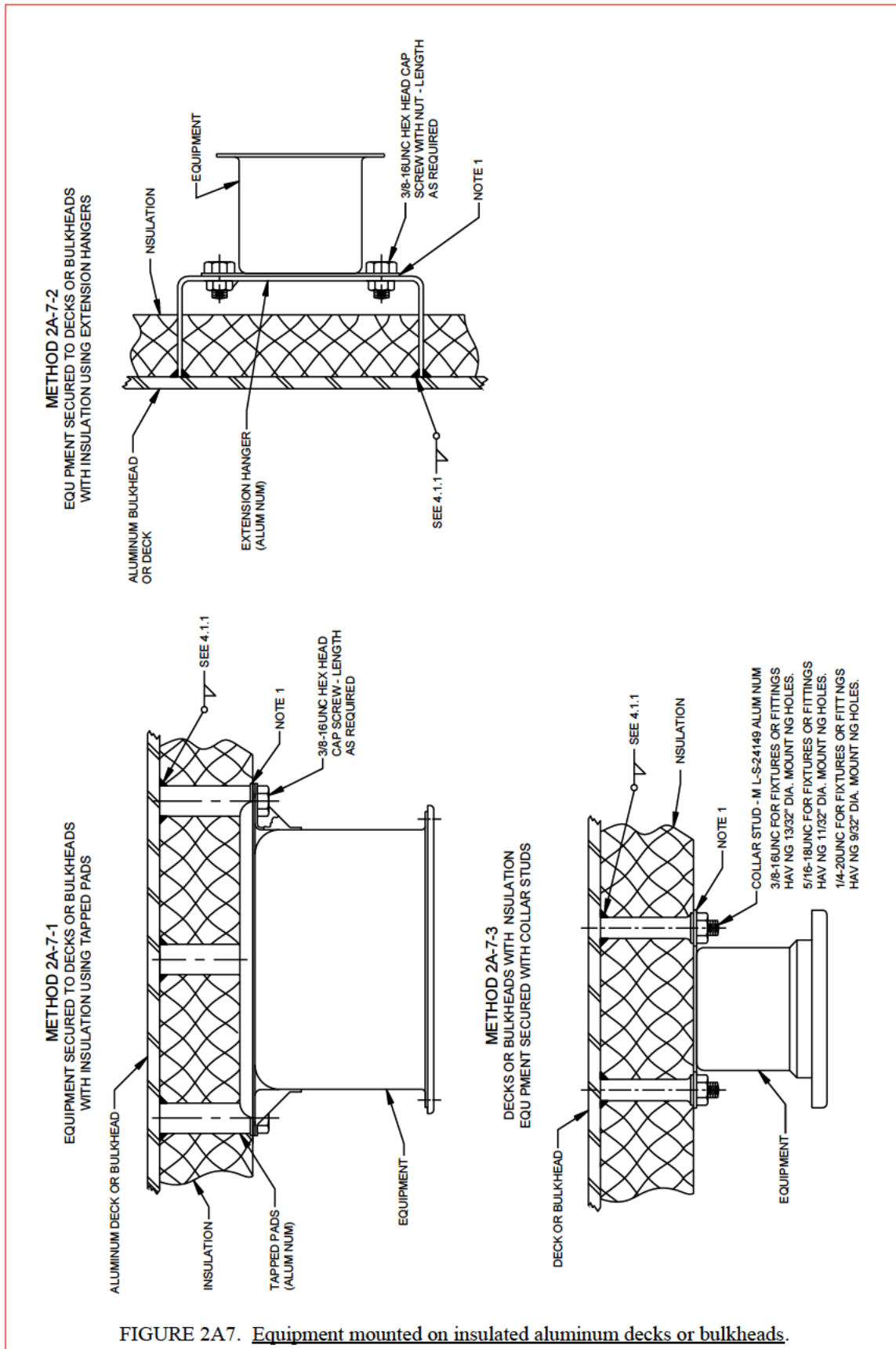


FIGURE 2A7. Equipment mounted on insulated aluminum decks or bulkheads.

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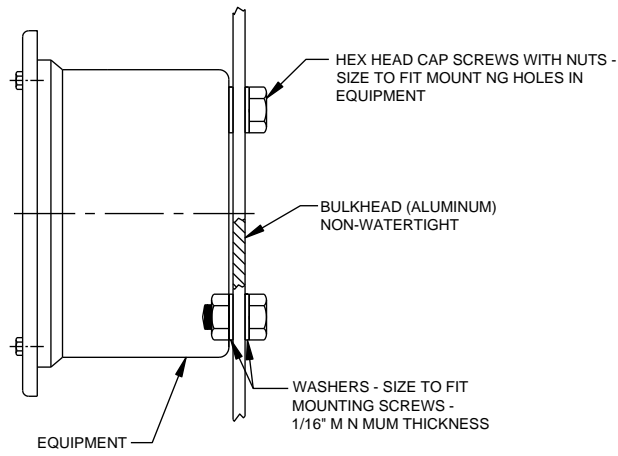
NOTES:

1. See 4.1.2 for mounting fastener requirements.
2. For use in interior of ships where not exposed to weather, moisture, or high temperature (125 °F+ [51.6 °C+]).
3. See 4.1.1 for welding and stud requirements.

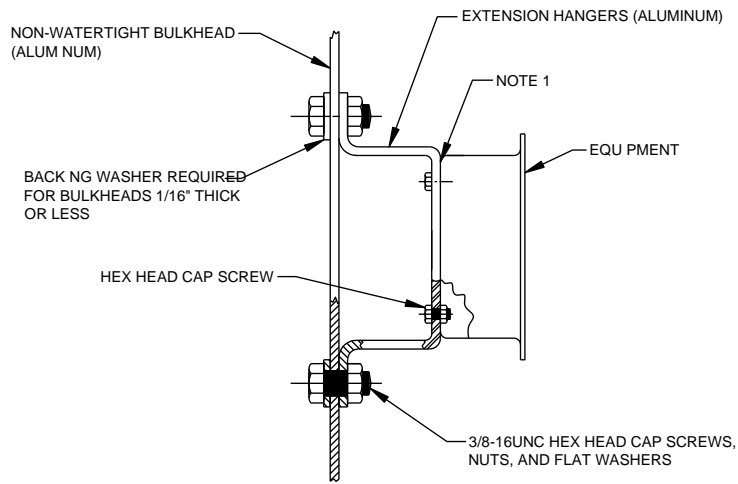
FIGURE 2A7. Equipment mounted on insulated aluminum decks or bulkheads – Continued.

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METHOD 2A-8-1
EQUIPMENT SECURED TO
BULKHEADS 3/16" THICK AND OVER



METHOD 2A-8-2
EQUIPMENT SECURED TO NON-WATERTIGHT BULKHEAD
USING EXTENSION HANGER TO CLEAR AN OBSTRUCTION



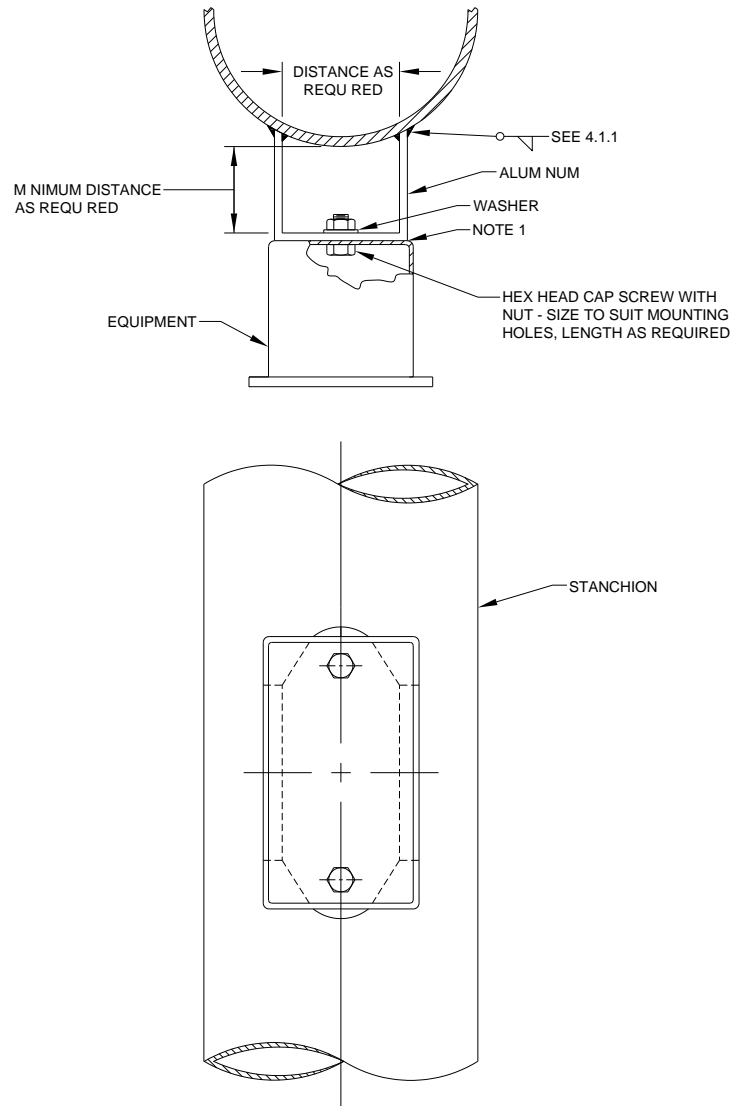
NOTE:

1. See 4.1.2 for mounting fastener requirements.

FIGURE 2A8. Equipment mounted on non-watertight aluminum bulkheads.

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METHOD 2A-9-1
EQUIPMENT SECURED TO ALUMINUM STANCHIONS
AND BULKHEADS LESS THAN 3/16" THICK



NOTE:

1. See 4.1.2 for mounting fastener requirements.

FIGURE 2A9. Equipment mounted on aluminum stanchions.

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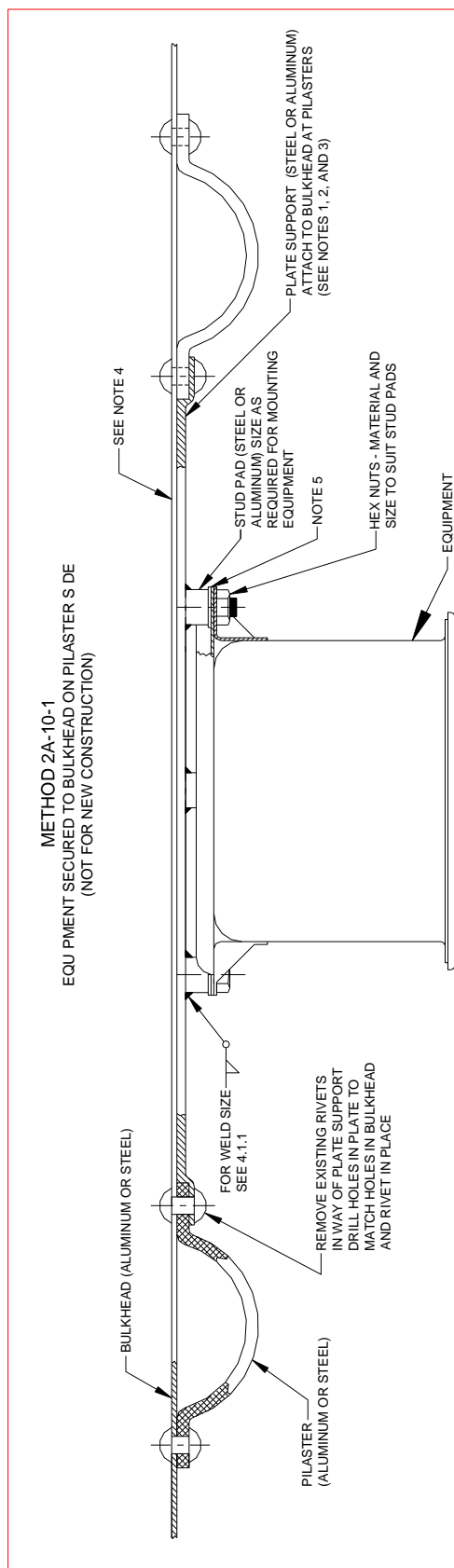


FIGURE 2A10. Equipment mounted on aluminum or steel pilaster bulkheads.

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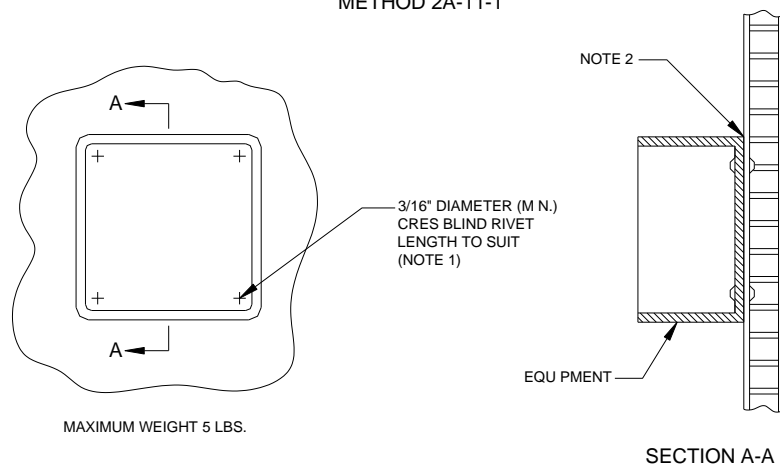
NOTES:

1. Plate support is not required except when equipment to be mounted is greater than 6 by 9 inches or weighs 15 pounds or more.
2. Steel plate supports shall be used when attaching brass equipment.
3. Aluminum plate supports may be used when attaching aluminum or steel equipment.
4. Apply two coats of primer in accordance with MIL-PRF-23236 or MIL-DTL-24441/20, F150 between faying surface of bulkhead and plate support.
5. See 4.1.2 for mounting fastener requirements.
6. See 4.1.1 for welding and stud requirements.

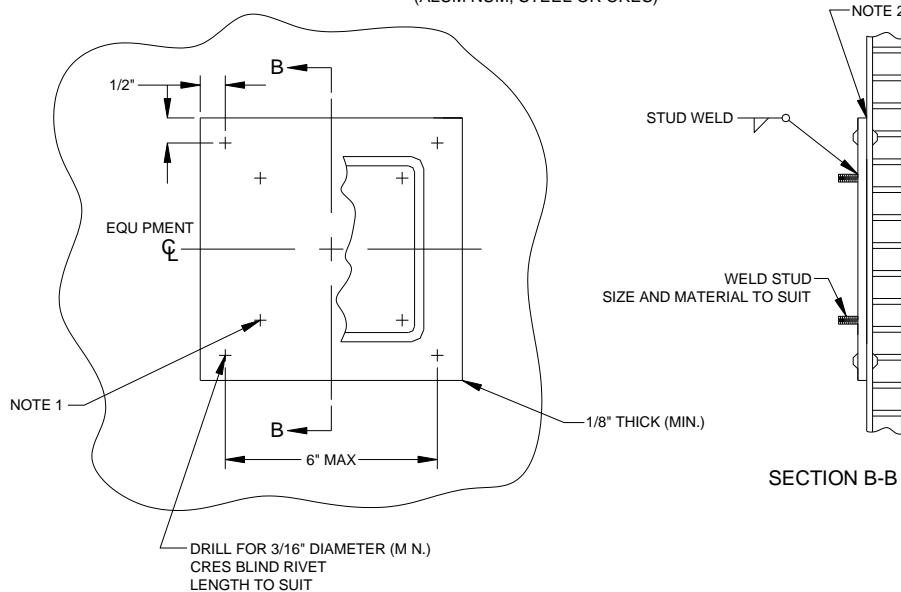
FIGURE 2A10. Equipment mounted on aluminum or steel pilaster bulkheads – Continued.

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METHOD 2A-11-1



METHOD 2A-11-2
MOUNTING PLATE
(ALUM NUM, STEEL OR CRES)

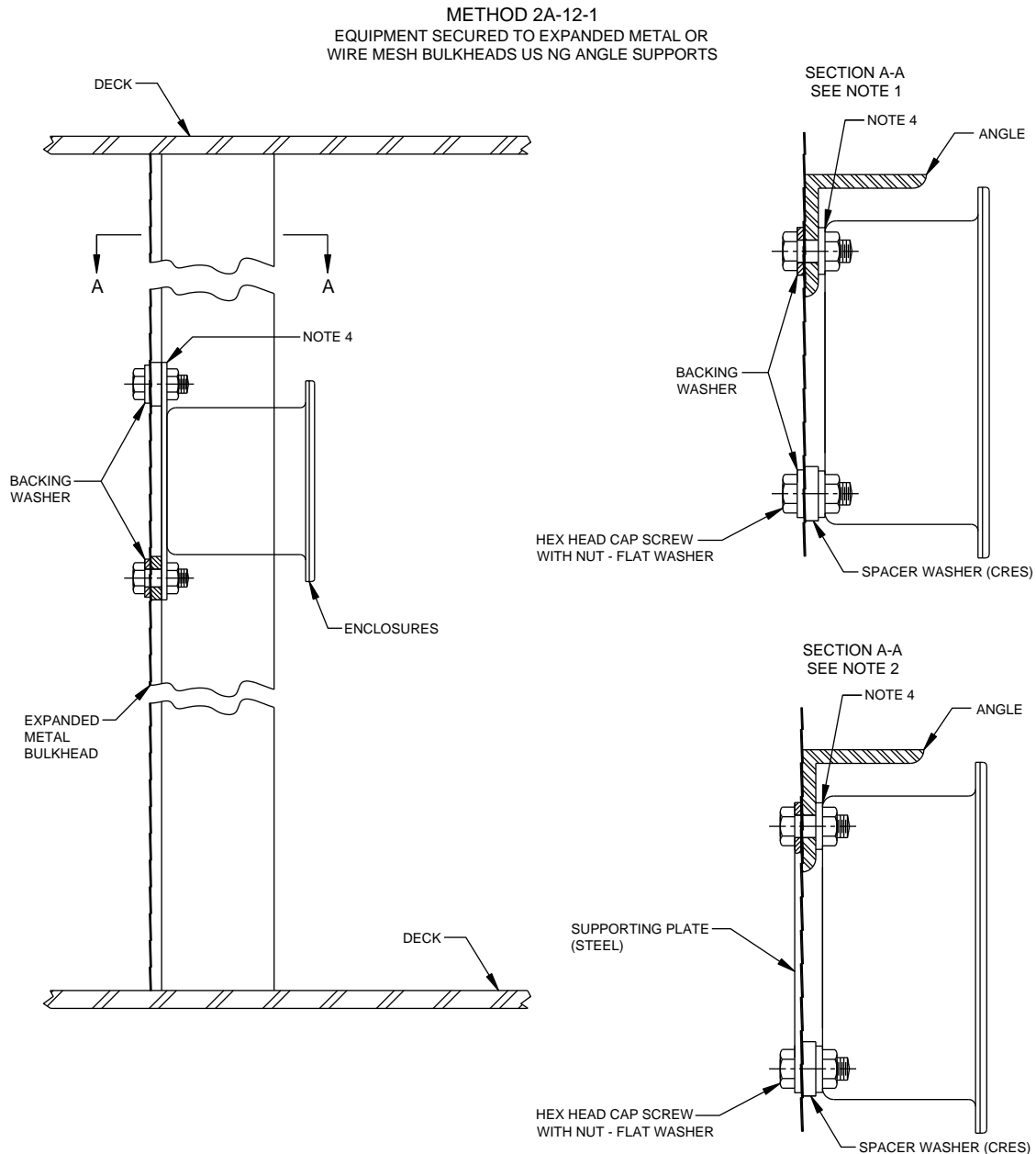


NOTES:

1. Location of mounting holes to be templated from unit being installed.
2. All faying surfaces of aluminum to dissimilar metal to be protected with one layer of scotch wrapped no. 22 tape, Minnesota Mining and Mfg. Co., or equal (see 4.8).
3. See 4.1.1 for welding and stud requirements.

FIGURE 2A11. Equipment mounted on metal joiner bulkheads.

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NOTES:

1. Method shown is for components up to 10 pounds.
2. Method for appliances over 10 pounds and up to 30 pounds use backing plates extended to angle support for mesh. Backing plates to be 1/8-inch steel.
3. No appliances are to be mounted on portable sections of expanded metal bulkheads except small fixtures which may easily be moved and which must be attached thereto for efficient operation.
4. See 4.1.2 for mounting fastener requirements.

FIGURE 2A12. Equipment mounted on expanded metal or wire mesh bulkheads.

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METHOD 2A-13-1
EQUIPMENT SECURED TO EXPANDED
METAL OR WIRE MESH BULKHEADS

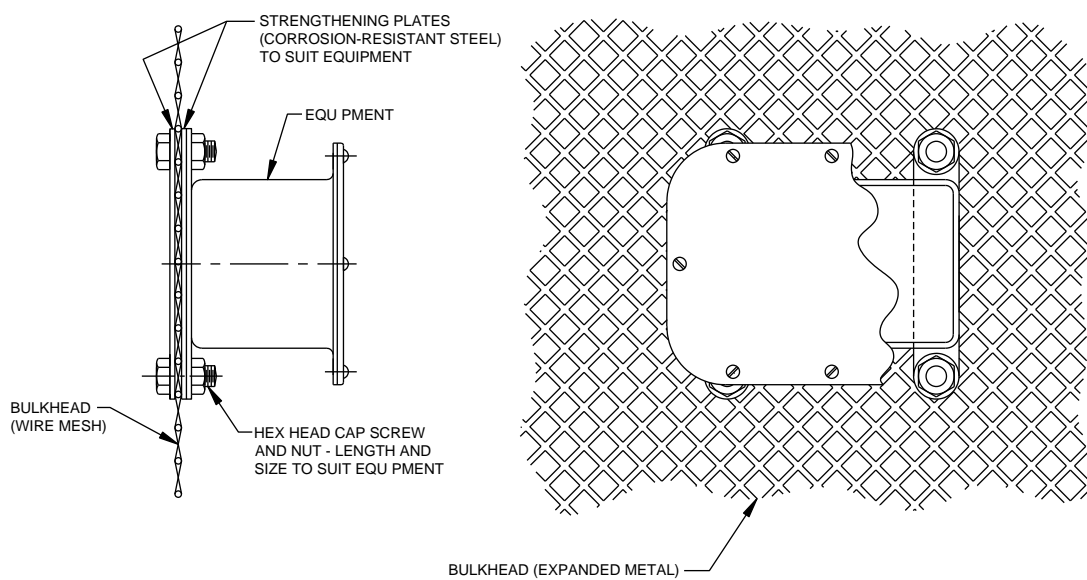


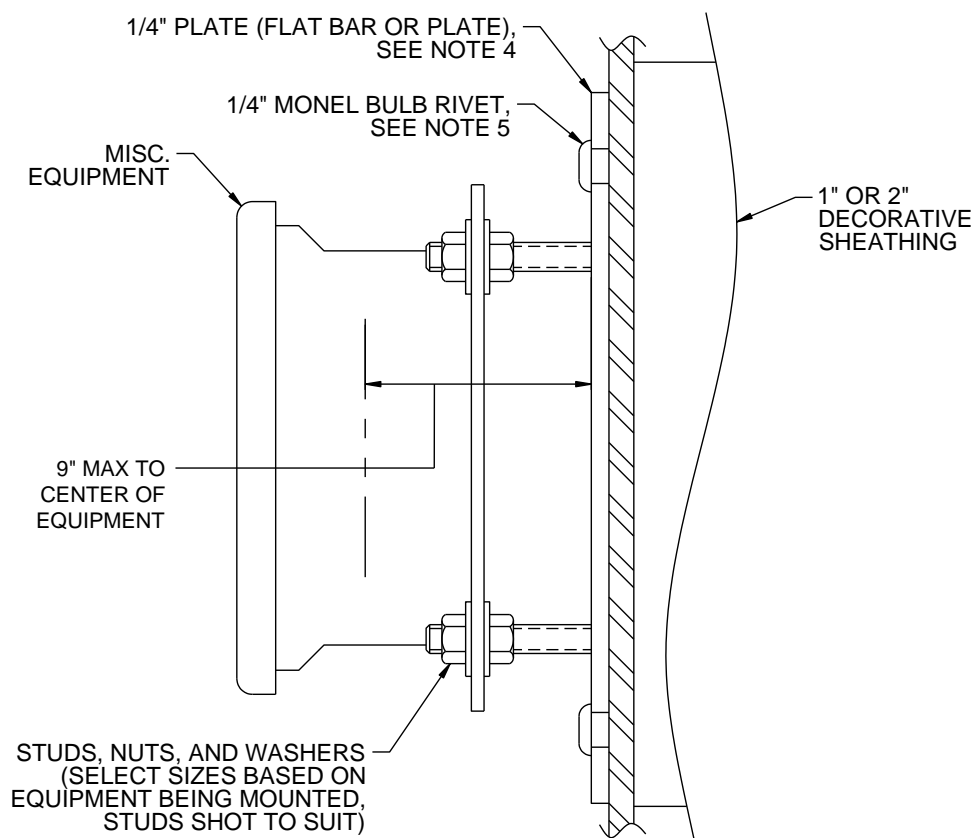
FIGURE 2A13. Equipment mounted on expanded metal or wire mesh bulkhead.

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Method 2A-13-2
Equipment secured to decorative sheathing

NOTES:

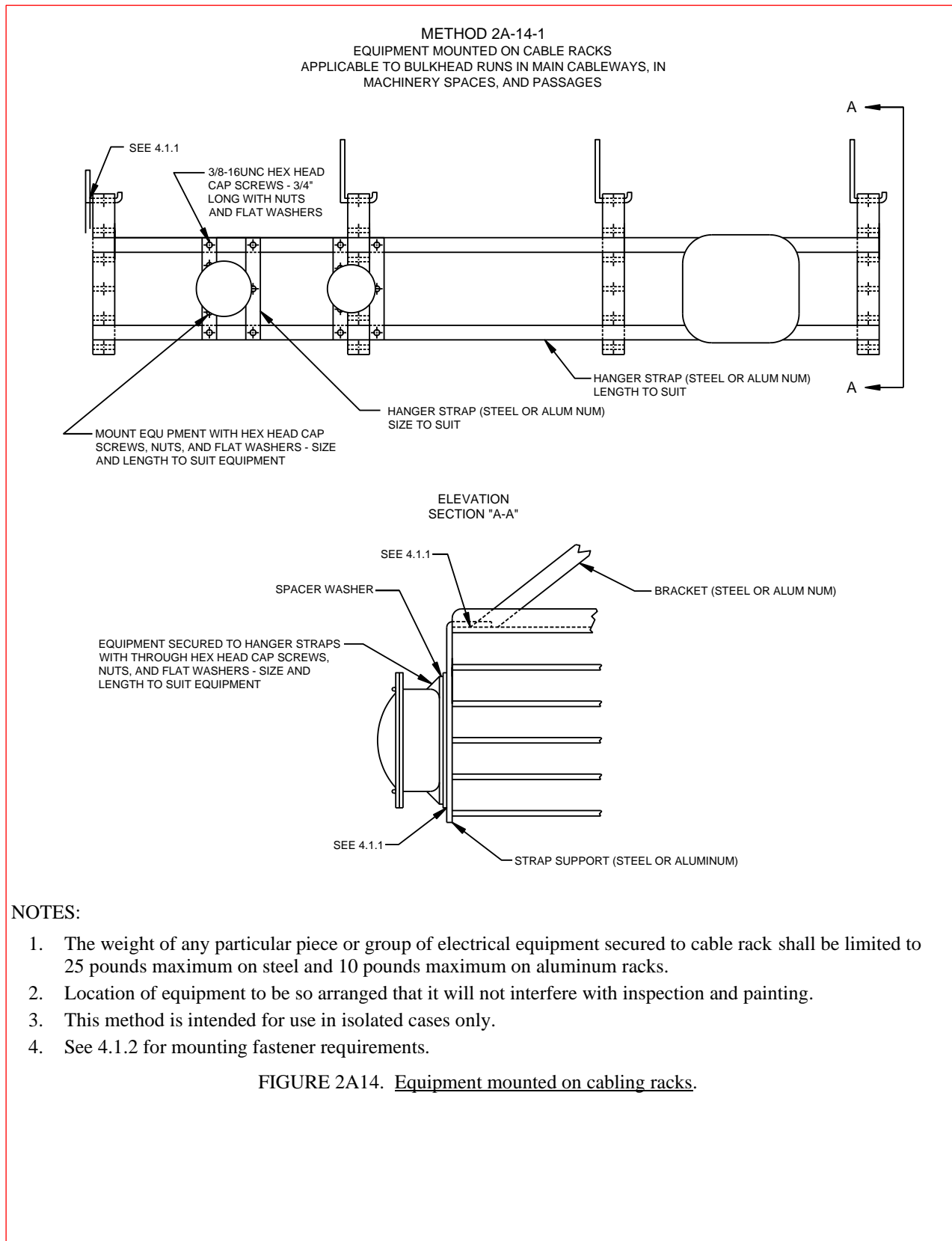
1. This method is applicable only for mounting equipment to 1-inch thick or 2-inch thick decorative sheathing.
2. Total load on the sheathing shall not exceed 40 pounds per panel.
3. Fasteners for attaching equipment to decorative sheathing shall be 1/4-inch monel bulb rivets.
4. The 1/4-inch plate shown in the following illustration may be made from either 1/4-inch flat bar or 1/4-inch plate, based on the size needed for mounting. The size of the plate or flat bar varies based on the space required to mount equipment.
5. Each monel bulb rivet requires a 1/4-inch hole through the plate or flat bar.
6. A minimum of four monel bulb rivets is required per piece of equipment. For larger equipment or plates, more than four rivets should be used.
7. See 4.1.2 for mounting fastener requirements.
8. See 4.1.1 for welding and stud requirements.



MOUNTING MISC. EQUIPMENT ON DECORATIVE SHEATHING

FIGURE 2A13. Equipment mounted on expanded metal or wire mesh bulkhead – Continued.

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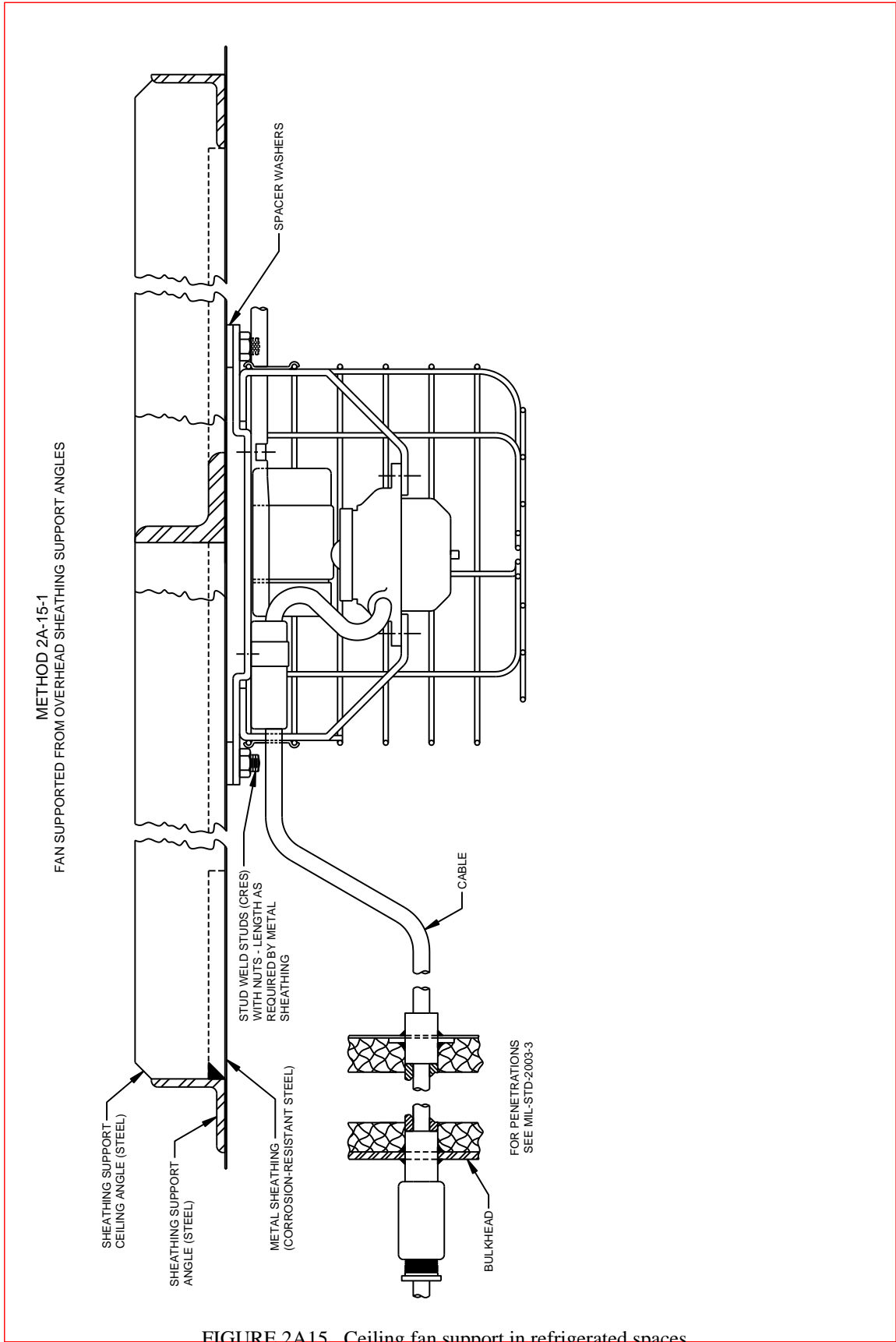


FIGURE 2A15. Ceiling fan support in refrigerated spaces.

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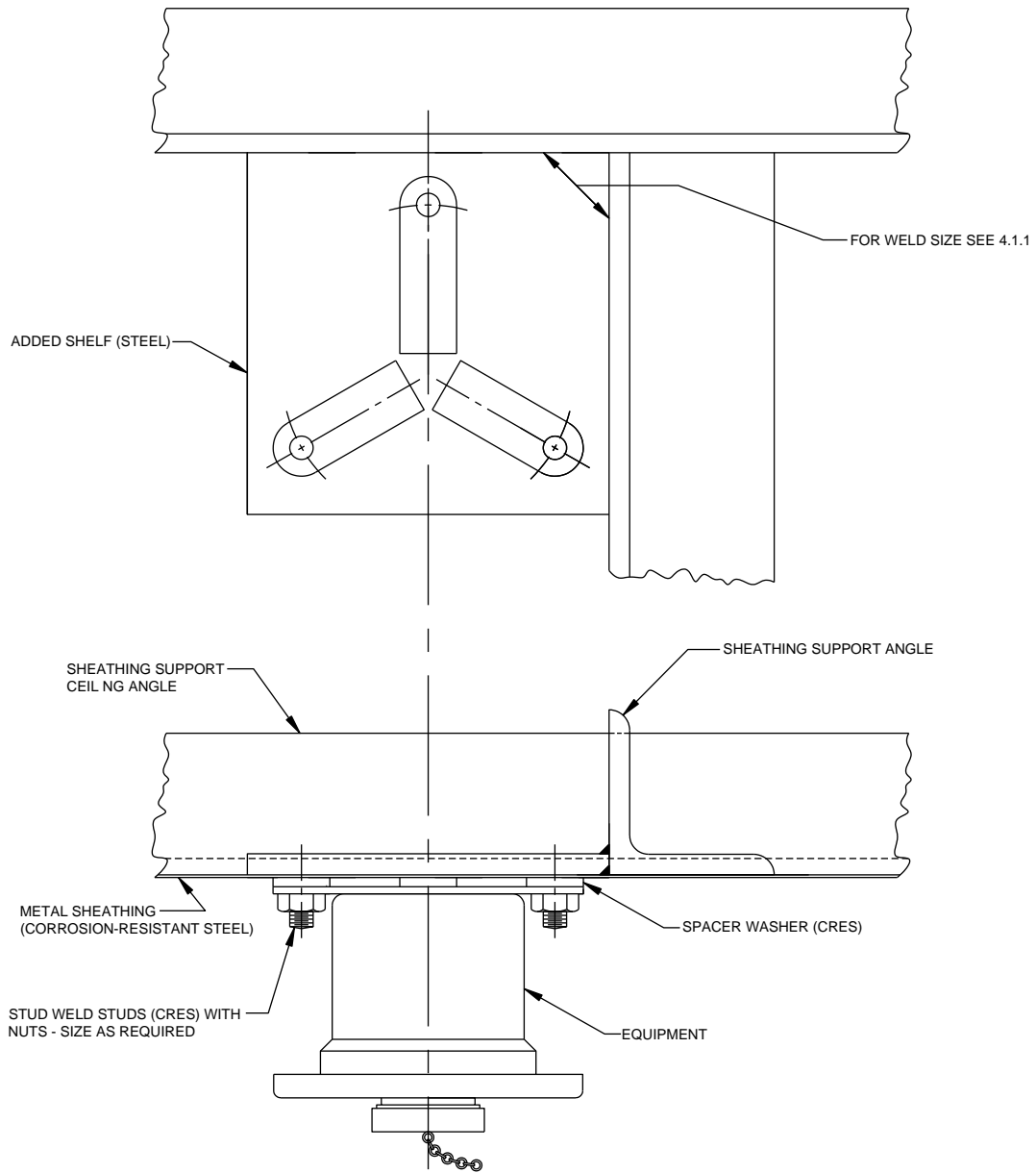
NOTES:

1. See 4.1.2 for mounting fastener requirements.
2. See 4.1.1 for welding and stud requirements.

FIGURE 2A15. Ceiling fan support in refrigerated spaces - Continued.

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METHOD 2A-16-1
EQUIPMENT SECURED TO SHEATHING SUPPORTS



NOTES:

1. See 4.1.2 for mounting fastener requirements.
2. See 4.1.1 for welding and stud requirements.

FIGURE 2A16. Equipment mounted in refrigerated spaces.

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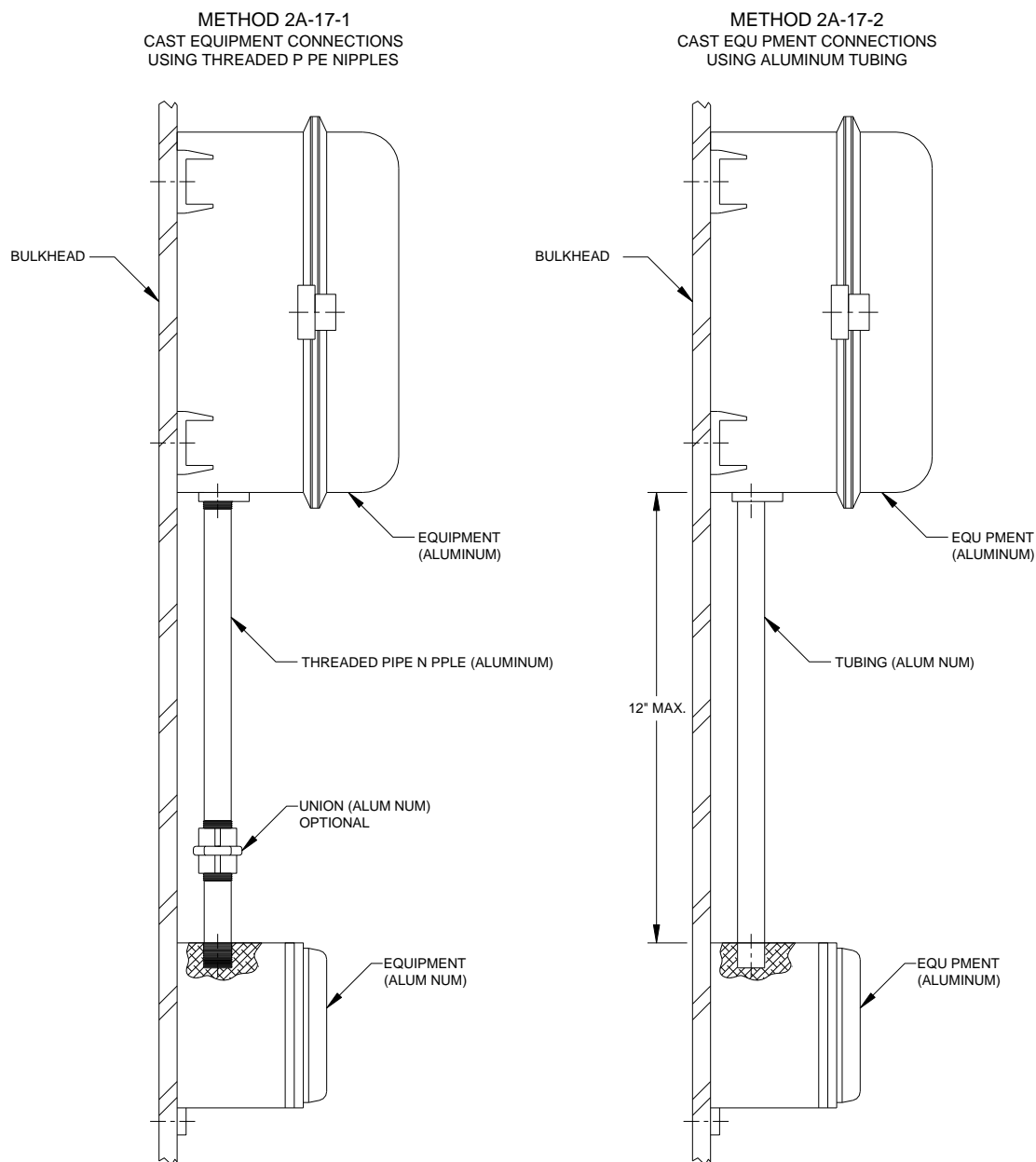


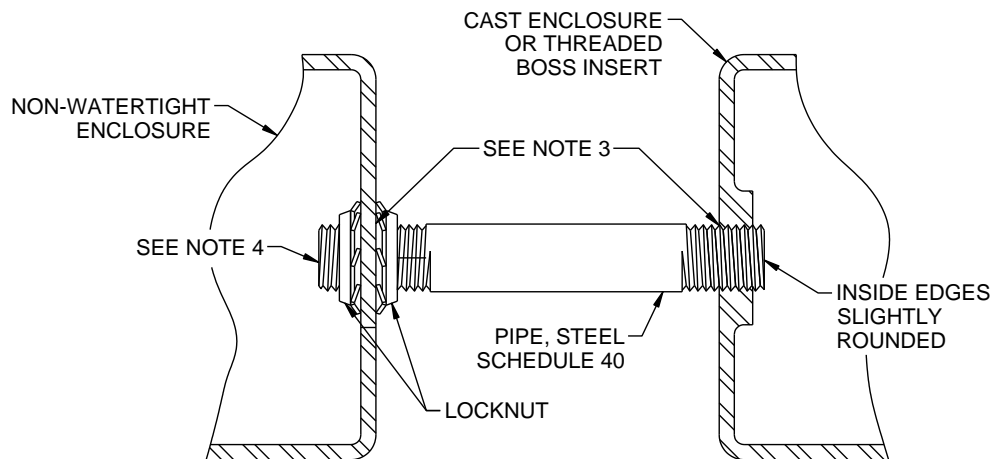
FIGURE 2A17. Connecting adjacent equipment with pipe nipples or rigid conduit.

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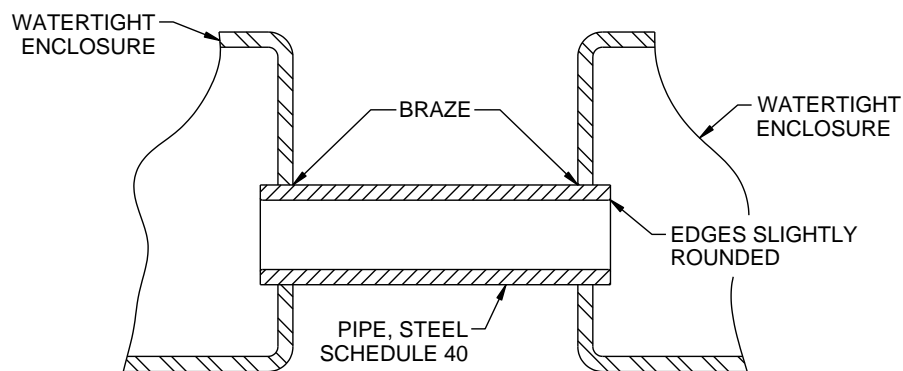
Method 2A-17-3
Connecting sheet metal enclosures with rigid conduit or pipe nipples

NOTES:

1. This method is applicable to connecting sheet metal enclosures with rigid conduit or pipe nipples.
2. Rigid conduit or pipe nipples should be sized to suit and should be of aluminum or steel depending on the material of the enclosures to be joined. Brass enclosures require steel pipe nipples.
3. Tapered and straight threads shall not be mixed. When there is a tapered fitting on the enclosure, a tapered fitting shall be used on the connecting conduit or pipe nipple.
4. If straight threaded conduit or pipe nipples are used, the conduit or pipe nipples shall be threaded into locknuts on both sides of the enclosure penetration.
5. Locknuts shall not be installed if the conduit or pipe nipple is to be brazed or welded to the enclosure, if a watertight penetrator in accordance with MIL-S-24235 is used, or if tapered fittings are used.
6. Seal penetration with plastic sealer in accordance with MIL-I-3064.
7. Round the edges of nipples to prevent chafing.



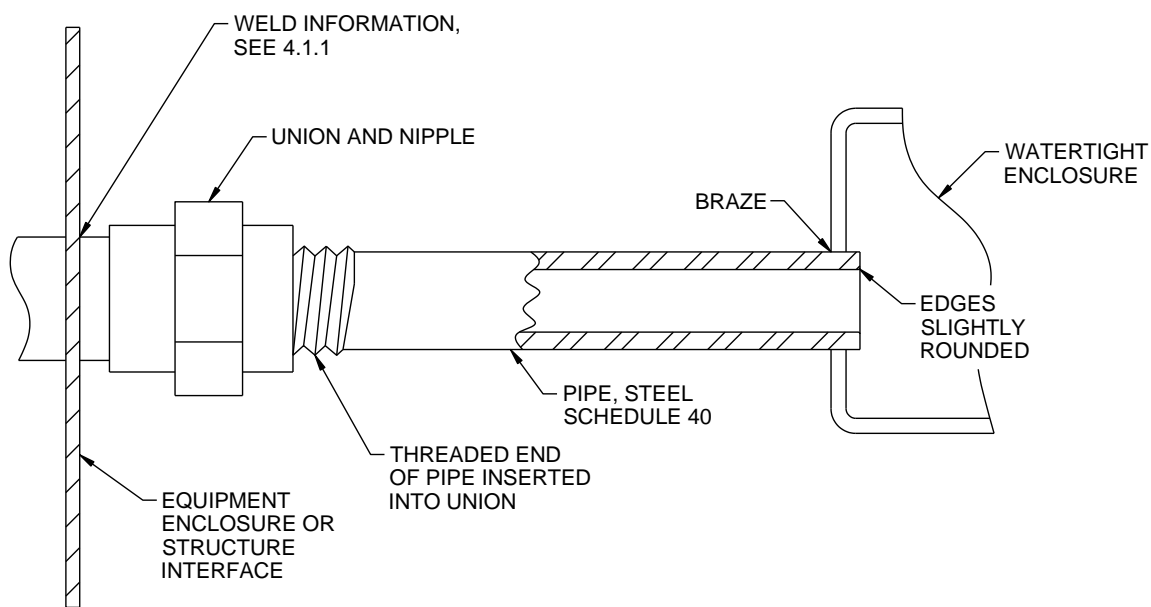
METAL ENCLOSURES



WATERTIGHT METAL ENCLOSURES

FIGURE 2A17. Connecting adjacent equipment with pipe nipples or rigid conduit – Continued.

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EQUIPMENT OR STRUCTURE WITH UNION AND
WATERTIGHT ENCLOSURES (THREADED AND BRAZED PIPE)

FIGURE 2A17. Connecting adjacent equipment with pipe nipples or rigid conduit – Continued.

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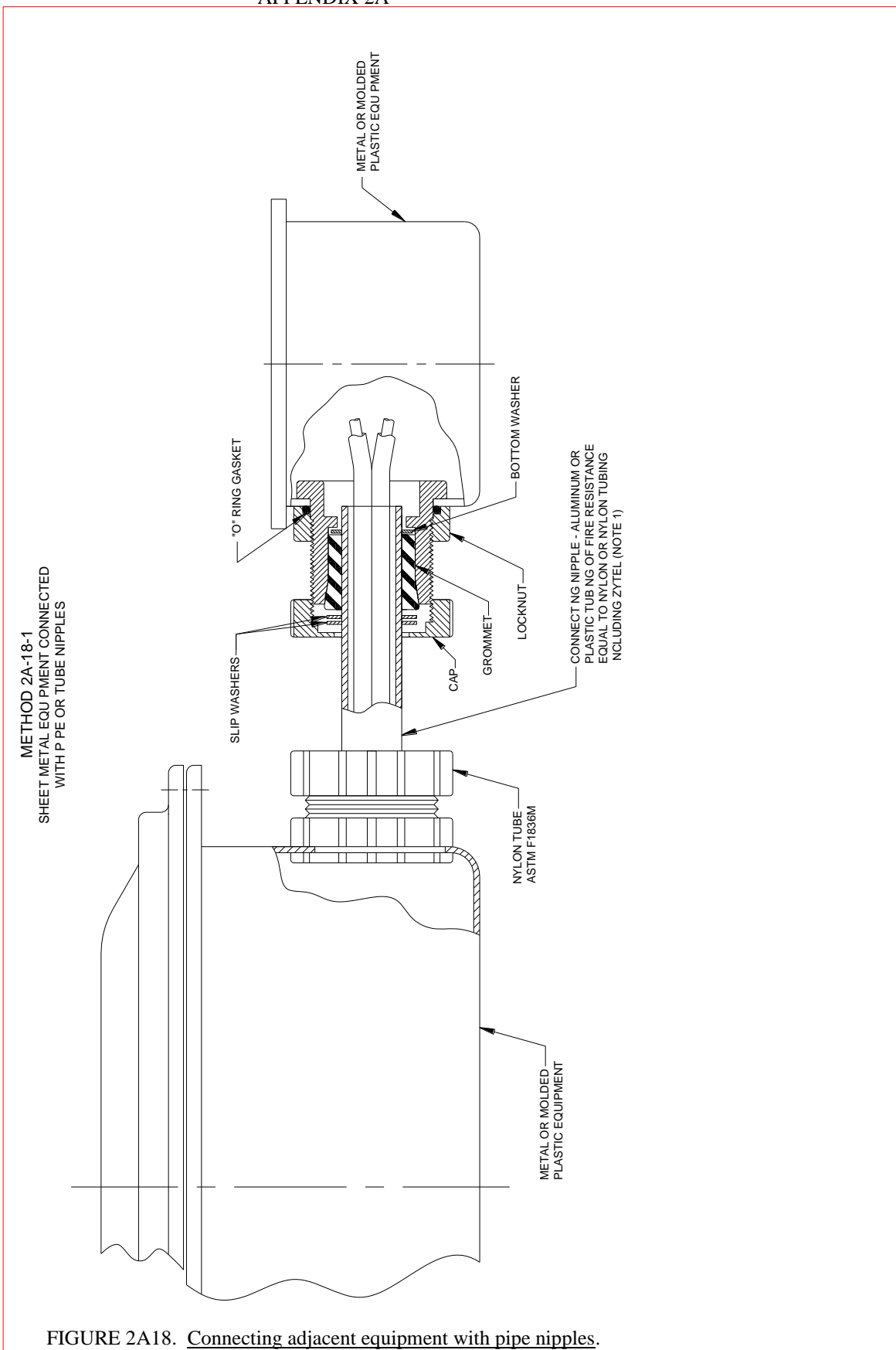


FIGURE 2A18. Connecting adjacent equipment with pipe nipples.

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NOTE:

1. Plastic and composite equipment enclosures shall be connected with plastic or composite tubing only.

FIGURE 2A18. Connecting adjacent equipment with pipe nipples – Continued.

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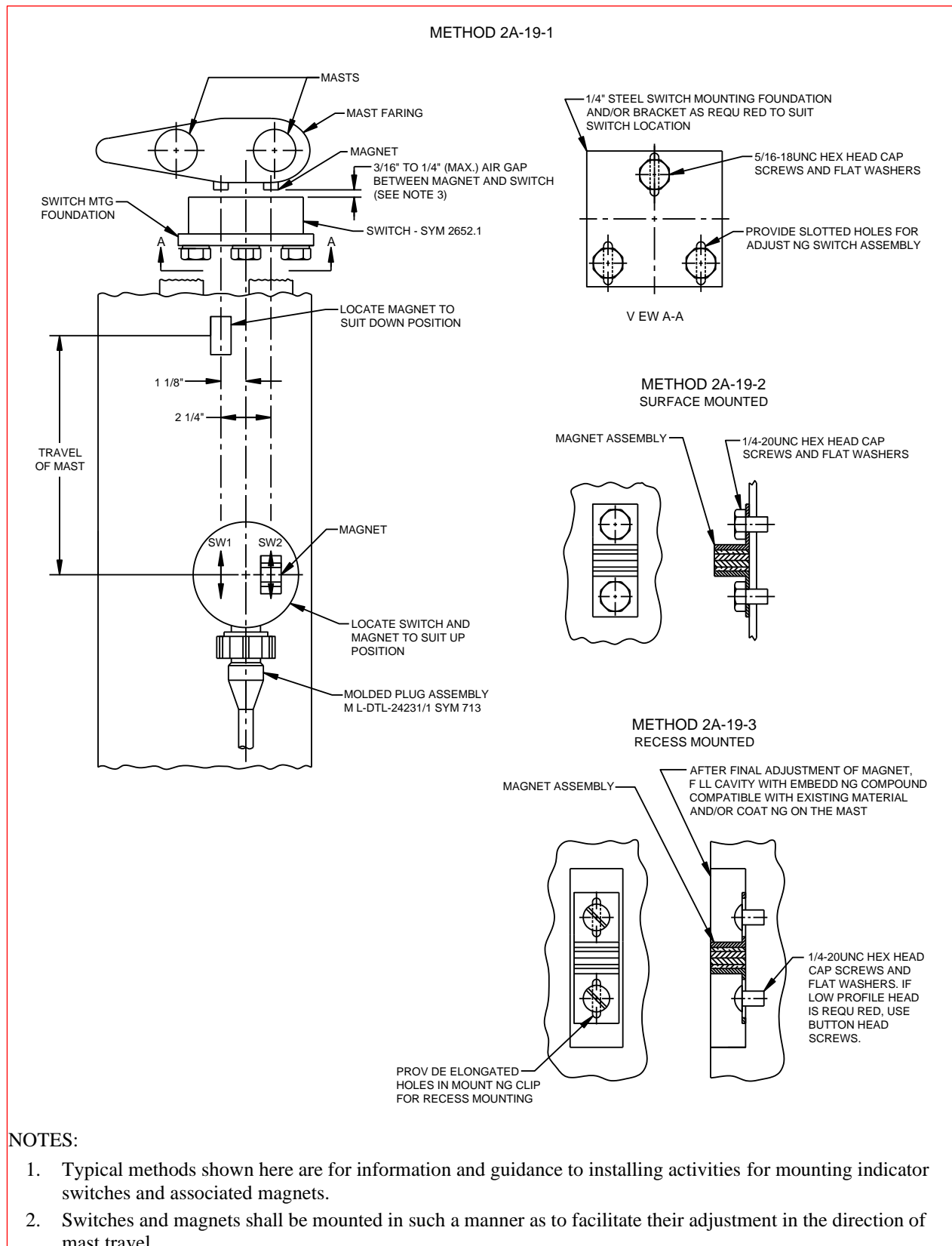


FIGURE 2A19. Mast position indicator switches for submarines.

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NOTES (continued):

3. If magnets other than those furnished with switch assembly are required, the following precautions shall be taken:
 - a. Air gap between switch and magnet shall be set to ensure that the coercive force of the magnet is sufficient to operate the switch at an ambient of -40 °F (-40 °C).
 - b. The coercive force shall be limited to operate only the switch for which it is intended.
4. All welding shall be in accordance with 4.1.1.
5. Magnet assemblies other than those furnished with switch shall have a thin coating of epoxy resin compound PR-610-TCF (chockfast orange) of ITW Philadelphia Resins Corp., or equal (see 4.8).
6. See 4.1.2 for mounting fastener requirements

FIGURE 2A19. Mast position indicator switches for submarines – Continued.

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Locking devices
Method 2A-20-1
Electrical connections

NOTES:

1. Motors and generators:
 - a. Use locknuts, lock washers, or other means to lock connections which tend to become loose because of vibration. Refer to S9086-KC-STM-010/300. See 4.1.2.7 for requirements for locking devices.
2. Control and instrument circuits:
 - a. Unless otherwise specified in the individual equipment specification or equipment technical manual, locking devices shall be provided on the following basis for electrical connections in all control and instrument equipment: all nuts, bolts, studs, and screws used for electrical connections shall be secured by means of a locking device in accordance with acceptable locking devices such as nut and locknut self-locking nut, external tooth lock washers, or internal tooth lock washers except that a locking device need not be provided where lug terminals are used for conductors below 4,000 circular mils (CM) (14AWG). Terminal board locking devices shall be in accordance with A-A-59125, except that lock washers are not required under terminal nuts. Refer to MIL-DTL-917. See 4.1.2.7 for requirements for locking devices.
3. Propulsion control cubicle (other than bus bar joints):
 - a. Unless otherwise specified in the individual equipment specifications or equipment technical manuals, locking devices shall be provided on the following basis for electrical assemblies in all propulsion control cubicle units and in all propulsion control cubicle equipment. All nuts, bolts, studs, and screws used for electrical connections shall be secured by means of an acceptable locking device except that a locking device need not be provided where solderless type connectors are used for conductors below 4,000 circular mils (CM) (14AWG). Terminal board locking devices shall be in accordance with A-A-59125, except that lock washers are not required under terminal nuts. Refer to MIL-DTL-917 and applicable switchboard specification. See 4.1.2.7 for requirements for locking devices.
4. Bus bar joints (main and auxiliary power):
 - a. In securing bus joints, bolts shall be fitted with a securing nut and a locknut or may be fitted with locking nuts of special design that have been specifically approved by NAVSEA. Flat washers shall be used under all bolt heads and nuts adjacent to the conductor. See 4.1.2.7.2 for restrictions on the use of jam nuts.
 - b. Intercell connectors in battery compartments shall be secured with stainless steel bolts, flat washers, and nuts conforming to ASTM A276/A276M, type 316. Refer to MIL-PRF-32273, MIL-PRF-32273/1, and MIL-PRF-32273/2. See 4.1.2.7 for requirements for locking devices.
5. Interior communication (I.C.) and fire control (F.C.) equipment:
 - a. Locking devices shall be employed with bolts or machine screws and nuts in all cables used to secure electrical connections. Refer to MIL-HDBK-2036. See 4.1.2.7 for requirements for locking devices.
6. Switchboards and control equipment:
 - a. Use locking devices such as check nuts or lock washers where necessary to keep connections tight. Refer to S9086-KC-STM-010/300. See 4.1.2.7 for requirements for locking devices.

FIGURE 2A20. Locking devices on electrical connections.

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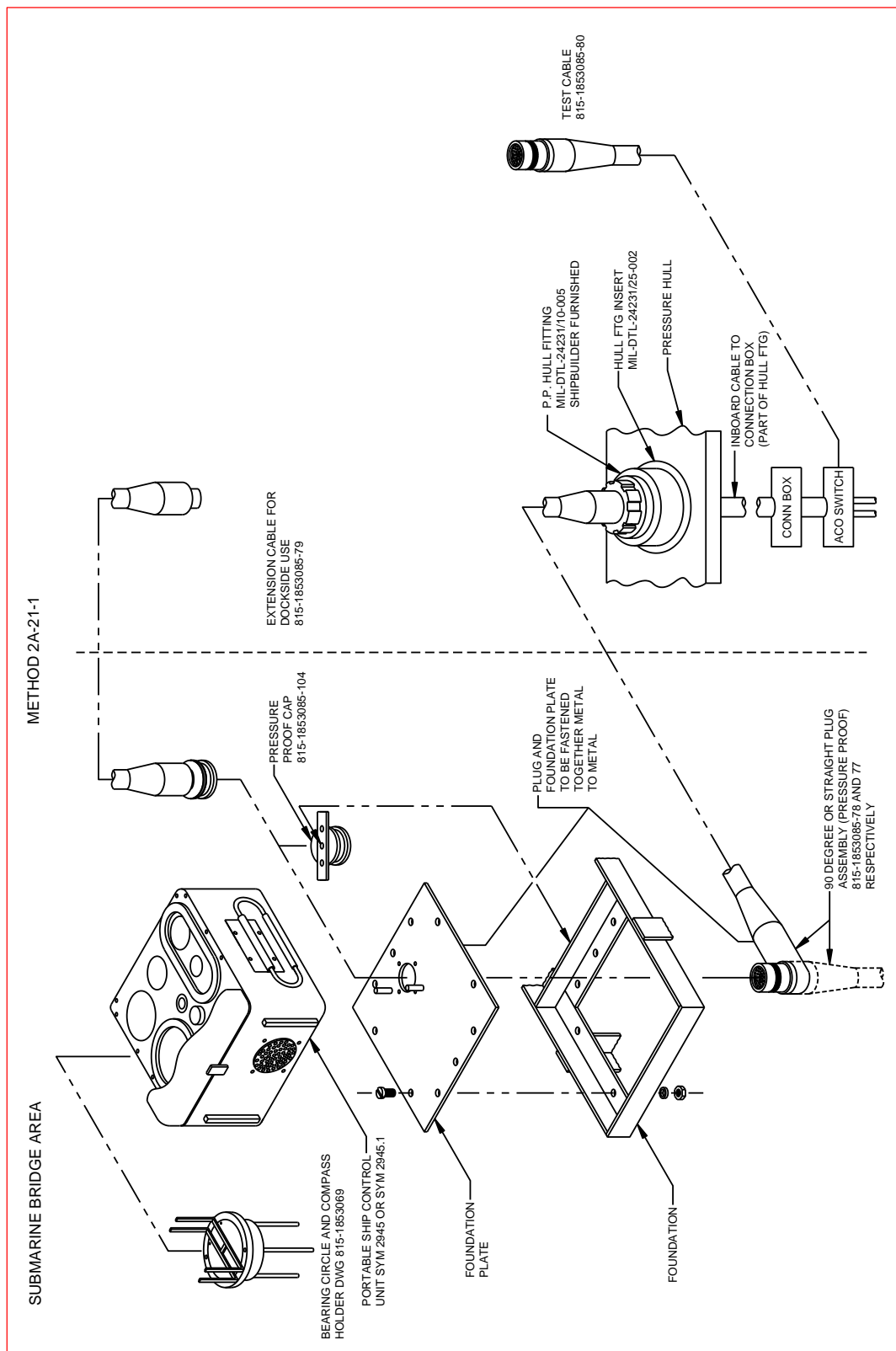


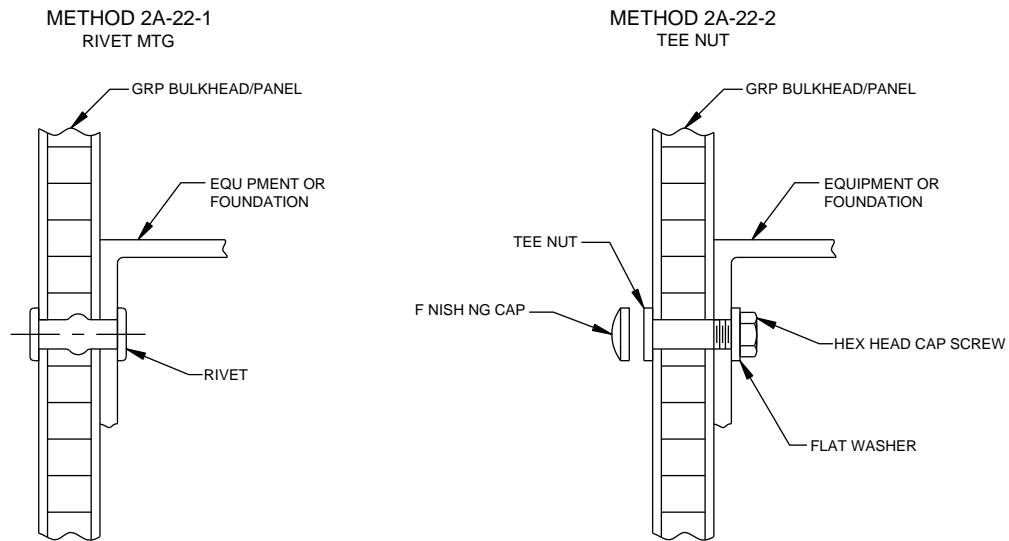
FIGURE 2A21. Portable ship control unit submarine bridge type.

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APPENDIX 2ATABLE 2A21-I. Portable ship control unit submarine bridge type and NSN.

Name	Sym	PC no.	NSN
Cont unit	2945		
Cable assy	2945.1		
	2945.2	77	
		78	6150-00-590-0863
	2945.4	79	6150-00-590-3453
	2945.5	80	6150-00-590-3454

FIGURE 2A21. Portable ship control unit submarine bridge type – Continued.

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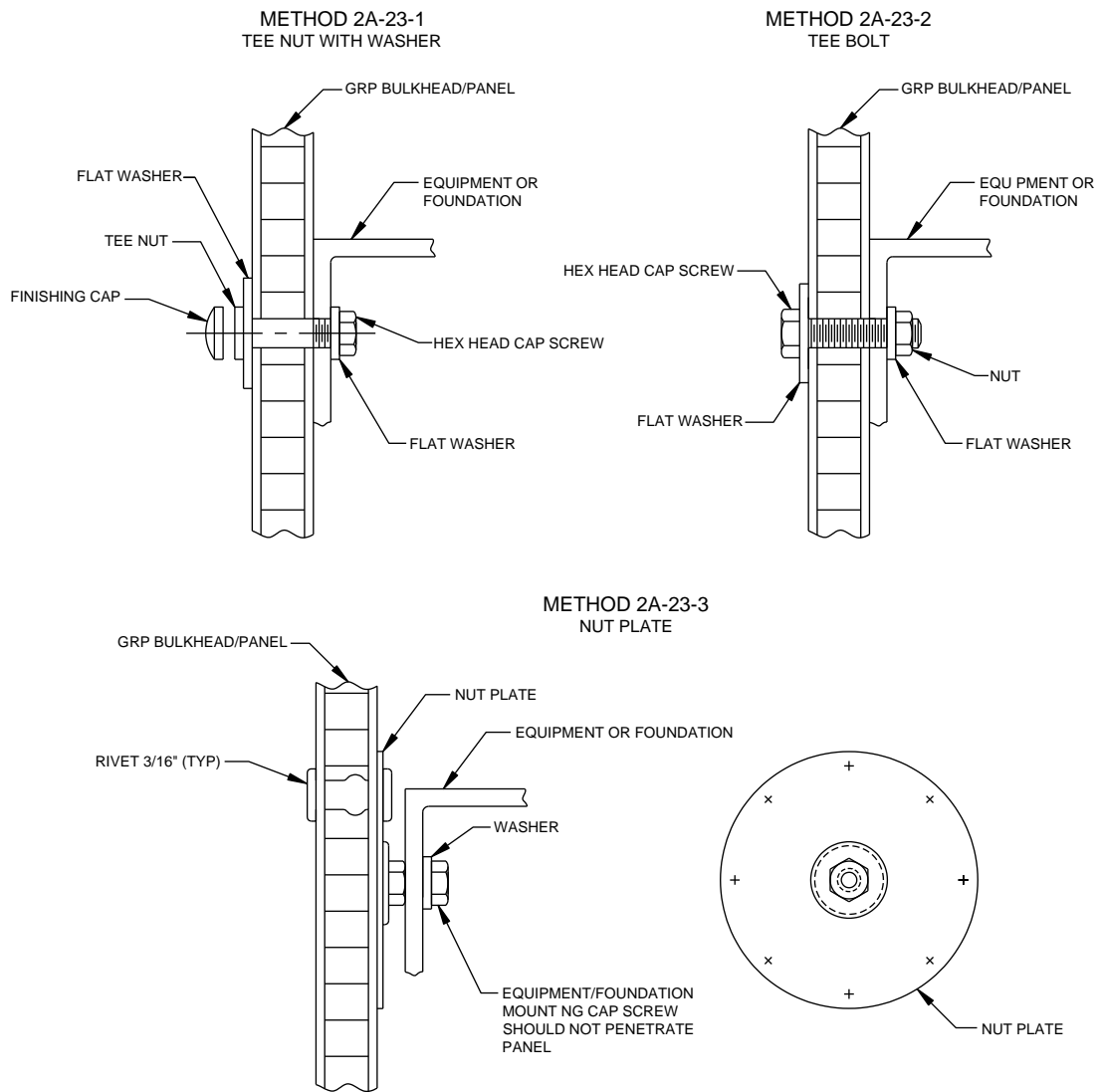
THIS METHOD IS TO BE USED WHEN THE DISTANCE FROM THE BULKHEAD TO THE CENTER OF GRAVITY OF THE EQUIPMENT IS LESS THAN 4 INCHES.

NOTES:

1. Location of mounting holes to be templated from unit being installed.
2. Small holes can be drilled into glass reinforced plastic (GRP) panels with a sharp, twist-type drill bit. Prick punch to center drill bit. Larger holes can be drilled with a hole cutter. When drilling holes for "blind fasteners", a drill stop should be utilized to prevent drilling through the entire panel. When using a hole cutter, first drill through one face sheet, and from the opposite side of the panel, use the pilot hole from the first cut to drill the second face sheet. This method will help avoid panel delamination and high-pressure plastic laminate (HPPL) chipping.
3. When cutting and drilling GRP panels, care shall be taken to provide adequate ventilation and dust collection. Eye and ear protection and the use of a dust mask are recommended. CAUTION: if any signs of allergic reaction appear when working with GRP panels, work should stop immediately.
4. Some chipping and cracking of the HPPL may occur when cutting or drilling GRP panels. This degradation of the panel, while unavoidable, shall be kept to a minimum so as not to degrade the holding capacity of fasteners or take away from the finished appearance of the panel. In many cases, keeping the drill bits and blades sharp, and using masking tape over the area to be cut or drilled, will keep degradation of the panel at a minimum. If chips and cracks propagate out beyond where the mounting hardware ends, the damage will be noticeable and will require cosmetic repair. In some cases, through-type fasteners may dimple the panel. This condition is acceptable as long as there is no cracking of the panel face.
5. GRP panels are easily scratched, punctured, and scorched by hot work. Care should be taken when working on or close to these panels.
6. For weight limitation of equipment installed on GRP panels, see [figure 2A24](#).
7. See 4.1.2 for mounting fastener requirements

FIGURE 2A22. Electrical equipment mounting to glass reinforced plastic (GRP) bulkheads/panels.

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NOTE: See 4.1.2 for mounting fastener requirements.

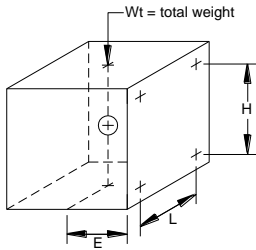
FIGURE 2A23. Electrical equipment mounting to glass reinforced plastic (GRP) bulkheads/panels.

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Fastener selection (size) for installation of electrical equipment/foundations to GRP bulkheads/panels

Procedure for selecting fastener size and type:

1. Establish correct E, H, L, and Wp per pair of bolts:
E = Horizontal distance (inches) from bulkhead to equipment center of gravity (taken from vendor drawings)
H = Vertical distance (inches) between the pair of bolts
Wp = Weight (pounds) of equipment acting through each pair of bolts ($Wt \div$ number of bolt pairs)
L = Horizontal distance between the extreme pair of fasteners



2. Locate correct "E" and "H" values on the "E" and "H" scales shown in [table 2A24-I](#).
3. Make a straight line connecting these points.
4. Where the line made in step 3 crosses the "K" scale shown in [table 2A24-I](#), make a horizontal line all the way to the right side of the chart.
5. The vertical lines located under each detail represent different ranges of weight that the vertical pair of fasteners can support.
If the horizontal line made in step 4 crosses these vertical lines at values greater than the Wp found in step 1, the fastener detail can be used. In the event that the Wp required exceeds the Wp available on the chart, a pedestal foundation should be considered.
6. If more than one detail will work, the final choice will depend on such factors as available inventory, size of existing mounting holes on equipment, type of space where the equipment is located, and the required finish on the opposite face of the bulkhead.
7. "L" is a function of the number of pairs as shown:

<u>No. of pairs</u>	<u>"L"</u>
2	0.5H
3	0.75H
4	1.0H

Example:

Equipment: Feeder distribution box Weight (Wt) = 20 pounds, Height = 14 inches, Width = 13 inches, Depth = 8 inches

Mounting data: Four holes – $1\frac{1}{32}$ -inch dia, 10 inches (vertical), 9 inches (horizontal)

1. E = 4 (vendor data), H = 10, Wp = $Wt \div$ number of bolt pairs = $20 \div 2 = 10$ pounds
2. A straight-line connection of E = 4 and H = 10 results in a "K" value of 0.4.
3. A horizontal line drawn from a 0.4 "K" value to the right end of the chart shows that method 2A-23-1 meets the requirement.

FIGURE 2A24. Electrical equipment mounting to glass reinforced plastic (GRP) bulkheads/panels.

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TABLE 2A24-I. Fastener size and type selection.

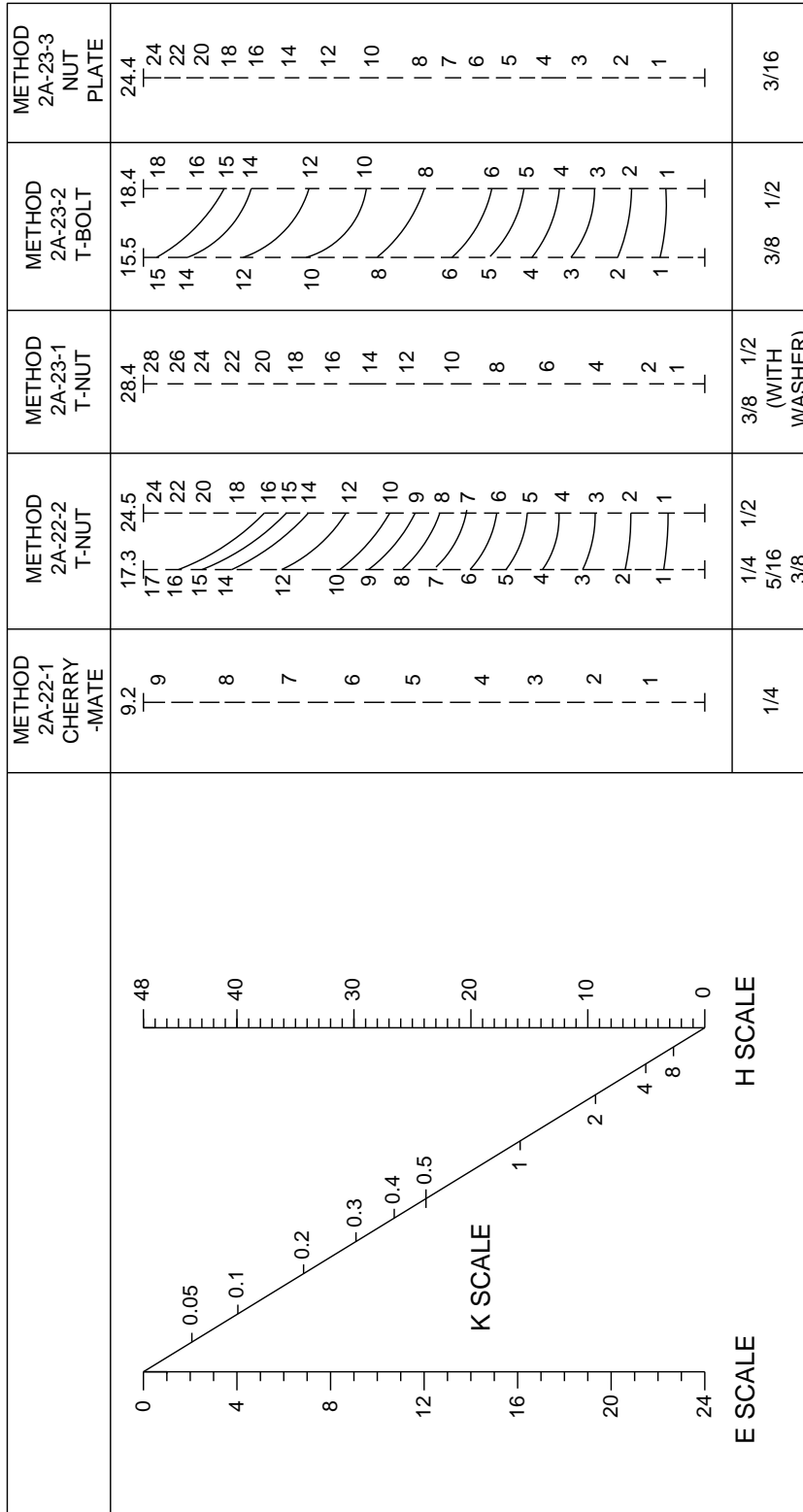


FIGURE 2A24. Electrical equipment mounting to glass reinforced plastic (GRP) bulkheads/panels – Continued.

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General Notes:

1. This method is applicable to mounting electrical equipment up to 300 pounds to structural bulkheads and decks. For flat bar supports shown in method 2A-25-1, the equipment weight shall be limited to 175 pounds.
2. Methods 2A-25-1 and 2A-25-2 are restricted to hard mounted equipment. Method 2A-25-3 is applicable to equipment using shock mounts.
3. Bulkhead thickness shall be equal to or greater than 0.25 inch to use clip mounting of equipment.
4. Grounding: Equipment installed in accordance with methods 2A-25-1, 2A-25-2, and 2A-25-3 shall be grounded in accordance with 4.6.
5. Mounting bolts shall be of proper size and number to suit the equipment to be mounted. Mounting holes in clips may be drilled as required to suit larger diameter hardware. Holes shall be $\frac{1}{2}$ inch larger than the equipment mounting hardware and shall not exceed $\frac{25}{32}$ -inch diameter.
6. Washers may be used as shims to allow for bulkhead deviations up to $\frac{3}{8}$ inch in accordance with the guidance of 4.1.2.2.
7. If the straight bar is bent to achieve the 90-degree angled clip bar, the straight bar shall be heated prior to bending to prevent cracks in the bent area.
8. See 4.1.2 for mounting fastener installation and material requirements.

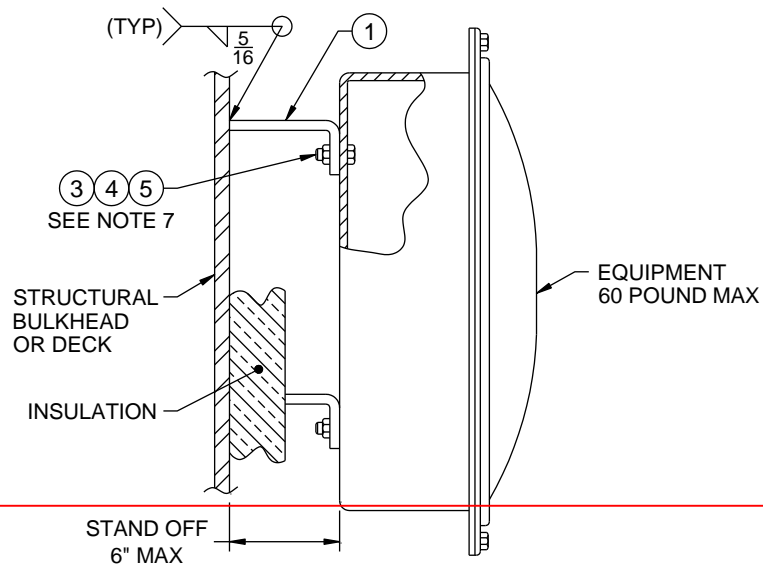
TABLE 2A25-I. Parts list for clip mounted electrical equipment (all dimensions in inches).

Item	Description
1	Flat bar, 2 wide by $\frac{3}{8}$ thickness by length to suit
2	Angle bar, 2½ by 2 by $\frac{3}{8}$
3	Self-locking nut
4	Hex head screw
5	Flat round washer
6	Straight flat bar mounting clip
7	Hex head screw, 3/8-16UNC by 1¼
8	Angle bar support, 3 by 3 by $\frac{3}{8}$ thick

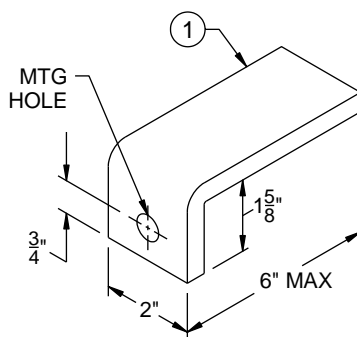
FIGURE 2A25. Clip mounting of electrical equipment.

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Method 2A-25-1
Clip mounting using flatbar clips
Item numbers correspond to [table 2A25-I](#)



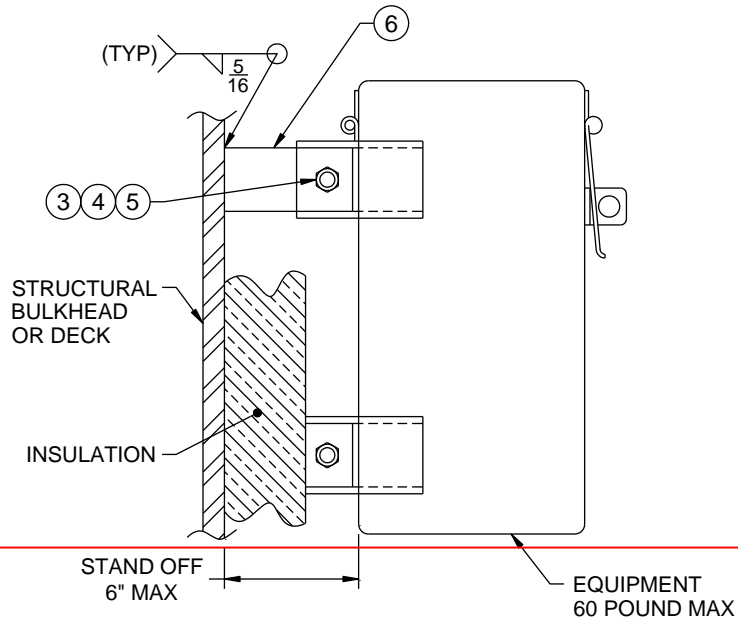
TYPICAL FLAT BAR CLIP
INSTALLATION DETAIL



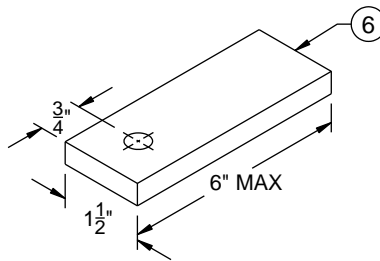
FLAT BAR CLIP
MANUFACTURED FROM
2" X $\frac{3}{8}$ " FLAT BAR

FIGURE 2A25. Clip mounting of electrical equipment – Continued.

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TYPICAL INSTALLATION DETAIL FOR
SOUND POWERED TEL STORAGE BOX

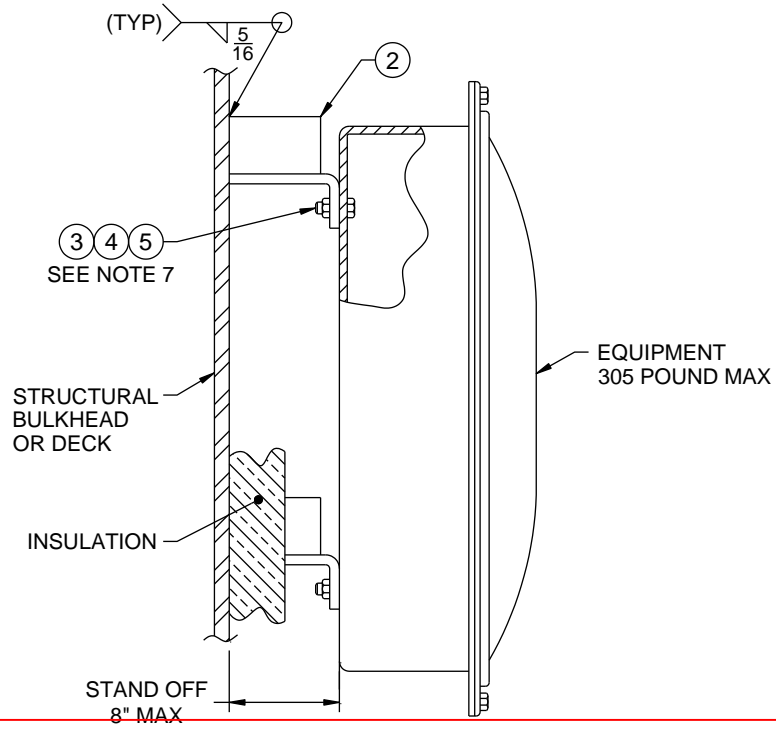


STRAIGHT FLAT BAR CLIP
MANUFACTURED FROM 1-1/2 X 3/8 FLAT BAR

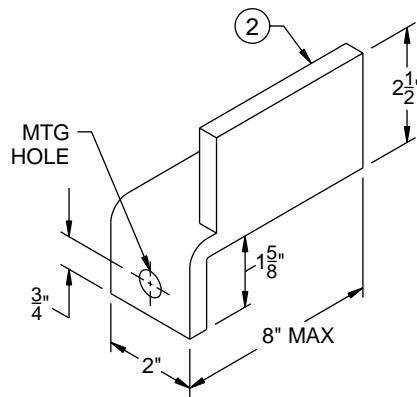
FIGURE 2A25. Clip mounting of electrical equipment – Continued.

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Method 2A-25-2
Clip mounting using angle bar clips
Item numbers correspond to [table 2A25-I](#)



TYPICAL ANGLE BAR CLIP
INSTALLATION DETAIL



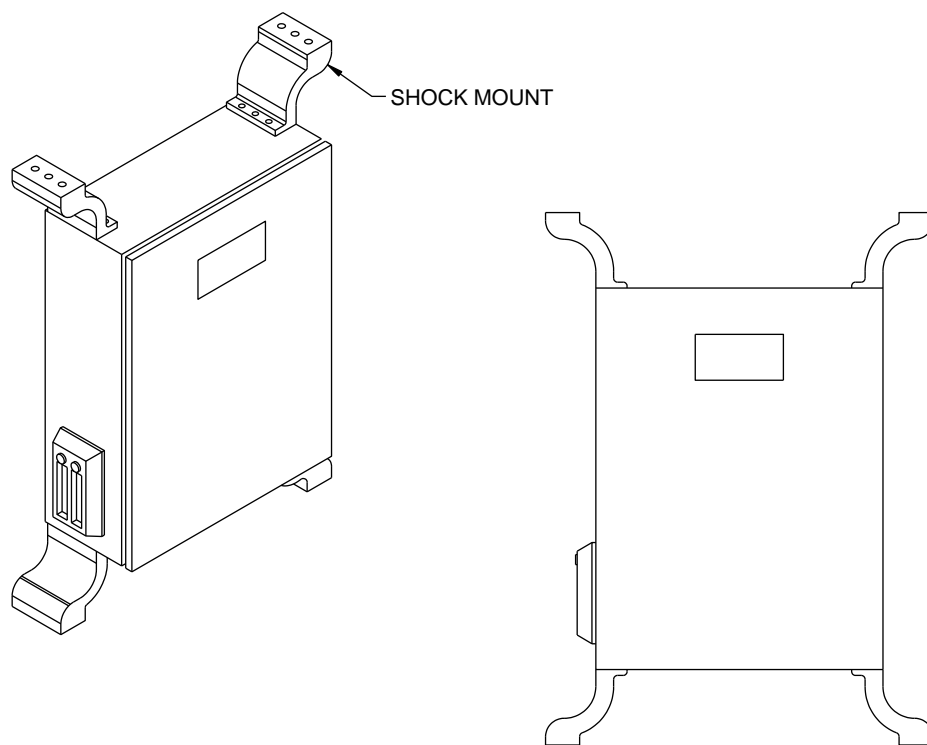
ANGLE BAR CLIP
MANUFACTURED FROM
2" X $2\frac{1}{2}$ " X $\frac{3}{8}$ " ANGLE BAR

FIGURE 2A25. Clip mounting of electrical equipment – Continued.

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Method 2A-25-3

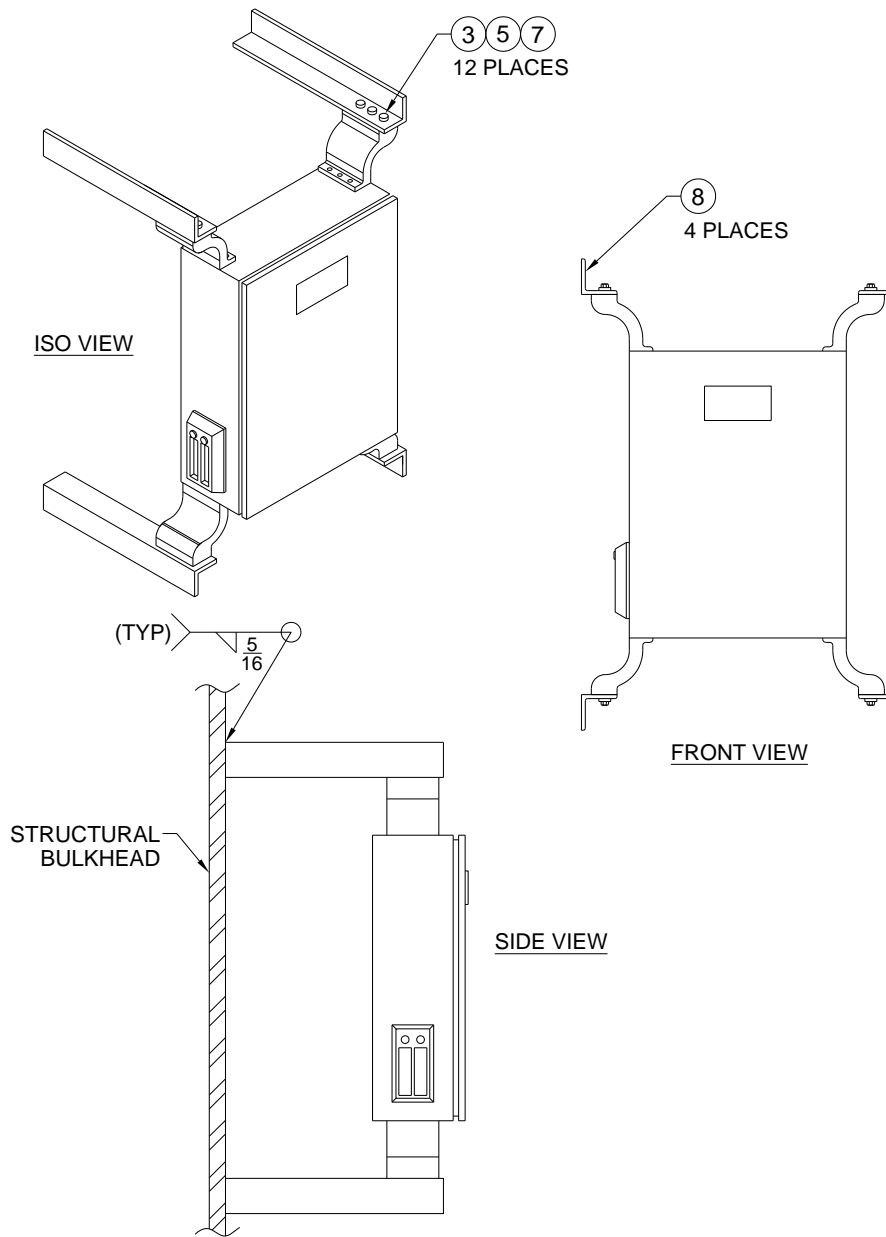
Clip mounting using angle bar clips for shock isolated equipment
Item numbers correspond to [table 2A25-I](#)



ISOMETRIC AND FRONT VIEWS OF EQUIPMENT
AS SUPPLIED WITH SHOCK MOUNTS

FIGURE 2A25. Clip mounting of electrical equipment – Continued.

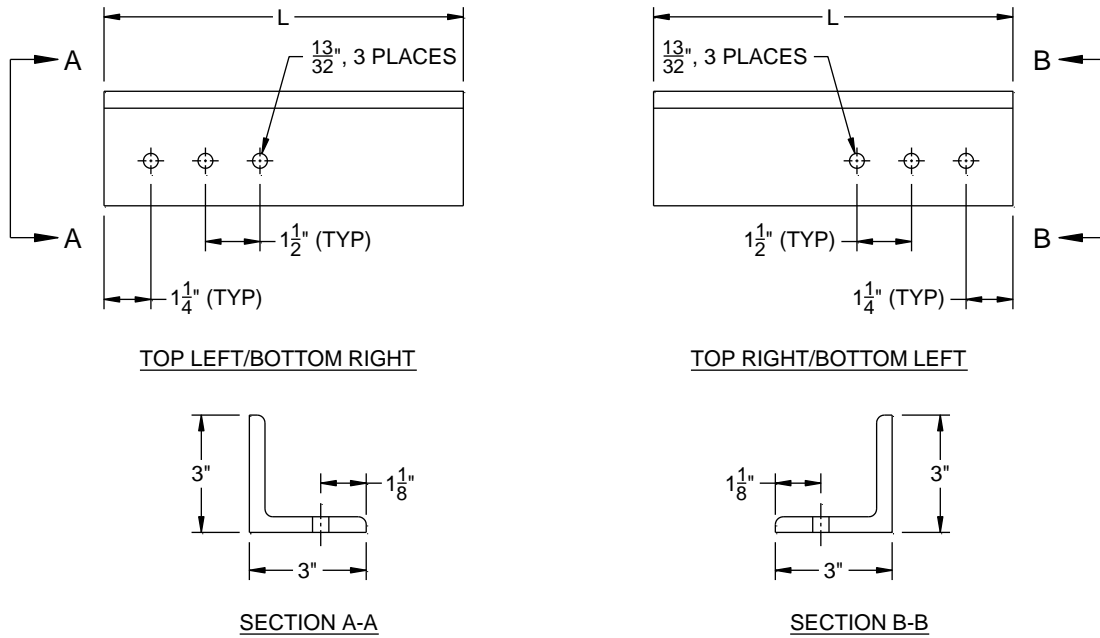
MIL-STD-2003-2B(SH)
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EQUIPMENT MOUNTED ON
3 X 3 ANGLE BAR SUPPORTS

FIGURE 2A25. Clip mounting of electrical equipment – Continued.

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APPENDIX 2A



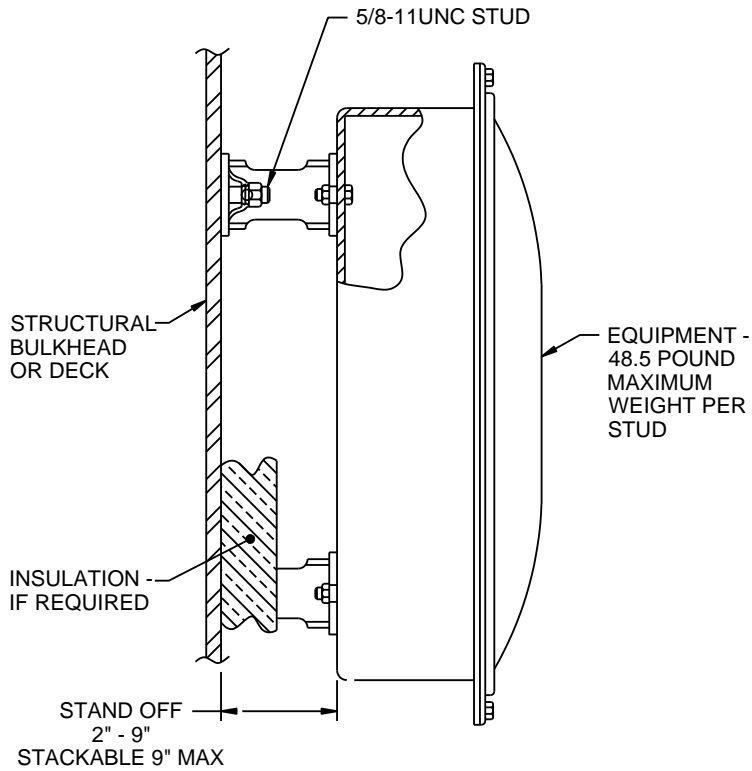
ANGLED BAR SUPPORT
MANUFACTURED FROM
ANGLE BAR, 3 X 3 X 3/8 THK

NOTE: Angle bar support is part 8 from [table 2A25-I](#).

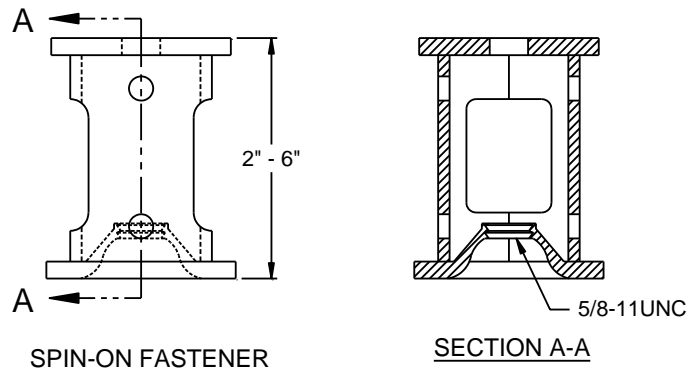
FIGURE 2A25. Clip mounting of electrical equipment – Continued.

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APPENDIX 2A

Method 2A-25-4
Stud mount using spin on panel mount



TYPICAL SPIN-ON PANEL MOUNT
INSTALLATION DETAIL

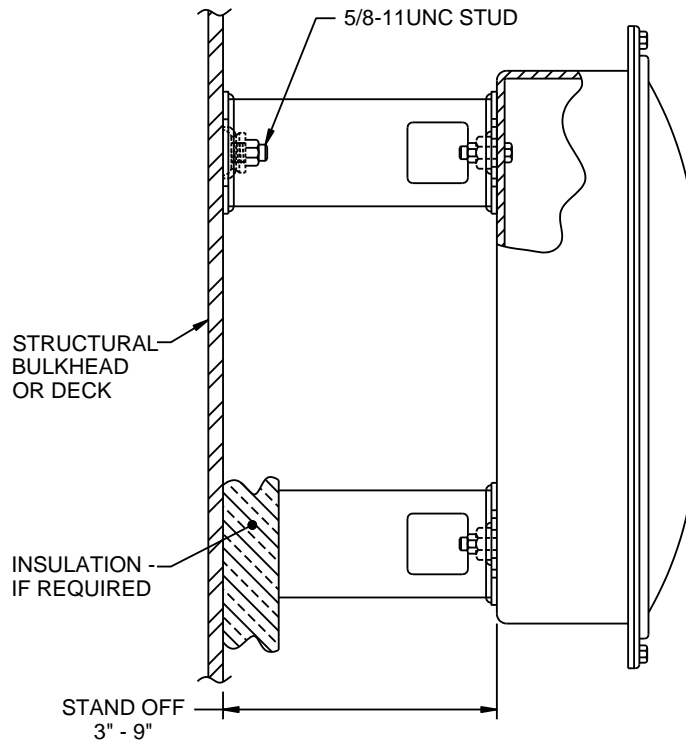


NOTE: Spin on components shall be Research Tool and Die, EFPM09 series, or equal (see 4.8).

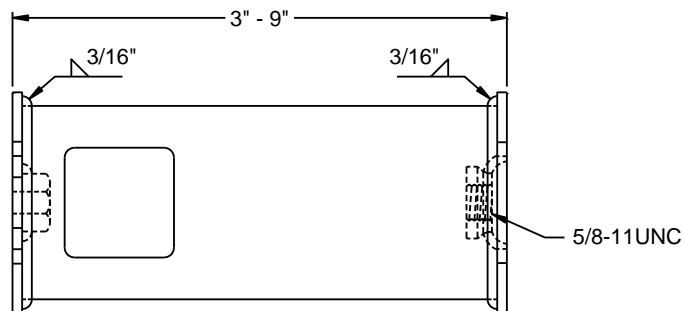
FIGURE 2A25. Clip mounting of electrical equipment – Continued.

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APPENDIX 2A

Method 2A-25-5
Stud mount using spin on panel mount



TYPICAL SPIN-ON PANEL MOUNT
INSTALLATION DETAIL



NOTES:

1. Spin on components shall be Research Tool and Die, EFPM09 series, or equal (see 4.8).
2. NAVSEA approval shall be obtained for the weight of the equipment to be supported in excess of 48.5 pounds per stud.

FIGURE 2A25. Clip mounting of electrical equipment – Continued.

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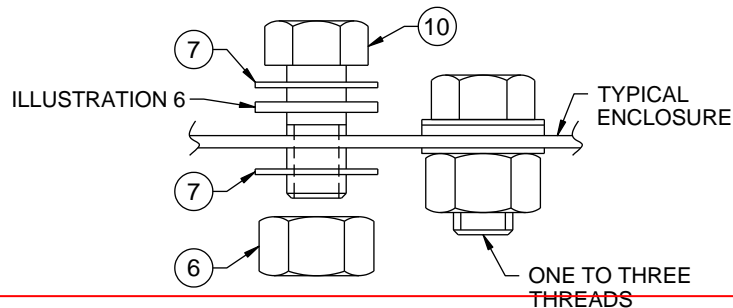
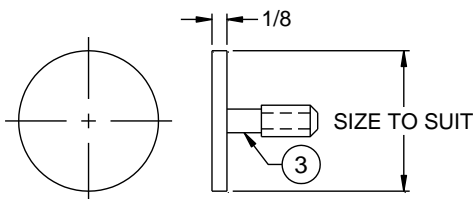
NOTES:

1. Purpose: This figure provides instructions for sealing holes in electrical equipment.
 - a. Illustration 5: Sealing holes in the following enclosure types: watertight (WT), non-watertight (NWT), drip-proof, and totally enclosed.
 - b. Illustration 7: Alternate method for sealing holes in NWT and drip-proof enclosures.
2. General guidelines:
 - a. These methods shall only be used on flat surfaces so that the faying surfaces of the equipment and the gaskets and plates are in contact completely around the circumference.
 - b. See 4.1.2 for mounting fastener installation and material requirements.
 - c. Ensure that all items are centered over enclosure holes.
 - d. Over-tightening shall be avoided to prevent deformation of sealing devices.
3. Using standard hardware (see illustrations 1 and 6):
 - a. Hardware shall be sized to suit the hole in the enclosure.
 - b. When sealing eyebolt holes, use original hardware, if possible, plus washers and rubber gaskets from item 2 in [table 2A26-I](#).
 - c. No gasket is required when enclosure type is open or NWT.
4. Using steel fabricated plates and studs (see illustrations 2 through 5):
 - a. The items in illustrations 2, 3, and 4 are to be supplied in the following diameters: 1¼ inches, 1½ inches, 2 inches, and 2½ inches.
 - b. Steel plates shall be shaped to suit usage and may be used to cover two or more adjacent holes provided individual studs are used for each hole and a ¼ inch overall is maintained.
 - c. The internal steel plate (see illustration 3) may be trimmed to clear internal interferences. No more than 120 degrees of any plate's circumference may be removed.
 - d. Plates shall be a minimum of ¼ inch larger in diameter than the enclosure to be sealed.
 - e. The length of the weld stud (item 3 from [table 2A26-I](#)) in illustration 5 may be reduced to maintain satisfactory clearance with internal components in enclosures.
5. Using aluminum pipe caps or steel plates with screws (see illustration 3 and 7):
 - a. Aluminum pipe caps should be ⅙ inch thick.
 - b. Aluminum pipe caps or steel plates shall be a minimum of ¼ inch larger in diameter than the enclosure hole to be sealed.
 - c. Plastic sealant (item 12 from [table 2A26-I](#)) or a rubber gasket (item 2 from [table 2A26-I](#)) is required if the hole being sealed is located on the top of the equipment.
 - d. When using the aluminum pipe caps, two pipe caps shall be used per side of the enclosure.
 - e. Drill holes through the center of each aluminum pipe cap or steel plate to suit the cap screw (item 10 from [table 2A26-I](#)).
 - f. For holes in brass enclosures, aluminum pipe caps shall not be used; steel plates shall be used (see illustration 3).
 - g. Internal steel plates or aluminum cap screws may be trimmed to clear internal interferences. No more than 120 degrees of the plate or cap screw may be removed.

FIGURE 2A26. Sealing holes in electrical equipment.

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APPENDIX 2ATABLE 2A26-I. List of material.

Item	Description	Remarks
1	Plate, steel, 1/8 inch thick	ASTM A1011/A1011M
2	Sheet rubber, 1/8 inch thick	MIL-PRF-15624
3	Weld stud	Pitch diameter, 1/4-20UNC, 7/8-inch length
4	Deleted	--
5	Hex nut	1/4-20
6	Self-locking nut	Size to suit
7	Flat round washer	Size to suit
8	Deleted	--
9	Deleted	--
10	Hex head cap screw	Size to suit
11	Aluminum pipe cap	--
12	Plastic sealant	MIL-I-3064, TY-HF

ILLUSTRATION 1
SEALING HOLES IN ENCLOSURES USING STANDARD HARDWAREILLUSTRATION 2
STEEL PLATE WITH STUD
MANUFACTURED FROM ITEM 1 AND ITEM 3Item numbers correspond to [table 2A26-I](#)FIGURE 2A26. Sealing holes in electrical equipment – Continued.

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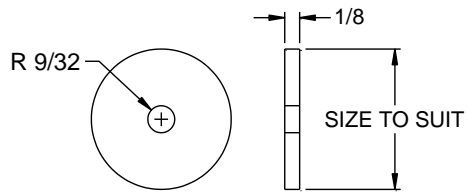


ILLUSTRATION 3
STEEL PLATE, MANUFACTURED FROM ITEM 1

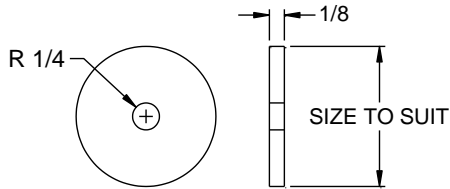


ILLUSTRATION 4
RUBBER GASKET, PLATE MANUFACTURED FROM ITEM 2

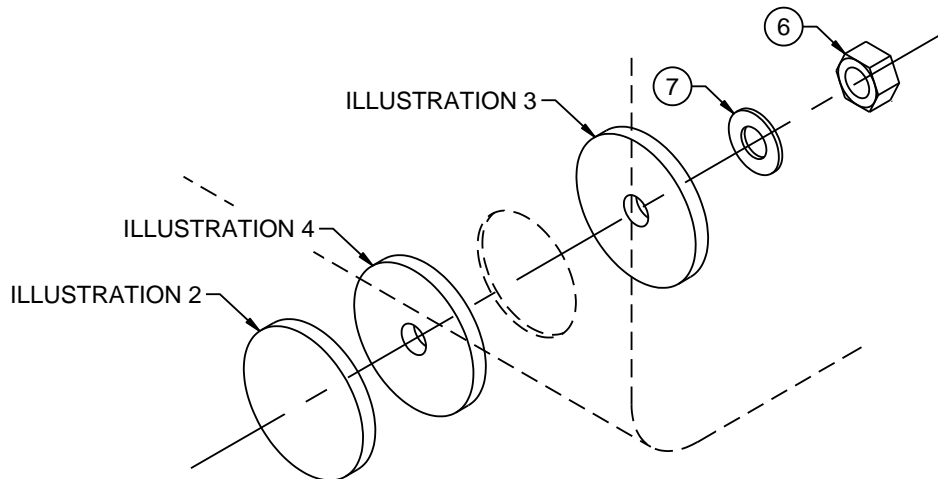


ILLUSTRATION 5
SEALING HOLES IN ENCLOSURES
USING FABRICATED STEEL PLATES

Item numbers correspond to [table 2A26-I](#)

FIGURE 2A26. Sealing holes in electrical equipment – Continued.

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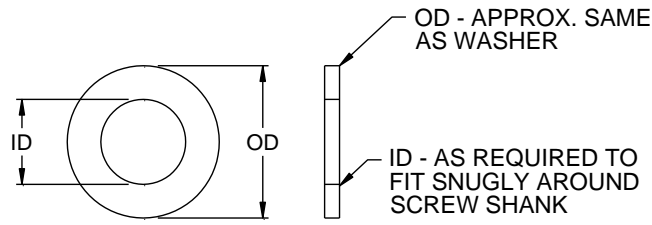


ILLUSTRATION 6
RUBBER GASKET, MANUFACTURED FROM ITEM 2

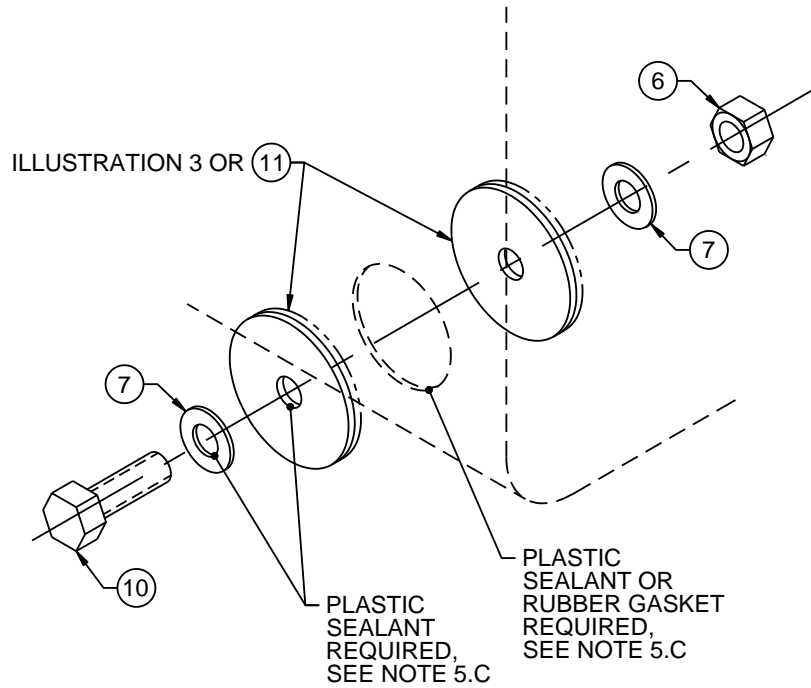


ILLUSTRATION 7
SEALING HOLES IN NWT, DRIP-PROOF ENCLOSURES
USING FABRICATED STEEL PLATES (1 PER SIDE) OR
ALUMINUM PIPE CAPS (2 PER SIDE)

Item numbers correspond to [table 2A26-I](#)

FIGURE 2A26. Sealing holes in electrical equipment – Continued.

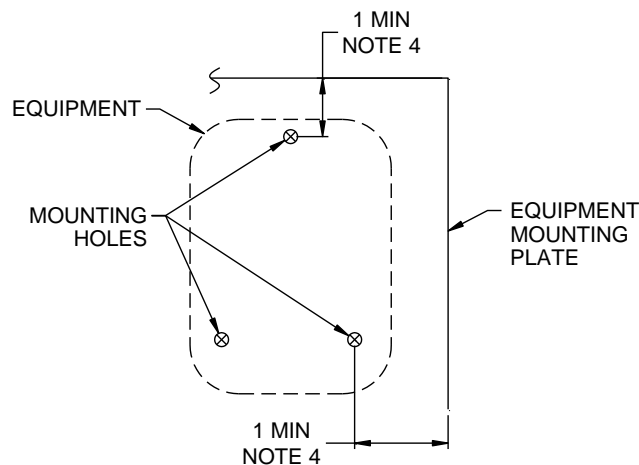
MIL-STD-2003-2B(SH)
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NOTES:

1. This figure is applicable to stool mounting of electrical equipment. Unless otherwise specified in the following illustrations and methods, the weight of equipment supported by stool mounts is limited to 60 pounds.
2. Equipment mounted using these methods shall be grounded in accordance with 4.6.
3. Items referencing this note shall not be used for weather deck applications.
4. The centers of drilled holes or welded studs shall be kept a minimum of one inch from the edge of the mounting plate. See illustration 1.
5. See 4.1.2 for mounting fastener installation and material requirements.
6. See 4.1.1 for welding and stud requirements.

TABLE 2A27-I. List of material.

Item	Description	Remarks
1	Pipe	1½ inch, schedule 40 per ASTM A53/A53M or ASTM A106/A106M
2	Bracket	--
3	Stud	½ round/square, two-hole
4	Stool	⅞ square by 0.065 wall
5	Bracket	11 gage steel
6	Hex head cap screw	⅜-16UNC
7	Deleted	--
8	Self-locking nut	⅜-16UNC
9	Ty-rap	SAE-AS23190
10	Flat washer	⅜ nominal
11	Plate	¼ inch thick, ASTM A36/A36M



EQUIPMENT MOUNTING

Illustration 1

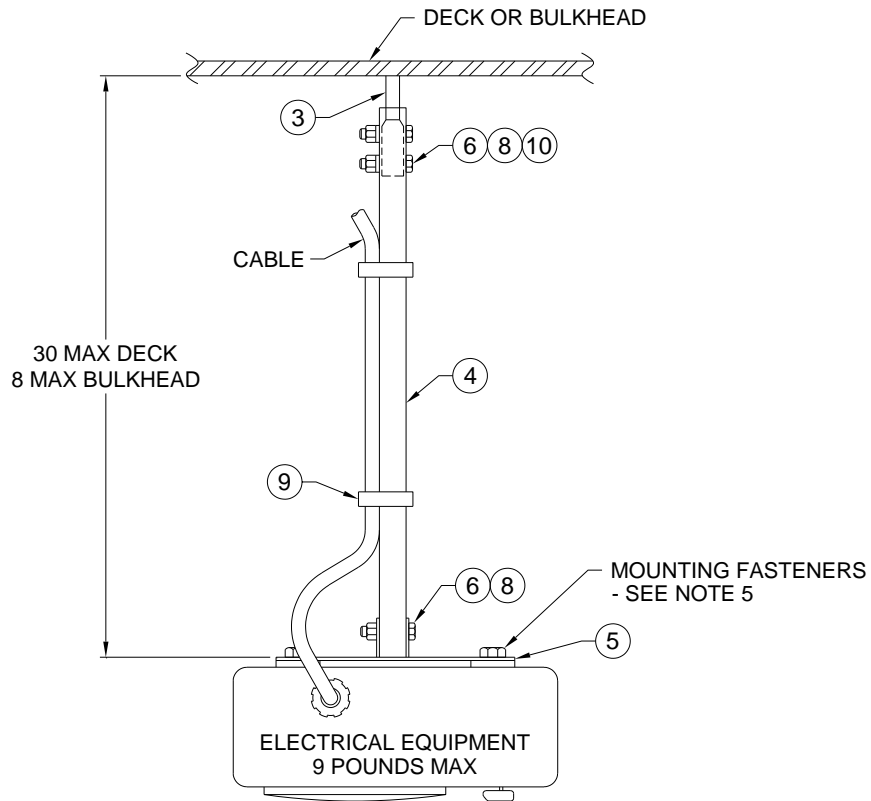
FIGURE 2A27. Stool mounting of electrical equipment.

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Method 2A-27-1
Typical stud mounted stool mount
Maximum of 9 pounds

See note 3

Item numbers correspond to [table 2A27-I](#)



TYPICAL STUD MOUNTED INSTALLATION DETAIL
9 POUNDS MAX
NON-WEATHER DECK APPLICATIONS

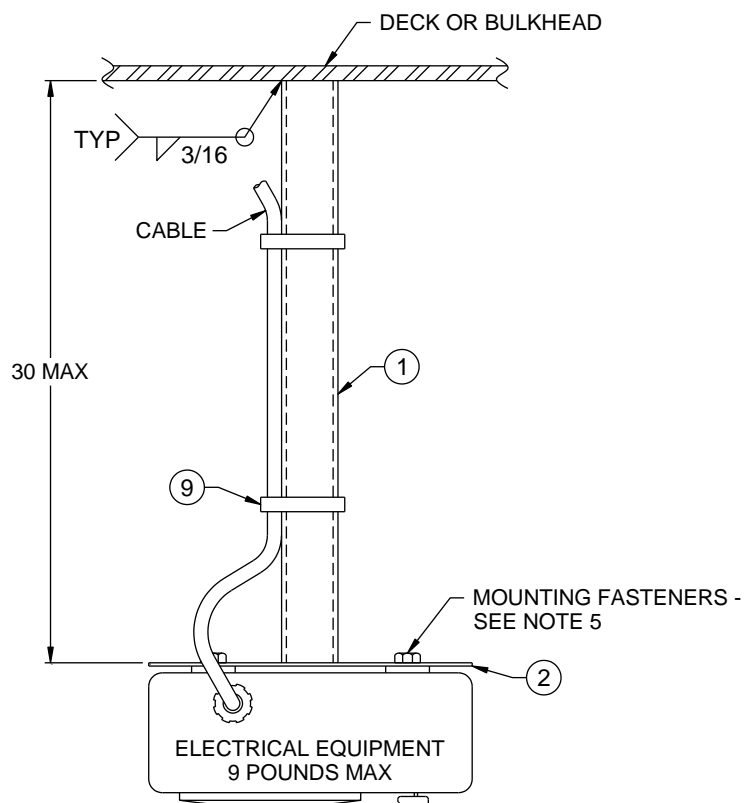
Illustration 2

FIGURE 2A27. Stool mounting of electrical equipment – Continued.

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Method 2A-27-2

Typical welded pipe installation detail
Maximum of 9 pounds
Item numbers correspond to [table 2A27-I](#)



TYPICAL WELDED PIPE INSTALLATION DETAIL
9 POUNDS MAX

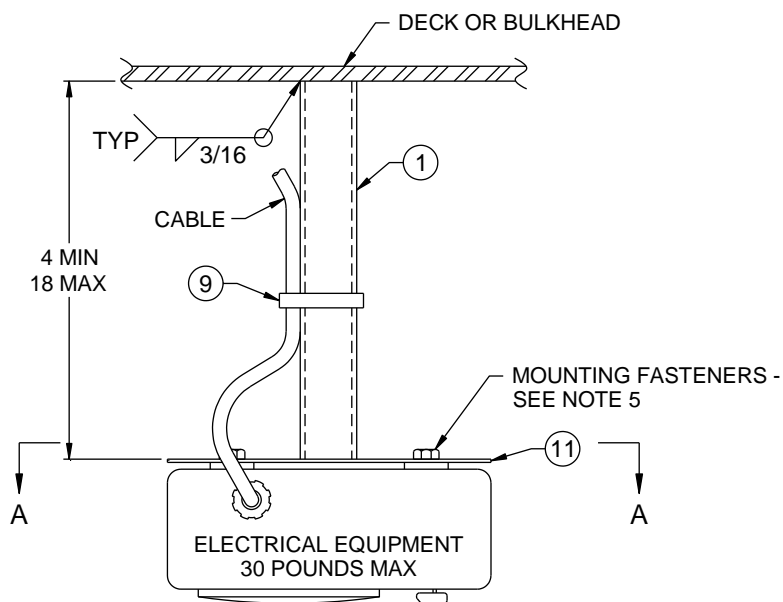
Illustration 3

FIGURE 2A27. Stool mounting of electrical equipment – Continued.

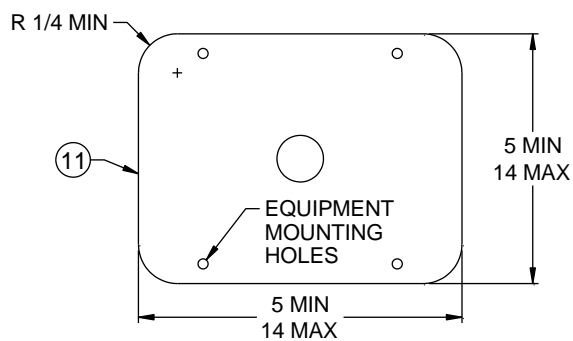
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Method 2A-27-3
Typical welded pipe installation detail
Maximum of 30 pounds

Item numbers correspond to [table 2A27-1](#)



TYPICAL WELDED SINGLE PIPE STOOL INSTALLATION DETAIL
30 POUNDS MAX



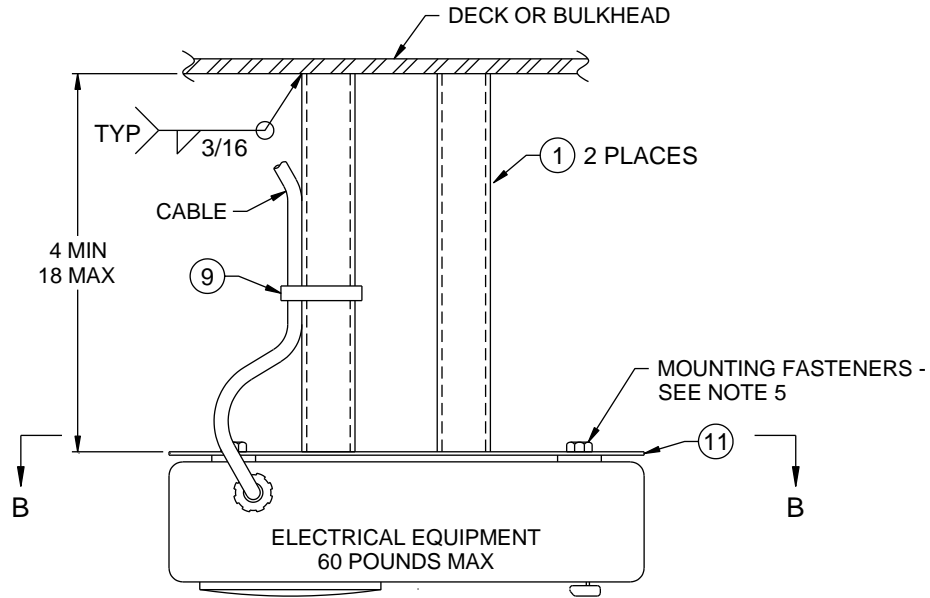
SECTION A-A

Illustration 4

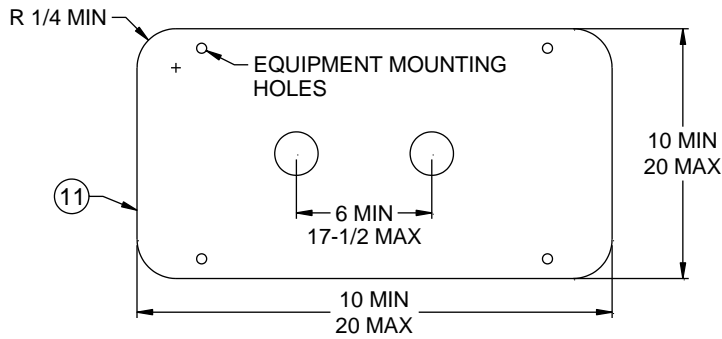
FIGURE 2A27. Stool mounting of electrical equipment – Continued.

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Method 2A-27-4
Typical welded double pipe stool installation detail
Maximum of 60 pounds
Item numbers correspond to [table 2A27-I](#)



TYPICAL WELDED DOUBLE PIPE STOOL INSTALLATION DETAIL
60 POUNDS MAX



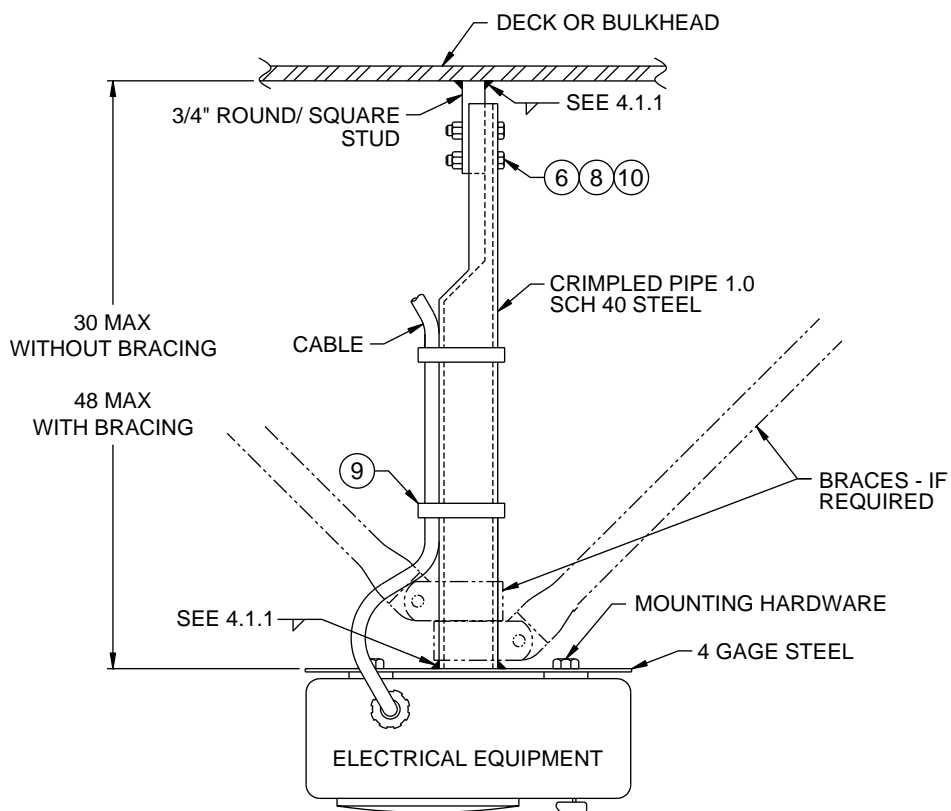
SECTION B-B

Illustration 5

FIGURE 2A27. Stool mounting of electrical equipment – Continued.

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Method 2A-27-5
Typical welded pipe installation detail
Maximum of 20 pounds
Item numbers correspond to [table 2A27-I](#)



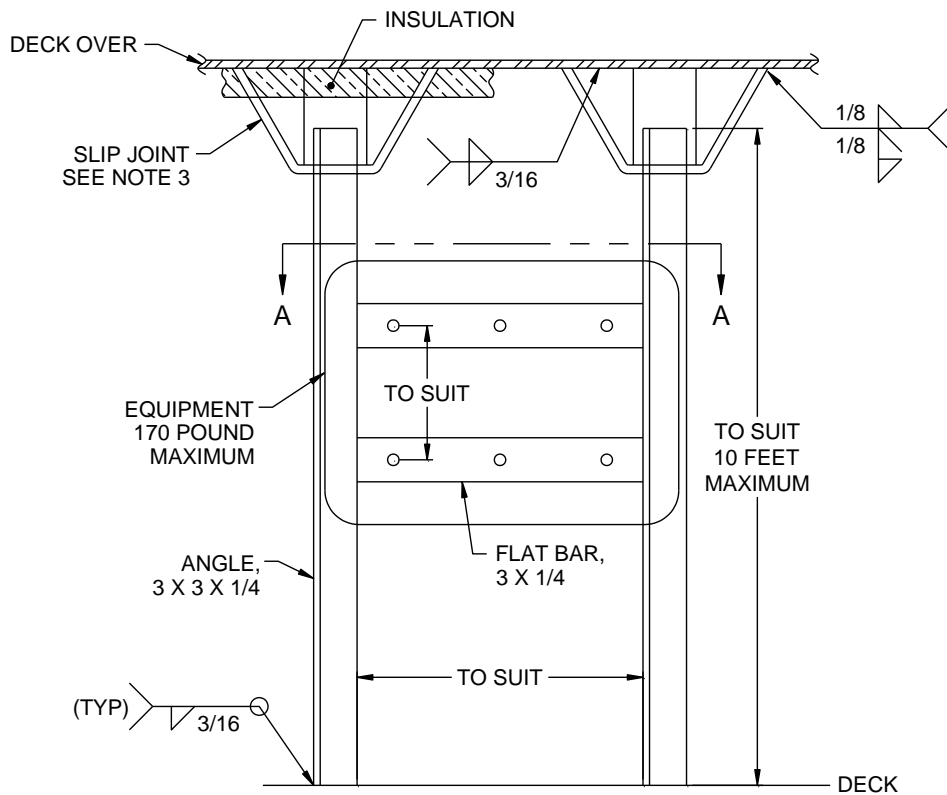
TYPICAL STUD MOUNTED INSTALLATION DETAIL
20 POUNDS MAX

FIGURE 2A27. Stool mounting of electrical equipment – Continued.

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NOTES:

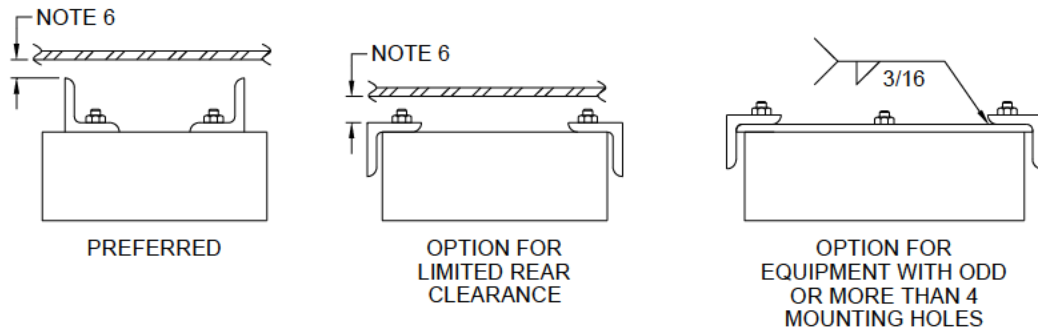
1. This method is applicable to mounting equipment, or groups of equipment, up to a weight of 170 pounds, when no other structure is available for mounting. This method provides typical installation details.
2. Equipment mounted in accordance with this method shall be grounded in accordance with 4.6.
3. Slip joints in accordance with the following illustrations shall be used under decks that may deflect. Under decks that do not deflect, weld the vertical angles directly to the deck over.
4. Equipment mounting hardware shall be of the proper size to fit the mounting holes of the equipment, as designed.
5. See 4.1.2 for mounting fastener installation and material requirements.
6. Maintain a minimum of 1-inch clearance between the mounting angle and adjacent non-structural bulkheads.



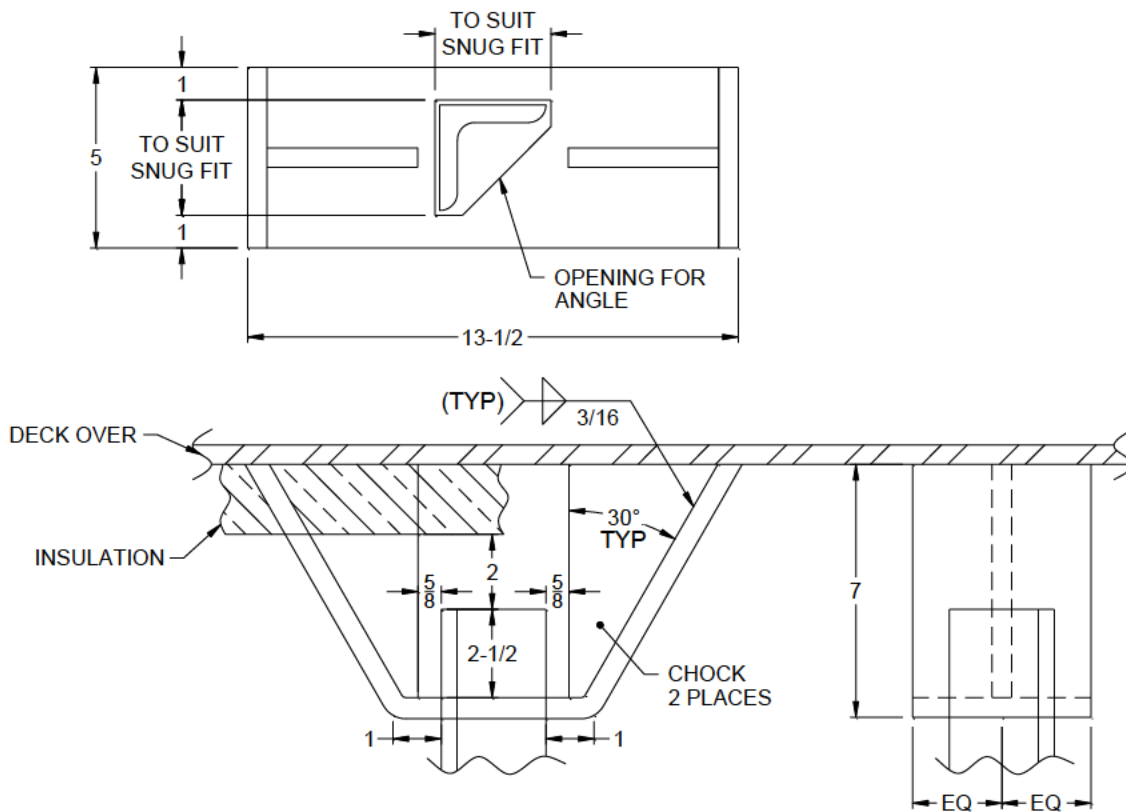
TYPICAL INSTALLATION DETAIL

FIGURE 2A28. Deck to deck support of electrical equipment.

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SECTION A-A
TYPICAL INSTALLATION DETAIL



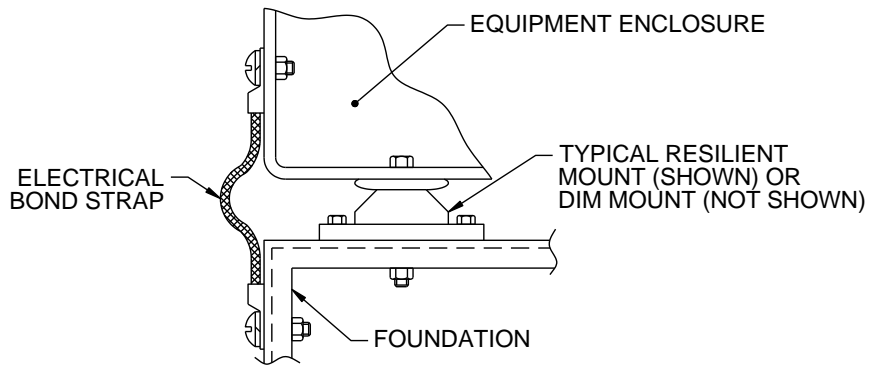
SLIP JOINT DETAIL

FIGURE 2A28. Deck to deck support of electrical equipment.

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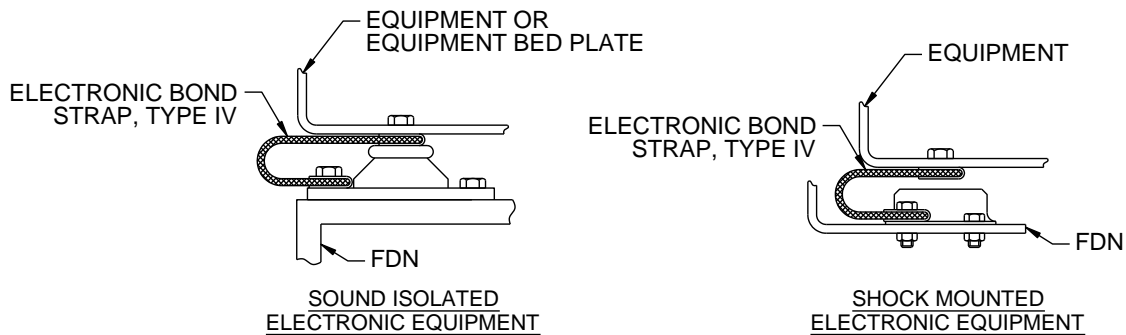
NOTES:

1. This method is applicable to grounding of electrical and electronic equipment that is isolated from the hull by resilient mounts, insulating washers, gaskets, or other material that would not provide effective grounding.
2. Bond strap installation shall meet the requirements of 4.6.
3. Bond straps shall be located in a visible location but shall be protected from mechanical damage.
4. Bond straps should be no longer than necessary to provide a slack flexible connection allowing for a possible 2-inch movement between the equipment and the supporting structure.
5. Bond strap length shall be as follows:
 - a. For electrical equipment, the bond strap shall have a cross sectional area equal or greater than the circular mil area of the power supply cable, but no less than 13 MCM and no greater than 100 MCM. Typical bond straps are described in MIL-STD-1310 and detailed in MIL-DTL-24749.
 - b. For electronic equipment, the bond strap shall be MIL-DTL-24749, type III or type IV.
 - c. Bond straps furnished with equipment may be used if the requirements herein are met.
6. Additional bond straps may be necessary for bolted equipment when electromagnetic testing indicates that the number of bond straps installed is not adequate.
7. Factory-installed grounding studs, bolts, or threaded holes shall be used as the bond strap tie-point to the equipment (when available) in accordance with 4.6.



GROUNDING ISOLATED
ELECTRICAL EQUIPMENT

Illustration 1

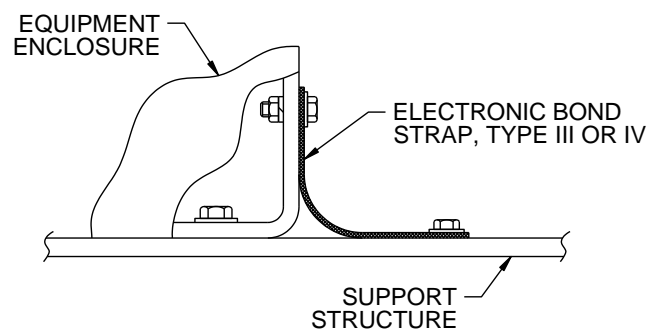


GROUNDING ISOLATED
ELECTRONICS EQUIPMENT

Illustration 2

FIGURE 2A29. Grounding of isolated equipment using bond straps.

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BOLTED ELECTRONICS EQUIPMENT
(SEE NOTE 6)

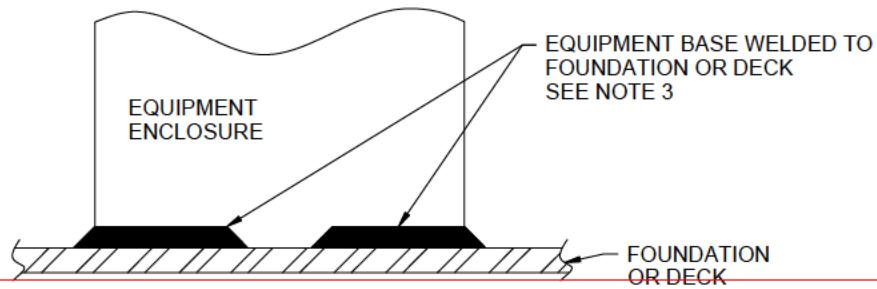
Illustration 3

FIGURE 2A29. Grounding of isolated equipment using bond straps – Continued.

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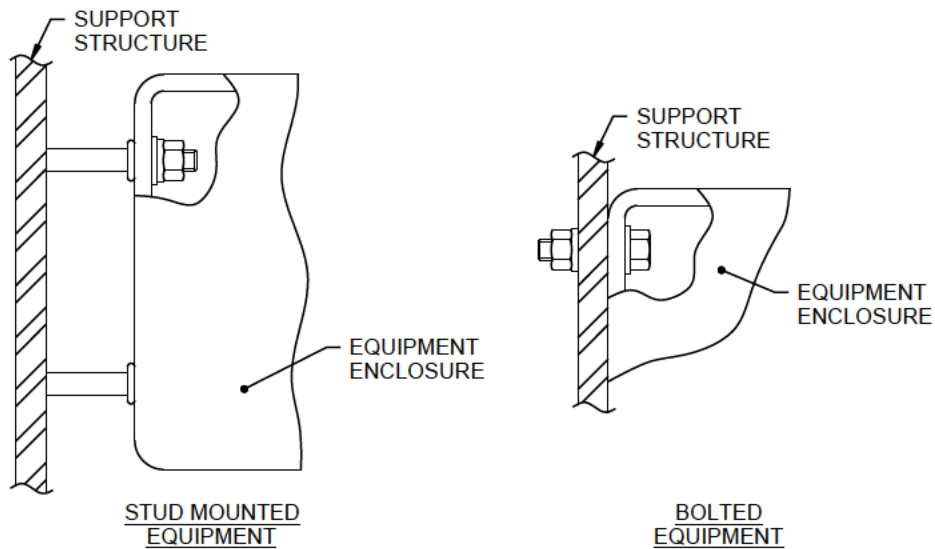
NOTES:

1. This method is applicable to creating a class A or class B bond in accordance with MIL-STD-1310, as specified in 4.6, for the purpose of equipment grounding of bolted or welded electrical equipment.
2. Ensure all requirements for class a or class B grounding in accordance with MIL-STD-1310 are met.
3. Equipment welded to foundations as an integral part of installation is considered to be class A bonded in accordance with MIL-STD-1310 (see illustration 1). Equipment bolted to foundations may be tack welded to the foundation at one point to facilitate grounding.
4. Equipment bolted to foundations or bolted to mounts that are welded directly to the ship structure is considered class B bonded. See illustration 2.
5. Class B bond installation: Follow class B bonding instructions in MIL-STD-1310.
6. Resistance between equipment enclosure and support structure shall be 0.10 ohm or less.



CLASS A BOND

Illustration 1



CLASS B BOND

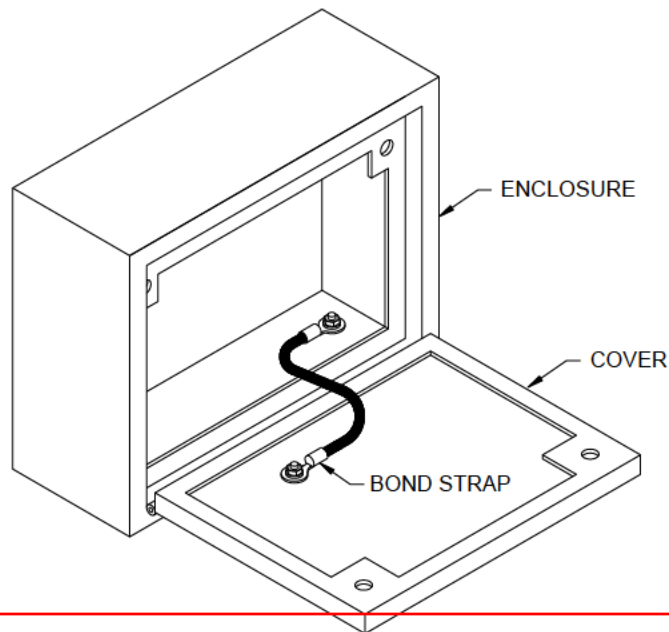
Illustration 2

FIGURE 2A30. Grounding of welded or bolted equipment.

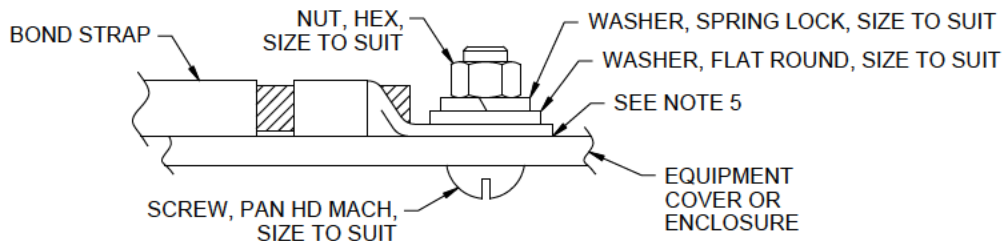
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NOTES:

1. This method is applicable to installing bond straps on hinged or removable panels and doors that have electrical devices mounted on them. Panels and doors that have mounted devices, such as meters, switches, or test points, shall be attached or hinged in such a manner as to ensure that the hinged panel or door is at the same ground potential as the attached mounted enclosure, whether the hinged panel is open or closed.
2. All requirements of 4.6 shall be met.
3. Any metal parts of components accessible to operators shall be hard grounded to the enclosure in which the components are installed.
4. The bond strap shall have a cross section area equal or greater than the circular mil area of the largest wire supplying power to the cover, but no less than 13 MCM or no greater than 100 MCM.
5. The bond strap lugs shall be soldered to the enclosure and to the cover. Where soldering is not possible, the lugs may be bolted as shown in the following illustration.
6. The bond strap shall be kept as short as practical but should allow the cover to be fully opened or removed.
7. Bond strap installation shall be in accordance with [figure 2A29](#) and MIL-STD-1310.



COVER GROUNDING DETAIL



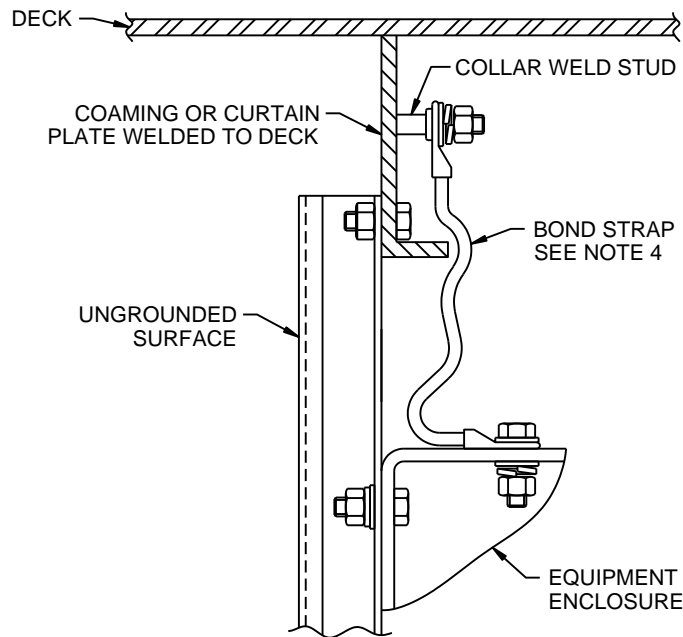
ASSEMBLY DETAIL

FIGURE 2A31. Grounding of electrical equipment box covers.

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NOTES:

1. This method is applicable to grounding electrical and electronic equipment mounted to ungrounded surfaces, such as bulkheads or decks.
2. All requirements of 4.6 shall be met.
3. Bond strap selection shall be in accordance with [figure 2A29](#).
4. Bond strap installation shall be in accordance with [figure 2A29](#) and MIL-STD-1310.
5. Bolted connections shall be in accordance with [figure 2A30](#).
6. ~~No more than one bond strap shall be installed on any one grounding stud or bolt in accordance with MIL-STD-1310.~~
7. See 4.1.2 for mounting fastener installation and material requirements.



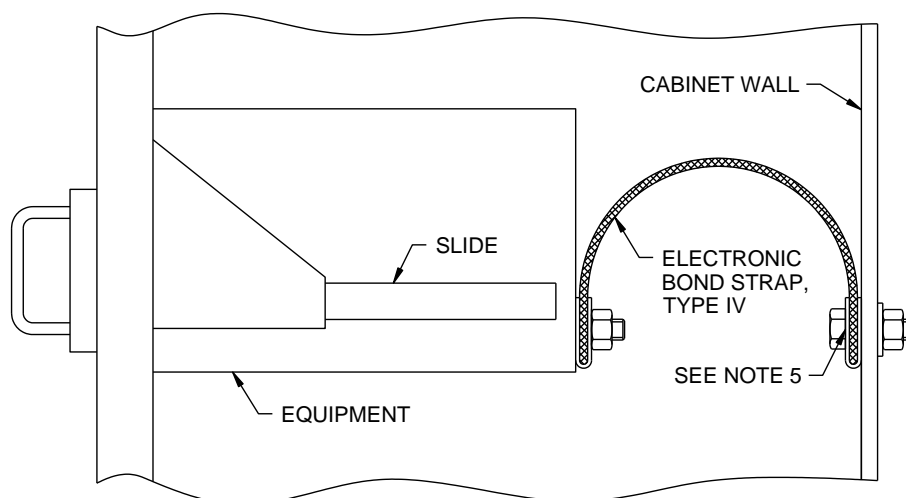
TYPICAL INSTALLATION DETAIL

FIGURE 2A32. Grounding of electrical equipment mounted on ungrounded surfaces.

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NOTES:

1. This method is applicable to grounding slide mounted electronics equipment not already grounded through a ground wire in the associated power cable.
2. Requirements of 4.6 shall be met.
3. Bond strap length shall be kept as short as practical, but long enough to allow the equipment to rack out completely. The bond strap shall not be allowed to bind or to snag other components when the equipment is racked in and out.
4. Bond strap installation shall be in accordance with [figure 2A29](#) and MIL-STD-1310.
5. Whenever possible, the bondstrap should be mounted on the side of the sliding component, with the strap connection located halfway between the front and back of the cabinet.

SLIDE MOUNTED EQUIPMENT
BOND STRAP ATTACHMENT
(TYPICAL)FIGURE 2A33. Grounding of slide mounted equipment.

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APPENDIX 2B

APPENDIX 2B – SWITCHBOARD MOUNTING

B.1 SCOPE

B.1.1 Scope. This section describes procedures for the proper installation and mounting of switchboards. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

B.2 APPLICABLE DOCUMENTS

B.2.1 General. The documents listed in this section are specified in this appendix. This section does not include documents cited in other sections of this standard 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 this appendix, whether or not they are listed.

B.2.2 Government documents.

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

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1310 - Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic
Compatibility, Electromagnetic Pulse (EMP) Mitigation, and Safety

(Copies of this document are available online at <https://quicksearch.dla.mil>.)

B.2.3 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.

B.3 REQUIRED EQUIPMENT AND MATERIALS

B.3.1 Required equipment and materials. The equipment and materials required for the proper installation and mounting of switchboards are specified on figures [2B1](#) through [2B6](#).

B.4 NOTES AND PROCEDURES

B.4.1 Dimensions. For figures and tables in this appendix, all dimensions are in inches unless otherwise noted.

B.4.2 Figures. [Table 2BI](#) provides information for the figures in this appendix.

TABLE 2BI. Figures for the installation and mounting of switchboards.

Figure number	Switchboard installation	Page
2B1	Switchboard foundation bolting	84
2B2	Switchboard bracing	85
2B3	Switchboard bracing	86
2B4	Switchboard bracing	87
2B5	Switchboard bracing	88
2B6	Switchboard bracing	90

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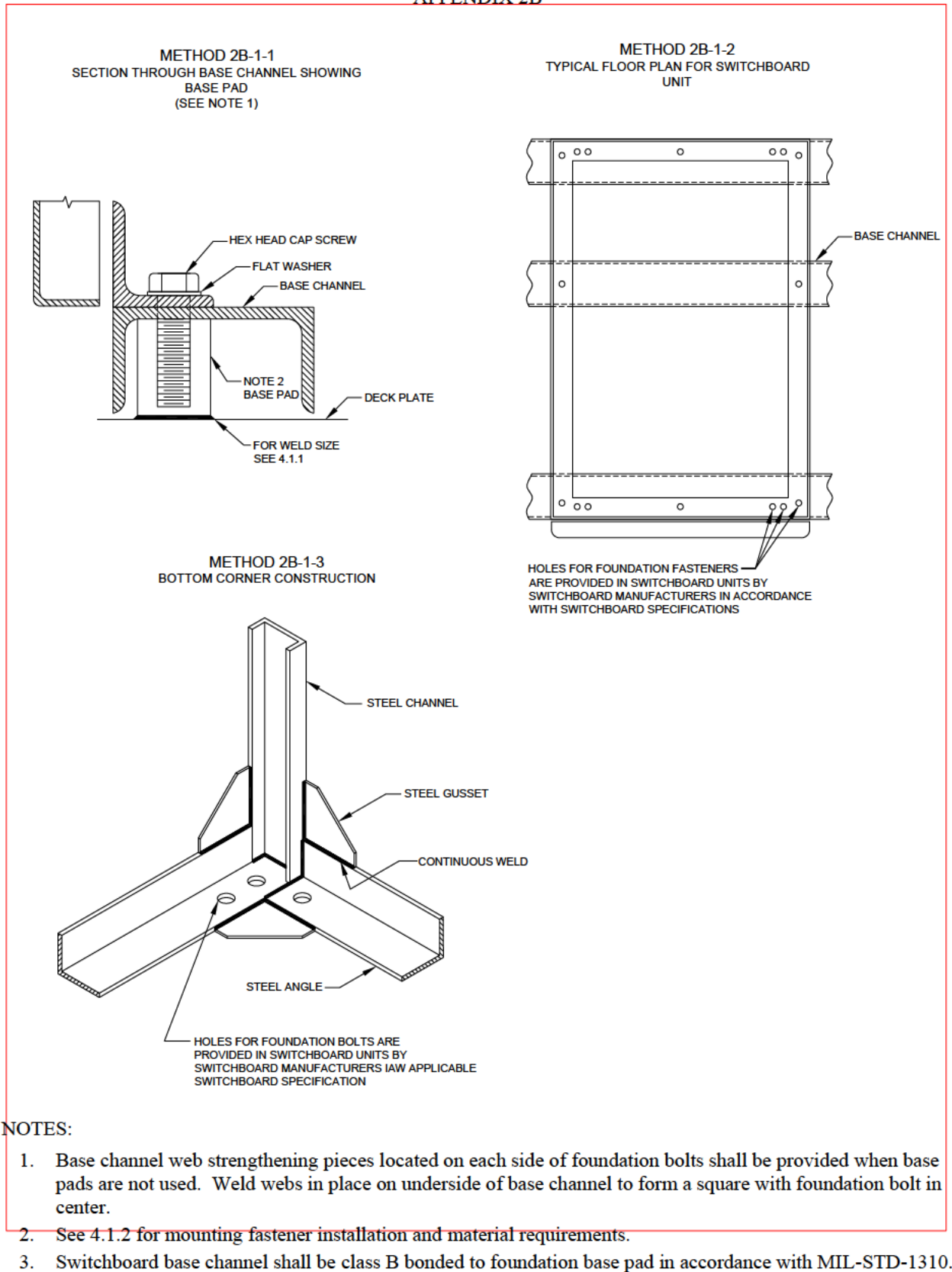


FIGURE 2B1. Switchboard foundation bolting.

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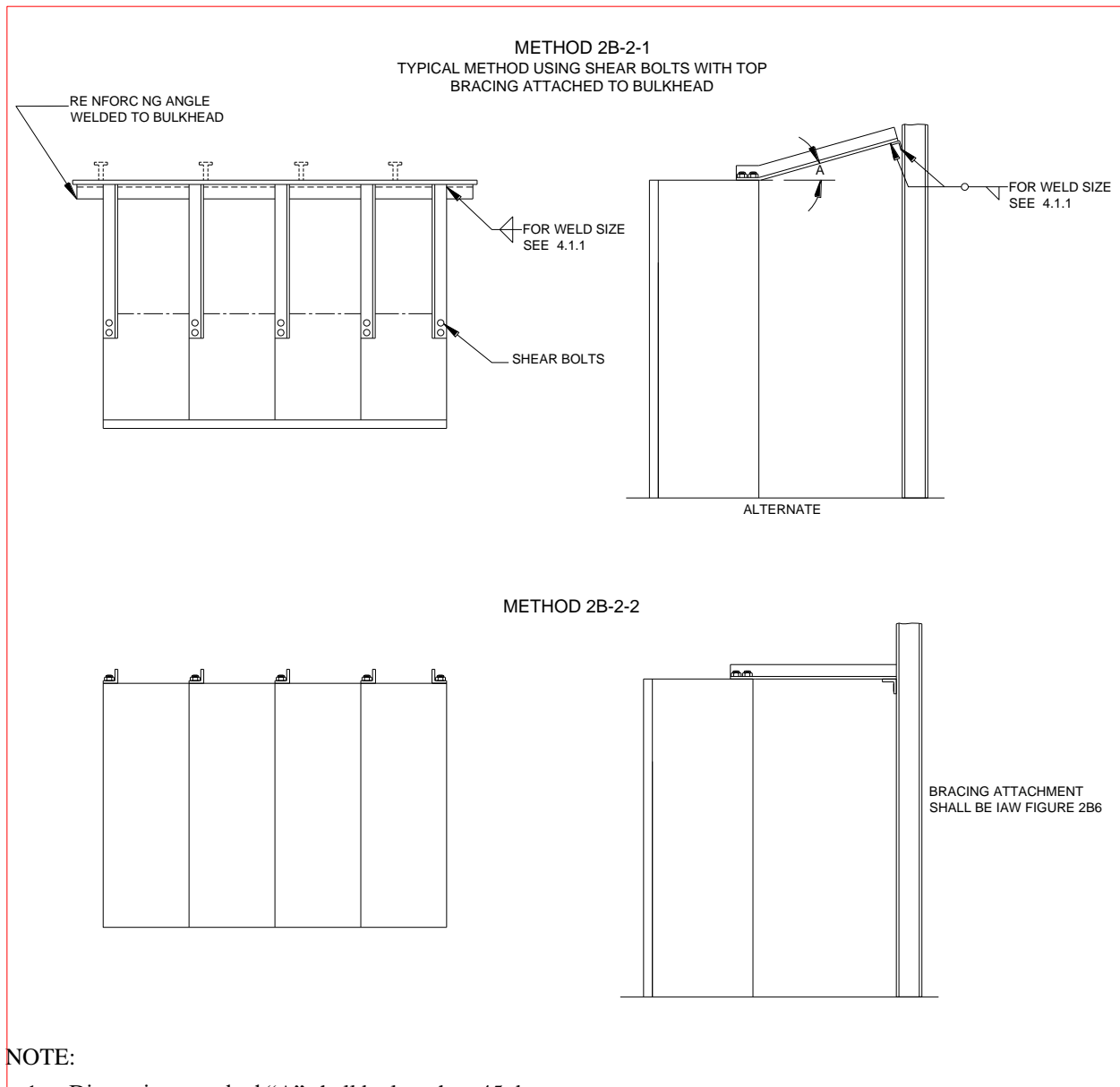


FIGURE 2B2. Switchboard bracing.

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METHOD 2B-3-1
TYPICAL METHOD USING INITIAL DEFLECTING BRACE

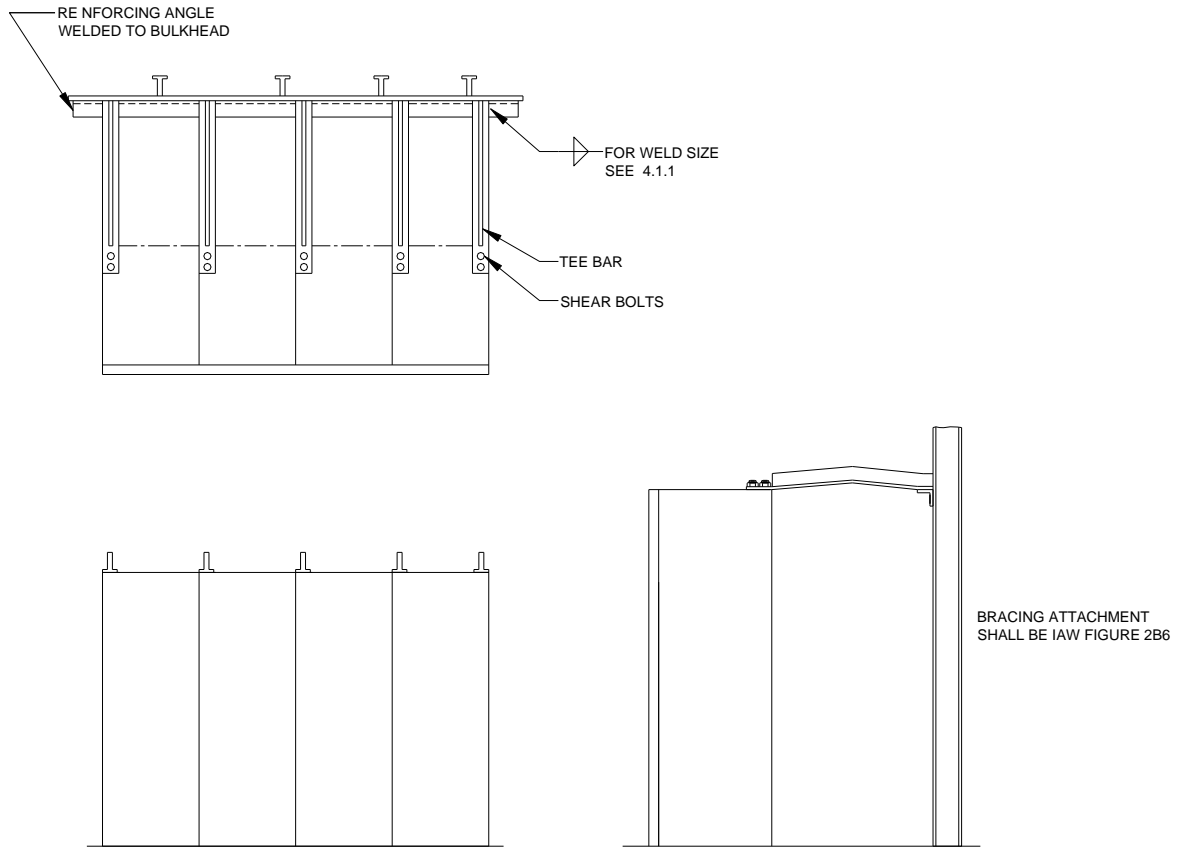
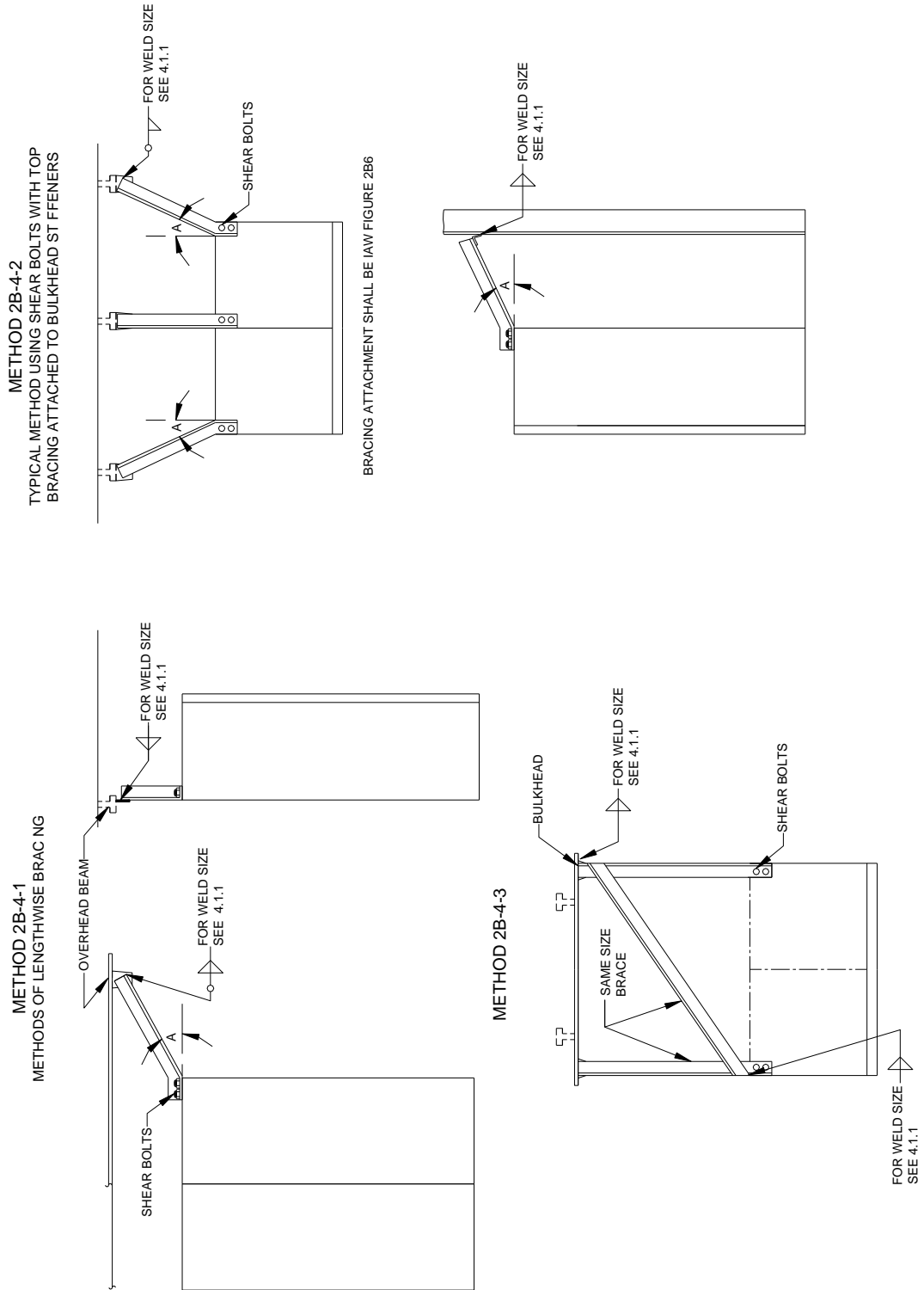


FIGURE 2B3. Switchboard bracing.

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NOTES:

1. Where the length of switchboard section is less than the height, lengthwise bracing shall be provided.
2. Dimensions marked "A" shall be less than 45 degrees.

FIGURE 2B4. Switchboard bracing.

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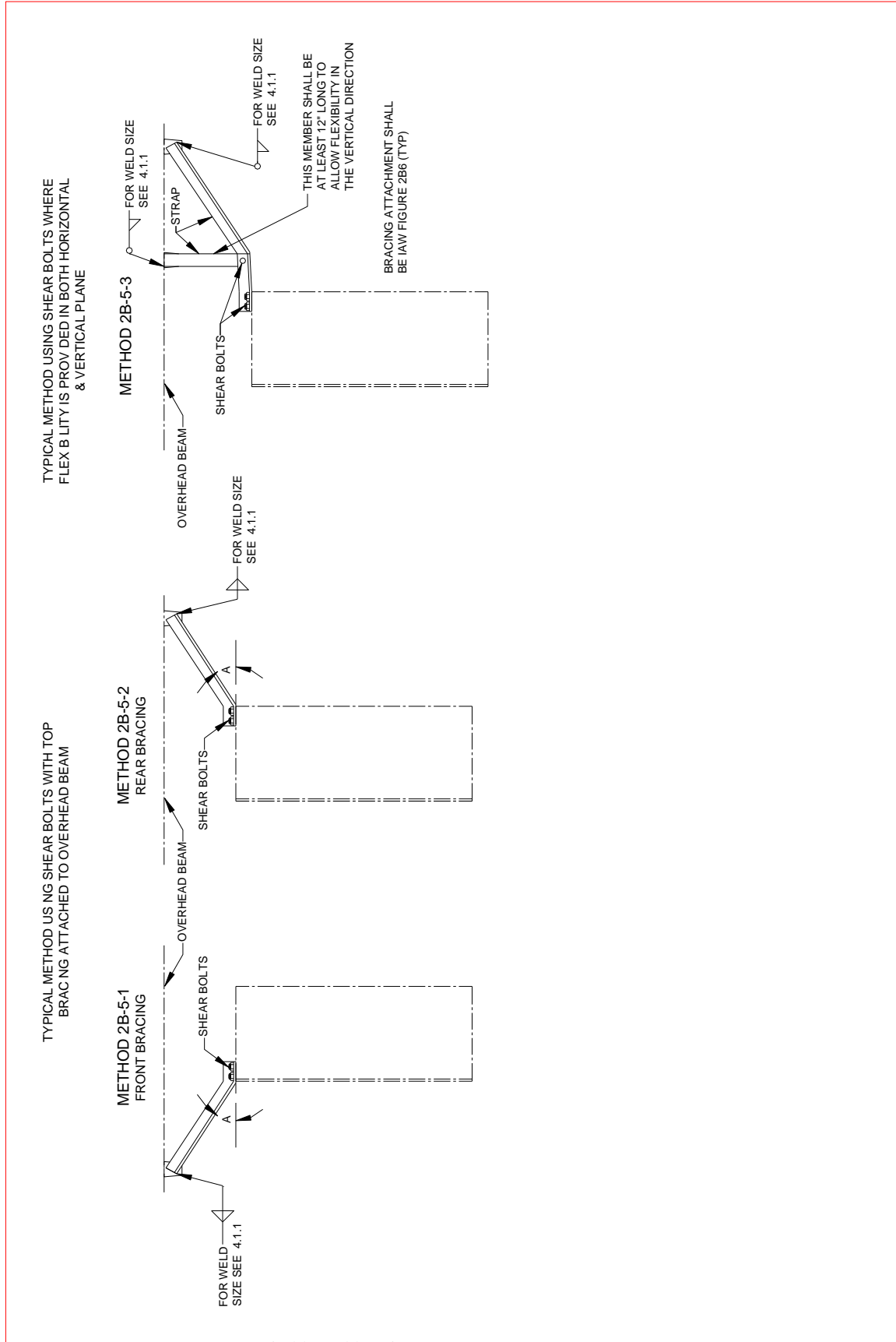


FIGURE 2B5. Switchboard bracing.

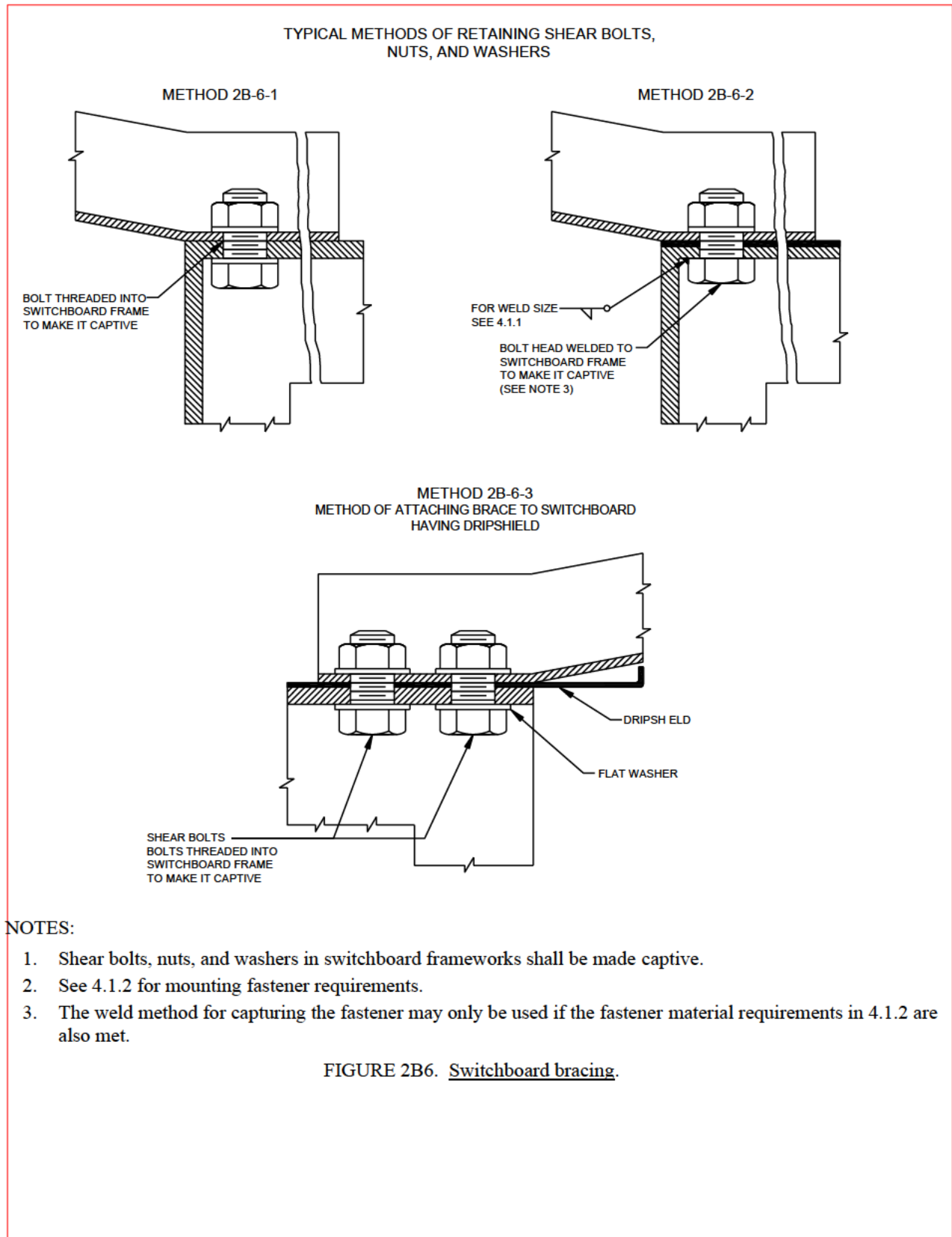
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NOTE:

1. Dimensions marked "A" shall be less than 45 degrees.

FIGURE 2B5. Switchboard bracing – Continued.

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APPENDIX 2C

APPENDIX 2C – BATTERY RACK MOUNTING

C.1 SCOPE

C.1.1 Scope. This section describes procedures for the proper installation and mounting of battery racks. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

C.2 APPLICABLE DOCUMENTS

C.2.1 General. The documents listed in this section are specified in this appendix. This section does not include documents cited in other sections of this standard 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 this appendix, whether or not they are listed.

C.2.2 Government documents.

C.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.

FEDERAL SPECIFICATIONS

- FF-S-92 - Screw, Machine, Slotted, Cross-Recessed or Hexagon Head
- MM-L-736 - Lumber; Hardwood

COMMERCIAL ITEM DESCRIPTIONS

- A-A-50608 - Battery, Storage (Portable, Sealed, Maintenance-Free, Lead-Acid) 2 Volt, 10 Ampere-Hour, Type 2V-S-10 AH
- A-A-50609 - Battery, Storage (Portable, Sealed, Maintenance-Free, Lead-Acid) 12 Volt, 15 Ampere-Hour, Type 12V-S-15 AH
- A-A-50610 - Battery, Storage (Portable, Sealed, Maintenance-Free, Lead-Acid) 2 Volt, 20 Ampere-Hour, Type 2V-S-20 AH
- A-A-50611 - Battery, Storage (Portable, Sealed, Maintenance-Free, Lead-Acid) 6 Volt, 50 Ampere-Hour, Type 6V-S-50 AH
- A-A-50612 - Battery, Storage (Portable, Sealed, Maintenance-Free, Lead-Acid) 12 Volt, 50 Ampere-Hour, Type 12V-S-50 AH
- A-A-50613 - Battery, Storage (Portable, Sealed, Maintenance-Free, Lead-Acid) 6 Volt, 100 Ampere-Hour, Type 6V-S-100 AH
- A-A-50614 - Battery, Storage (Portable, Sealed, Maintenance-Free, Lead-Acid) 12 Volt, 100 Ampere-Hour, Type 12V-S-100 AH
- A-A-50615 - Battery, Storage (Portable, Sealed, Maintenance-Free, Lead-Acid) 6 Volt, 130 Ampere-Hour, Type 6V-S-130 AH
- A-A-50616 - Battery, Storage (Portable, Sealed, Maintenance-Free, Lead-Acid) 12 Volt, 130 Ampere-Hour, Type 12V-S-130 AH
- A-A-50617 - Battery, Storage (Portable, Sealed, Maintenance-Free, Lead-Acid) 6 Volt, 200 Ampere-Hour, Type 6V-S-200 AH
- A-A-50618 - Battery, Storage (Portable, Sealed, Maintenance-Free, Lead-Acid) 6 Volt, 300 Ampere-Hour, Type 6V-S-300 AH

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A-A-50619 - Battery, Storage (Portable, Sealed, Maintenance-Free, Lead-Acid) 6 Volt, 780 Ampere-Hour, Type 6V-S-780 AH

A-A-59814 - Chargers, Battery, Lift Truck and Pallet Transporter Battery Service

DEPARTMENT OF DEFENSE SPECIFICATIONS

- MIL-DTL-917 - Electric Power Equipment, Basic Requirements for
- MIL-S-22698 - Steel Plate, Shapes and Bars, Weldable Ordinary Strength and Higher Strength: Structural
- MIL-C-24095 - Charger, Battery, Automatic, Portable, Rectifier Type
- MIL-DTL-24441 - Paint, Epoxy-Polyamide, General Specification for
- MIL-DTL-24643 - Cables, Electric, Low Smoke Halogen-Free, for Shipboard Use, General Specification for

DEPARTMENT OF DEFENSE STANDARDS

DOD-STD-2134 - Storage Battery Arrangement for Minimum Stray Magnetic Field (Metric)

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

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

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

- S9086-KR-STM-010/313 - NSTM Chapter 313, Portable Storage and Dry Batteries
- S9310-AQ-SAF-010 - Navy Lithium Battery Safety Program, Responsibilities and Procedures

(Copies of these documents are available online via Technical Data Management Information System (TDMIS) at <https://mercury.tdmis.navy.mil/> by searching for the document number without the suffix. Refer questions, inquiries, or problems to: DSN 296-0669, Commercial (805) 228-0669. These documents are available for ordering (hard copy) via the Naval Logistics Library (NLL) at <https://nll.navsup.navy.mil/>. For questions regarding the NLL, contact the NLL Customer Service at nllhelpdesk@navy.mil, (866) 817-3130, or (215) 697-2626/DSN 442-2626.)

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

ASTM INTERNATIONAL

- ASTM A36/A36M - Standard Specification for Carbon Structural Steel
- ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
- ASTM F1145 - Standard Specification for Turnbuckles, Swaged, Welded, Forged
- ASTM F1267 - Standard Specification for Metal, Expanded, Steel

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

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NATIONAL AEROSPACE STANDARDS COMMITTEE (NA/NAS)

NASM 25027 - Nut, Self-Locking, 250 °F, 450 °F, and 800 °F

(Copies of this document are available online at www.aia-aerospace.org.)

UNDERWRITERS LABORATORIES, INC. (UL)

UL 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

(Copies of this document are available online at www.comm-2000.com.)

C.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.

C.3 REQUIRED EQUIPMENT AND MATERIALS

C.3.1 Required equipment and materials. The equipment and materials required for the proper installation and mounting of battery racks are specified on figures [2C1](#) through [2C8](#).

C.4 NOTES AND PROCEDURES

C.4.1 Dimensions. For figures and tables in this appendix, all dimensions are in inches unless otherwise noted.

C.4.2 Figures. [Table 2CI](#) provides information for the figures in this appendix.

TABLE 2CI. Figures for the installation and mounting of battery racks.

Figure number	Battery rack installation	Page
2C1	Open battery racks	97
2C2	Open battery rack details	101
2C3	Enclosed battery racks	105
2C4	Enclosed battery rack details	106
2C5	Details of wood spacer blocks for battery racks	108
2C6	Battery clamp details	109
2C7	Battery clamp details	110
2C8	Battery clamp details	112

C.4.3 Lead acid battery and servicing facility installation requirements and guidance.

- a. Selection of lead-acid battery and battery servicing equipment.
 - (1) VRLA storage batteries generally shall comply with A-A-50608 through A-A-50619.
 - (2) The minimum temperature rating of battery cells shall be 50 °C during charging and 60 °C for discharging.
 - (3) For engine starting, batteries shall be provided as necessary to meet the current, voltage, and duty cycle of the starting motor for each application.

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(4) Portable charging cable, local and remote, and portable inter-tray connectors shall be type HOF cable in accordance with MIL-DTL-24643 of suitable current rating. Battery interconnection cable shall not put undue stress on battery cell posts. Multiple cable connections on the battery posts should be installed utilizing terminal plates where possible.

(5) All acid type batteries shall use flame retardant battery cases in accordance with UL 94.

b. The required number of trays or cells shall be connected in series to produce the required voltage. The necessary ampere-hour capacity shall be obtained by the use of the proper size of battery. As an alternative to using the largest battery available, lead-acid batteries may be connected in parallel in order to obtain greater capacities than those available from the largest sized battery.

c. Typical classes and applications of lead-acid storage batteries are shown in [table 2CII](#).

d. Storage batteries – tray and rack installation:

(1) Figures [2C1-2C8](#) provide typical drawings for installation of racks to support and contain groups of individual battery cells. These figures may be used as guides in the design and construction of battery racks.

(2) Trays for separately mounted batteries shall be installed to support battery ventilation and to be readily accessible for testing, cleaning, cell disconnection, and cell connection. Clearance above trays shall be not less than 12 inches.

(3) Racks that cannot be adequately secured to the deck and bulkhead shall be additionally secured by diagonal braces to the deck above, but in no case shall the vertical support extend from deck to deck.

(4) Spaces assigned for storage and service of spare batteries shall have sufficient shelf space or racks for storage of all spare batteries.

(5) On mine countermeasure ships and similar ship types designed for low magnetic signature, where it is required to reduce to a minimum the stray magnetic field produced by the current through the batteries and the battery connections, the arrangement and connections shall be in accordance with DOD-STD-2134.

(6) Inter-tray connectors for permanent installation shall not be longer than the length necessary to reach from tray-to-tray without putting any strain on battery terminals.

(7) Racks for engine starting batteries shall be located at the engine end of the set, as close as practicable to the engine starter, and as far as practicable from the generator. Batteries shall not be located closer than 30 inches from any open end of generators.

(8) Battery stowage racks and charger shall be installed so that the batteries may be charged while secured in racks.

(9) Terminals intended for connection of batteries shall indicate the polarity in accordance with S9086-KR-STM-010/313 or be so constructed as to prevent improper connection.

(10) Where batteries are installed in external enclosures or racks, the location of the overcurrent-protective device shall be mounted within a separate cabinet.

(11) Battery terminals and battery connectors shall be accessible so that the hardware can be tightened with required tools.

(12) VRLA battery terminals shall be oriented in the horizontal or upward position and shall never be mounted upside down.

(13) Battery installation instructions shall state voltage, ampere-hour (watt or kilowatt) rating, charging information, method of protection, and maximum fault current required on installation to coordinate with electrical system protective devices.

e. Gyrocompass batteries shall be located in the same compartment as the gyrocompass and shall be installed in an enclosed rack. The batteries shall be arranged to be charged in place from the normal gyrocompass power supply and controlled by the gyrocompass control cabinet so as to normally float charge the batteries. The batteries shall supply gyrocompass power in case of failure of the normal supply.

f. Battery compartments shall be provided with the following clearly legible information, fixed upon the battery cabinet or compartment of stationary batteries, in such a position that it can be clearly seen by service personnel before accessing the battery compartment.

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- (1) Battery manufacturer name, catalogue number, and number of batteries.
- (2) Nominal voltage of total battery string.
- (3) Nominal capacity of total battery string.
- (4) A caution label denoting an energy and chemical hazard and reference to the maintenance handling and disposal instructions for the safety of service personnel.

g. Battery disconnects shall be installed when the battery is located in another room from the load. Systems requiring a battery string to be installed on multiple racks, or for strings where bus voltage exceeds 250 VDC, a multiple battery disconnect should be utilized to split the string into sections, thereby minimizing the overall voltage on a rack and increasing personnel safety during maintenance. Battery disconnects should always be able to be activated (opened) from within the battery area and should have lock-out/tag-out capability within the battery room.

C.4.4 Lead acid battery charging stations.

- a. Acid type battery charging shops or stations shall be equipped with a battery charging unit in accordance with MIL-C-24095 or A-A-59814.
- b. Charging units for portable storage batteries shall comply with MIL-C-24095. Charging units for heavy duty storage batteries, such as industrial type cargo handling trucks, shall comply with A-A-59814.
- c. A permanently mounted battery charging unit or a battery charging outlet shall be installed at battery charging stations.
- d. Where battery charging units are used, a receptacle connector for AC power supply shall be installed.
- e. Local charging circuits shall terminate in a battery charging outlet box, Symbol 733.1, Symbol 731.1, or Symbol 732, as required. Portable charging cables shall have alligator clips with insulated grips at one end, and plugs, Symbols 1214.4 and 1243.3, at the other end for charging directly from battery chargers, or Symbols 1214.2 and 1214.5, for charging from battery outlet boxes.
- f. Plugs and jacks on outlet boxes and portable charging cables shall be marked "POS." or "+" or color-coded red for positive, and "NEG." or "-" or color coded black for negative.
- g. Remote charging circuits, except those for emergency generator starting batteries, shall terminate in a battery charging outlet box, Symbol 731.1. Remote charging circuits for emergency generator starting batteries shall terminate in the engine starting control panel. These circuits shall be arranged so that the batteries may be connected to the charging circuit by operating a switch on the associated engine starting control panel.
- h. Provisions shall be made for charging permanently-connected batteries (including small boat diesel engine starting batteries) in place.
- i. Lift truck battery charging shops and stations shall be provided with charging units in accordance with A-A-59814, suitable for the trucks specified.
- j. On replenishment-at-sea ships or cargo ships having rapid transfer handling rates, one charging unit shall be installed for each pair of batteries of each type onboard. On class 1 aviation facility ships, a battery charging unit and a battery storage rack, as required, shall be installed for each type of battery specified. In other ships, one charging unit shall be installed for each type battery onboard.
- k. Guard rails shall be installed to protect battery chargers mounted in lift truck operational areas.
- l. Chargers shall be installed so that the top of their enclosures will be less than 5 feet above the deck.

C.4.5 Battery ventilation for lead-acid batteries.

- a. Spacing of trays shall ensure effective ventilation and compliance with temperature and gassing limits in accordance with S9086-KR-STM-010/313.
- b. The power supply to battery chargers in battery shops shall be interlocked with the battery shop exhaust fans to prevent charging when the fans are not operating.
- c. The battery area shall be ventilated, either by a natural or mechanical ventilation system, to prevent accumulation of hydrogen. The location shall be free of areas that might collect pockets of hydrogen.

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C.4.6 Specific requirements for lithium-ion battery installation. Lithium ion batteries shall be certified and approved for use by the NAVSEA battery system Technical Authority in accordance with the processes in S9310-AQ-SAF-010. Specific stowage requirements will be determined through the certification process.

C.4.7 Specific requirements for alkaline battery installation.

- a. Alkaline batteries shall not be paralleled.
- b. Separate storage spaces shall be provided for alkaline batteries.
- c. The alkaline type battery charging shop shall be equipped with a battery charging unit designed for alkaline batteries. The alkaline shop, facilities, and tools shall be kept separate from those of the acid type battery shop. The charging bench or rack in the alkaline battery shop shall have a 15-pound CO₂ fire extinguisher mounted at each end of the charging bench or rack for use in case of thermal-runaway.
- d. Each alkaline type storage battery room and charging shop shall be provided with one battery water container and one 3-percent boric acid solution container. Containers shall be 5-gallon polyethylene bottles.

TABLE 2CII. Typical classes and applications of portable lead-acid storage batteries.

Battery classification	Reference	Typical uses
2V-S-20AH	A-A-50610	Portable floodlights
12V-S-15AH	A-A-50609	Gyros and emergency communications
6V-S-50AH 12V-S-50AH	A-A-50611 A-A-50612	Dial telephone systems having a capacity of 50 lines or less, interior communications, gyrocompass emergency power
6V-S-100AH 12V-S-100AH	A-A-50613 A-A-50614	All purposes mentioned for 50-AH type and for gun firing and sight lighting circuits, director instrument illumination, fire control instrument illumination, radio power, and 100- or 150-line telephone systems
6V-S-130AH 12V-S-130AH	A-A-50615 A-A-50616	Engine starting services
6V-S-200AH	A-A-50617	Engine starting services requiring greater capacity than 130-AH
6V-300AH	A-A-50618	General services emergency batteries, electronic, and dial telephone systems having a capacity of more than 150 lines
12V-75AH		Uninterruptible power supplies

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NOTES:

1. L-angles and plate steel shall be in accordance with MIL-S-22698, grade A.
2. Battery racks shall be painted prior to assembly with black acid-resistant paint, NAVSEA paint formula no. 28.
3. Turnbuckles shall be in accordance with ASTM F1145, class 7.
4. Retainer blocks shall be clean hard maple in accordance with MM-L-736.
5. See 4.1.2 for mounting fastener requirements.
6. All welding shall conform to 4.1.1.
7. Horizontal spacing shall be such as to provide equal space on sides and between adjacent batteries.
8. This battery rack is intended to accommodate sealed, lead-acid batteries having a length of 16.6 inches, width of 6.8 inches, case height of 8.6 inches, and terminals located on the battery top near the battery corners. If batteries having other dimensions are used, battery rack dimensions shall be adjusted accordingly.

Shock isolator shall be Aeroflex isolator part no. CB1500-20-C2, or equal (see 4.8), with the following characteristics:

- A. Helical 0.625-inch wire rope shock mount.
- B. Height 4.30 inches, width 5.30 inches, length 10.50 inches.
- C. Compression average, $K = 1,800$ pounds/inch, shear average, $K = 1,300$ pounds/inch, roll average, $K = 1300$ pounds/inch.
- D. Max. rated dynamic travel = 1.80 inches for compression and shear, 2.80 inches for 45-degree compression roll.
- E. Max. rated shock load = 3,200 pounds compression, and 2,400 pounds for shear or roll.
- F. Damping factor = 0.15.
- G. Lateral stiffness (percent of vertical) = 0.60.
- H. Oil, grease, ozone, salt spray, organic solvents, and fatigue resistant.
- I. Allows movement in any direction.
- J. Operating temperature range is -40 to $+212$ °F (-40 to $+100$ °C).

FIGURE 2C1. Open battery racks – Continued.

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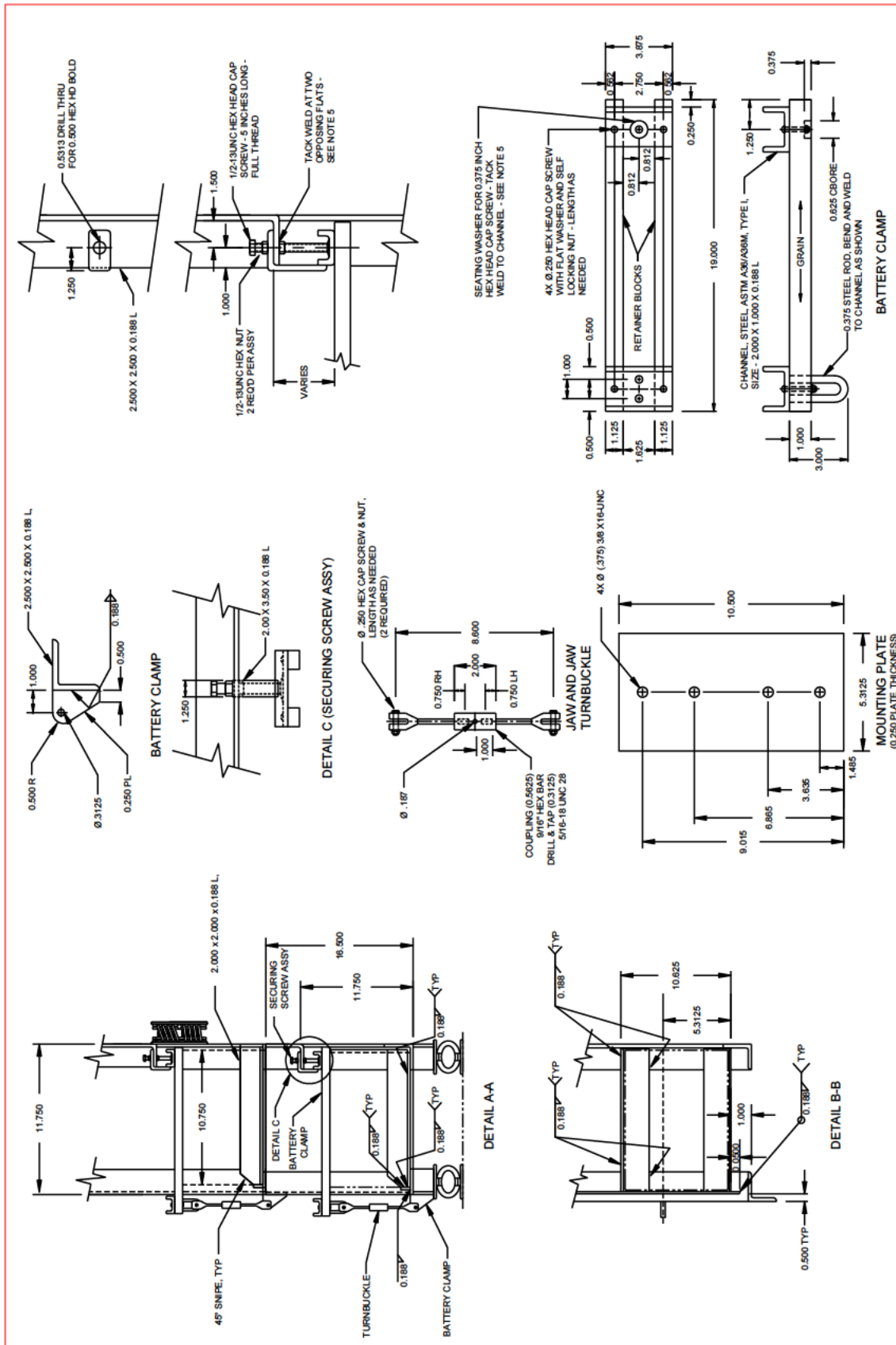


FIGURE 2C1. Open battery racks - Continued.

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NOTES:

1. L-angles and plate steel shall be in accordance with MIL-S-22698, grade A.
2. Battery racks shall be painted prior to assembly with black acid-resistant paint, NAVSEA paint formula no. 28.
3. Turnbuckles shall be in accordance with ASTM F1145, class 7.
4. Retainer blocks shall be clean hard maple in accordance with MM-L-736.
5. See 4.1.2 for mounting fastener requirements. For tack welding, the structure material shall be compatible with the fastener being welded.
6. All welding shall conform to 4.1.1.
7. Horizontal spacing shall be such as to provide equal space on sides and between adjacent batteries.
8. This battery rack is intended to accommodate sealed, lead-acid batteries having a length of 16.6 inches, width of 6.8 inches, case height of 8.6 inches, and terminals located on the battery top near the battery corners. If batteries having other dimensions are used, battery rack dimensions shall be adjusted accordingly.

FIGURE 2C1. Open battery racks – Continued.

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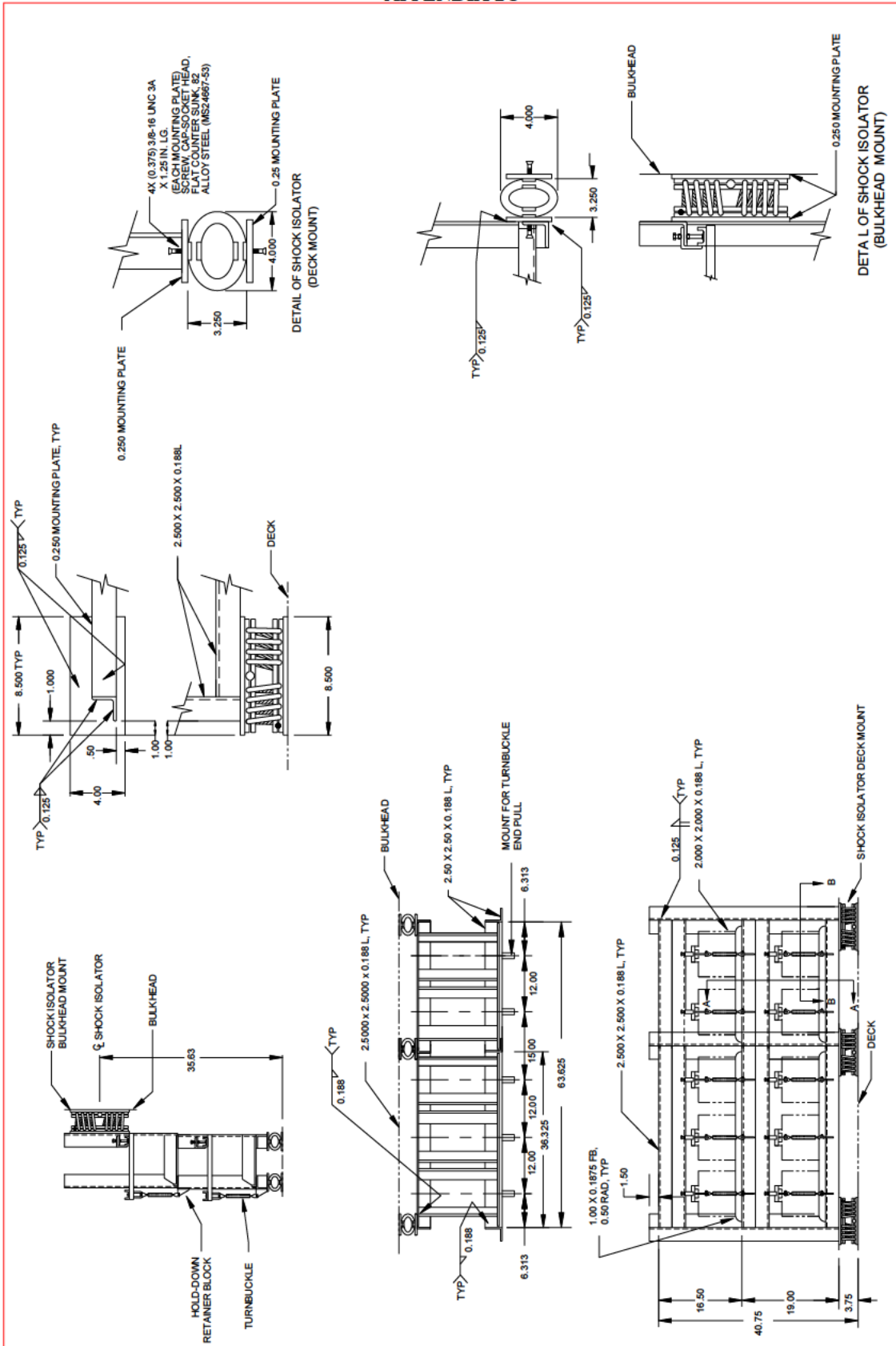


FIGURE 2C2. Open battery rack details.

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NOTES:

1. L-angles and plate steel shall be in accordance with MIL-S-22698, grade A.
2. Battery racks shall be painted prior to assembly with black acid-resistant paint, NAVSEA paint formula no. 28.
3. Turnbuckles shall be in accordance with ASTM F1145, class 7.
4. Retainer blocks shall be material that is electrically non-conductive. Melamine or clean hard maple in accordance with MM-L-736 is recommended. Alternate material is permitted when approved by NAVSEA.
5. See 4.1.2 for mounting fastener requirements.
6. All welding shall conform to 4.1.1.
7. Horizontal spacing shall be such as to provide equal space on sides and between adjacent batteries.
8. This battery rack is intended to accommodate sealed, lead-acid batteries having a length of 10.6 inches, width of 10.1 inches, height of 8.1 inches, and terminals located on the battery top near the battery diagonal corners. If batteries having other dimensions are used, battery rack dimensions shall be adjusted accordingly.
9. Assemble isolators to mounting plates before welding mounting plates.

Shock isolator shall be Aeroflex isolator part no. CB1400-15-T2, or equal (see 4.8), with the following characteristics:

- A. Helical 0.50-inch wire rope shock mount.
- B. Height 3.25 inches, width 4.00 inches, length 8.50 inches.
- C. Compression average, $K = 1,670$ pounds/inch, shear average, $K = 1,500$ pounds/inch, roll average, $K = 720$ pounds/inch.
- D. Max. rated dynamic travel = 2.50 inches for 45-degree compression roll, 1.50 inches for compression, and 1.20 inches for shear.
- E. Max. rated shock load = 2,500 pounds compression, and 1,800 pounds for shear or roll.
- F. Oil, ozone, grease, salt spray, organic solvents, and fatigue resistant.
- G. Operating temperature range is -40 to $+212$ °F (-40 to $+100$ °C) or greater inclusive range.

FIGURE 2C2. Open battery rack details – Continued.

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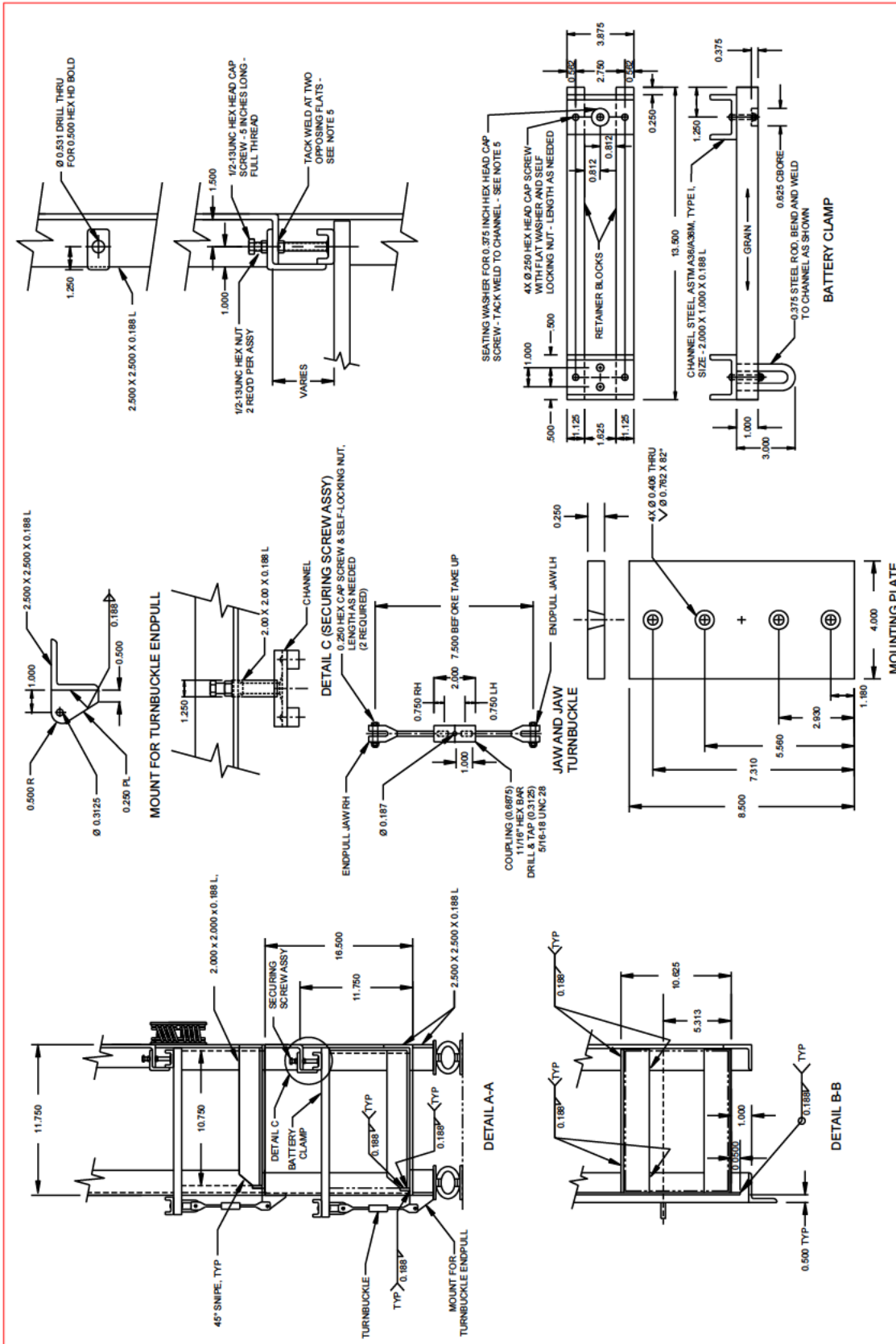


FIGURE 2C2. Open battery rack details - Continued.

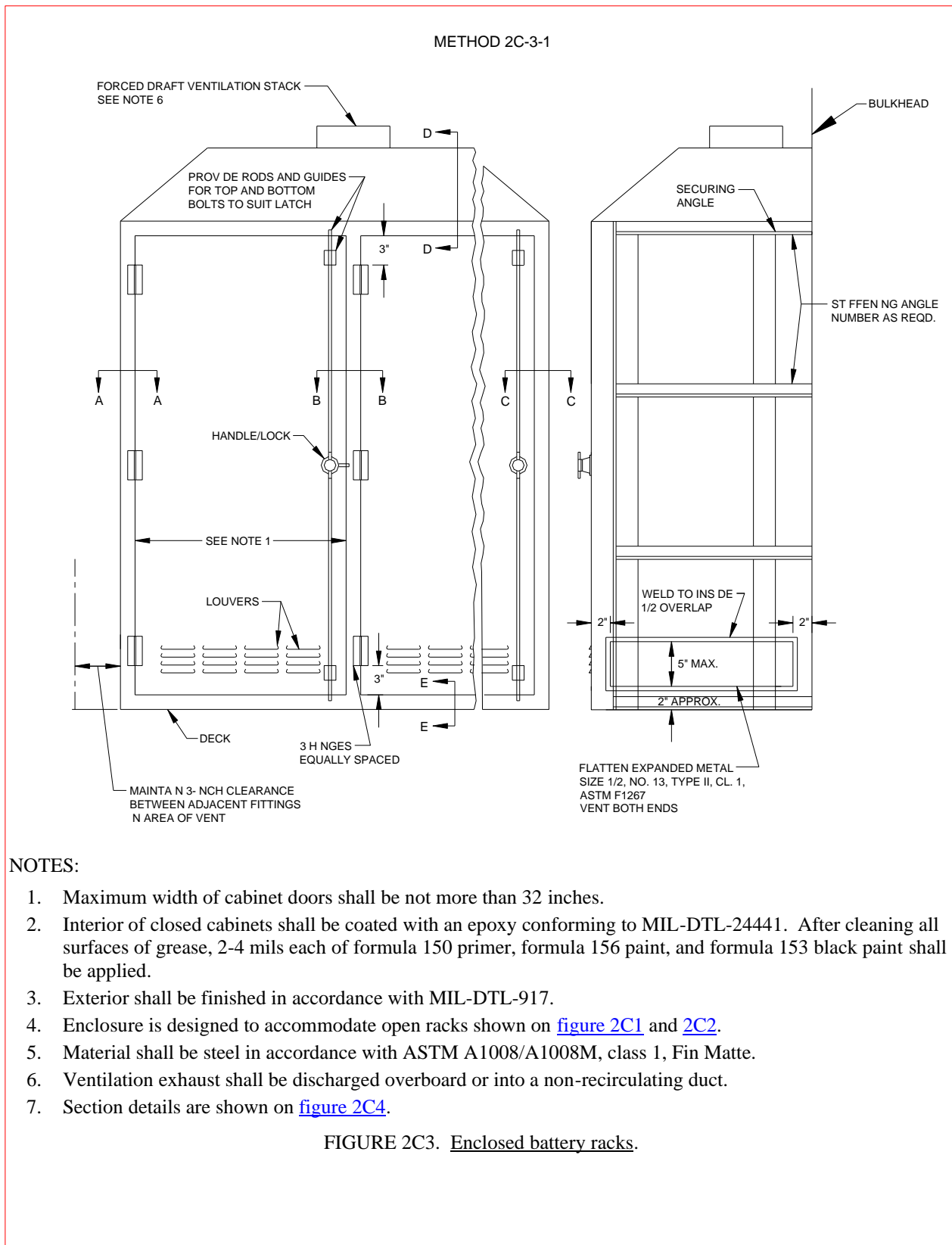
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NOTES:

1. L-angles and plate steel shall be in accordance with MIL-S-22698, grade A.
2. Battery racks shall be painted prior to assembly with black acid-resistant paint, NAVSEA paint formula no. 28.
3. Turnbuckles shall be in accordance with ASTM F1145, class 7.
4. Retainer blocks shall be clean hard maple in accordance with MM-L-736.
5. See 4.1.2 for mounting fastener requirements. For tack welding, the structure material shall be compatible with the fastener being welded.
6. All welding shall conform to 4.1.1.
7. Horizontal spacing shall be such as to provide equal space on sides and between adjacent batteries.
8. This battery rack is intended to accommodate sealed, lead-acid batteries having a length of 10.6 inches, width of 10.1 inches, height of 8.1 inches, and terminals located on the battery top near the battery diagonal corners. If batteries having other dimensions are used, battery rack dimensions shall be adjusted accordingly.

FIGURE 2C2. Open battery rack details – Continued.

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NOTES:

1. Maximum width of cabinet doors shall be not more than 32 inches.
2. Interior of closed cabinets shall be coated with an epoxy conforming to MIL-DTL-24441. After cleaning all surfaces of grease, 2-4 mils each of formula 150 primer, formula 156 paint, and formula 153 black paint shall be applied.
3. Exterior shall be finished in accordance with MIL-DTL-917.
4. Enclosure is designed to accommodate open racks shown on [figure 2C1](#) and [2C2](#).
5. Material shall be steel in accordance with ASTM A1008/A1008M, class 1, Fin Matte.
6. Ventilation exhaust shall be discharged overboard or into a non-recirculating duct.
7. Section details are shown on [figure 2C4](#).

FIGURE 2C3. Enclosed battery racks.

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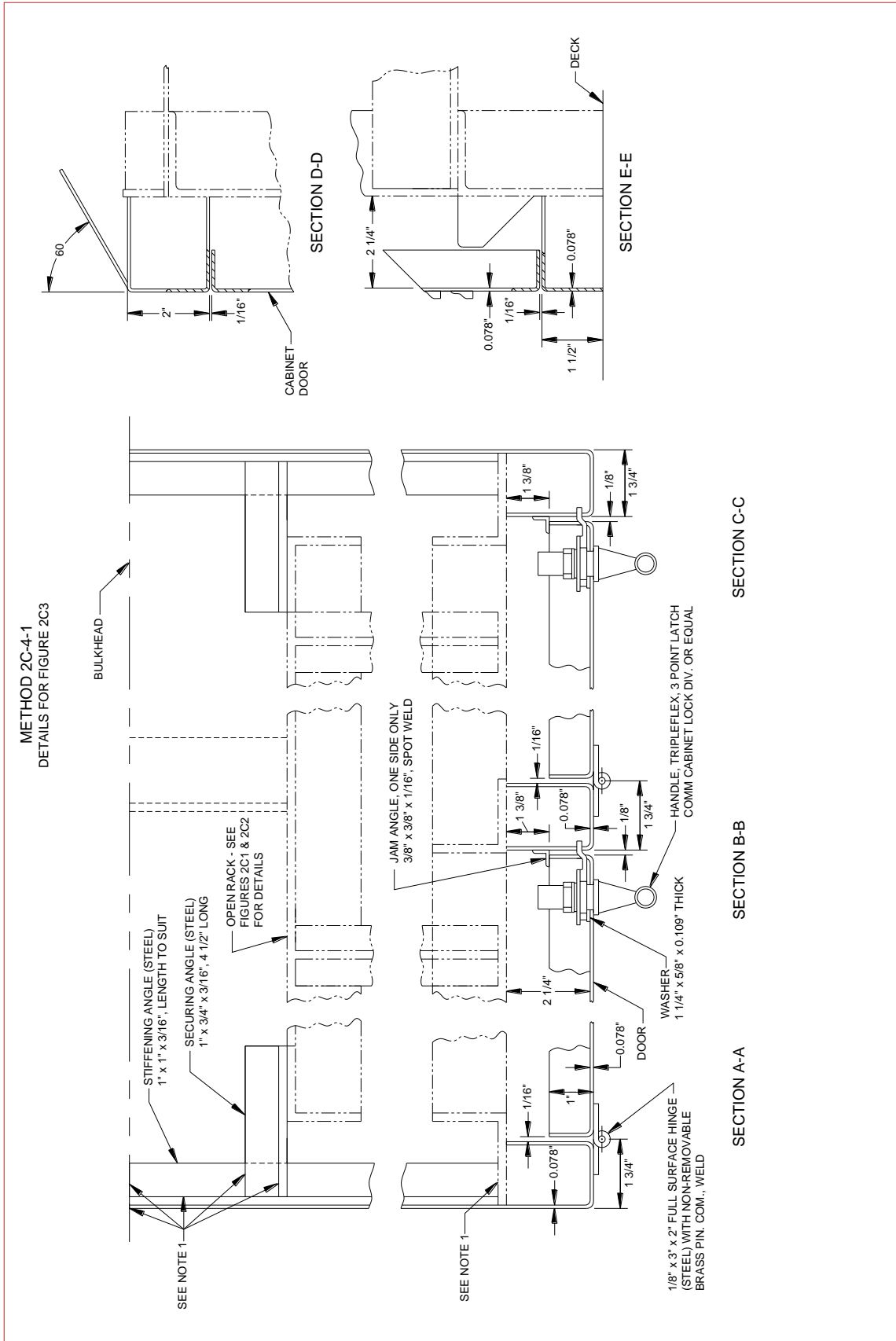


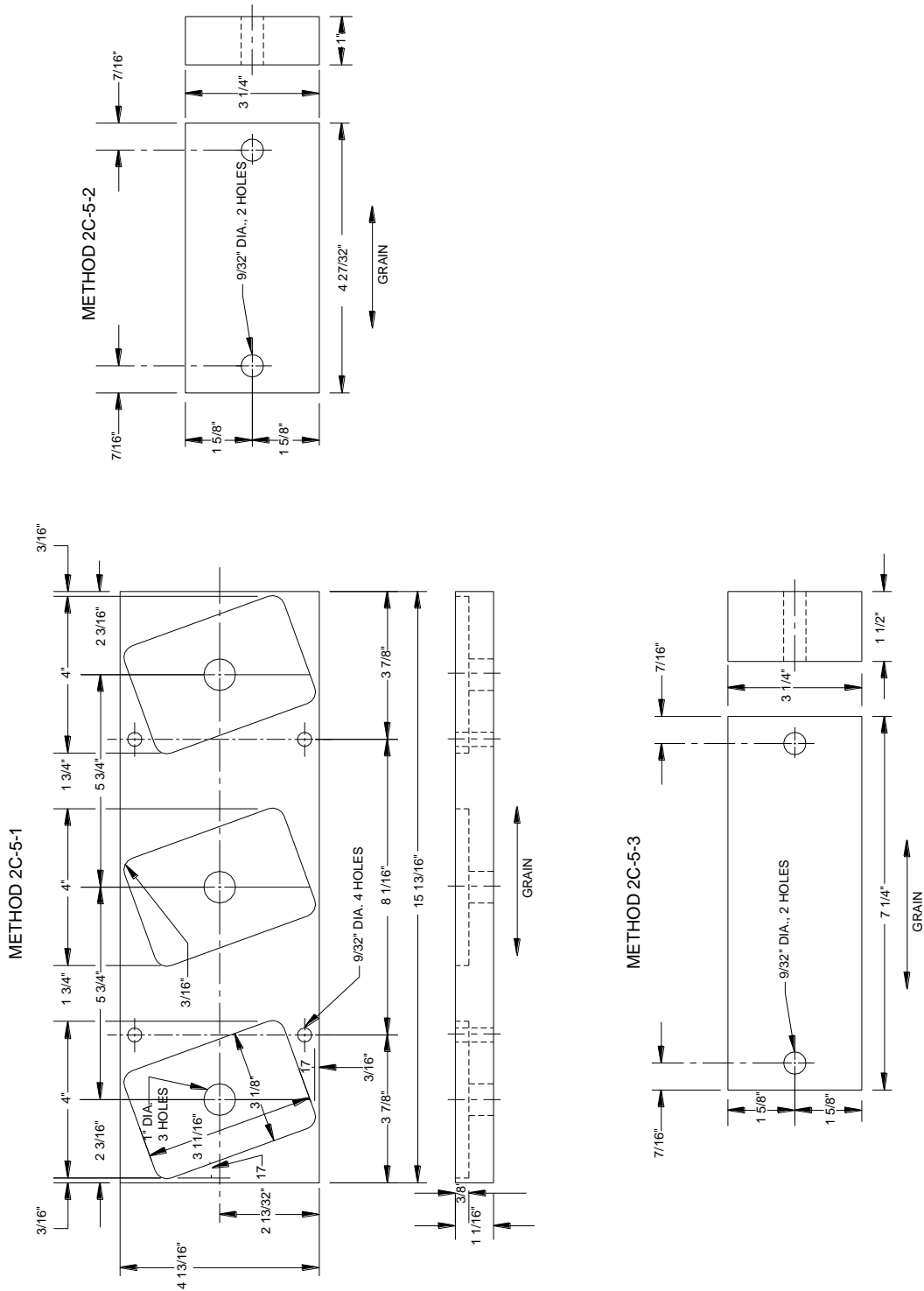
FIGURE 2C4. Enclosed battery rack details.

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NOTES:

1. For weld size, see 4.1.1.
2. These details are for [figure 2C3](#).

FIGURE 2C4. Enclosed battery rack details – Continued.

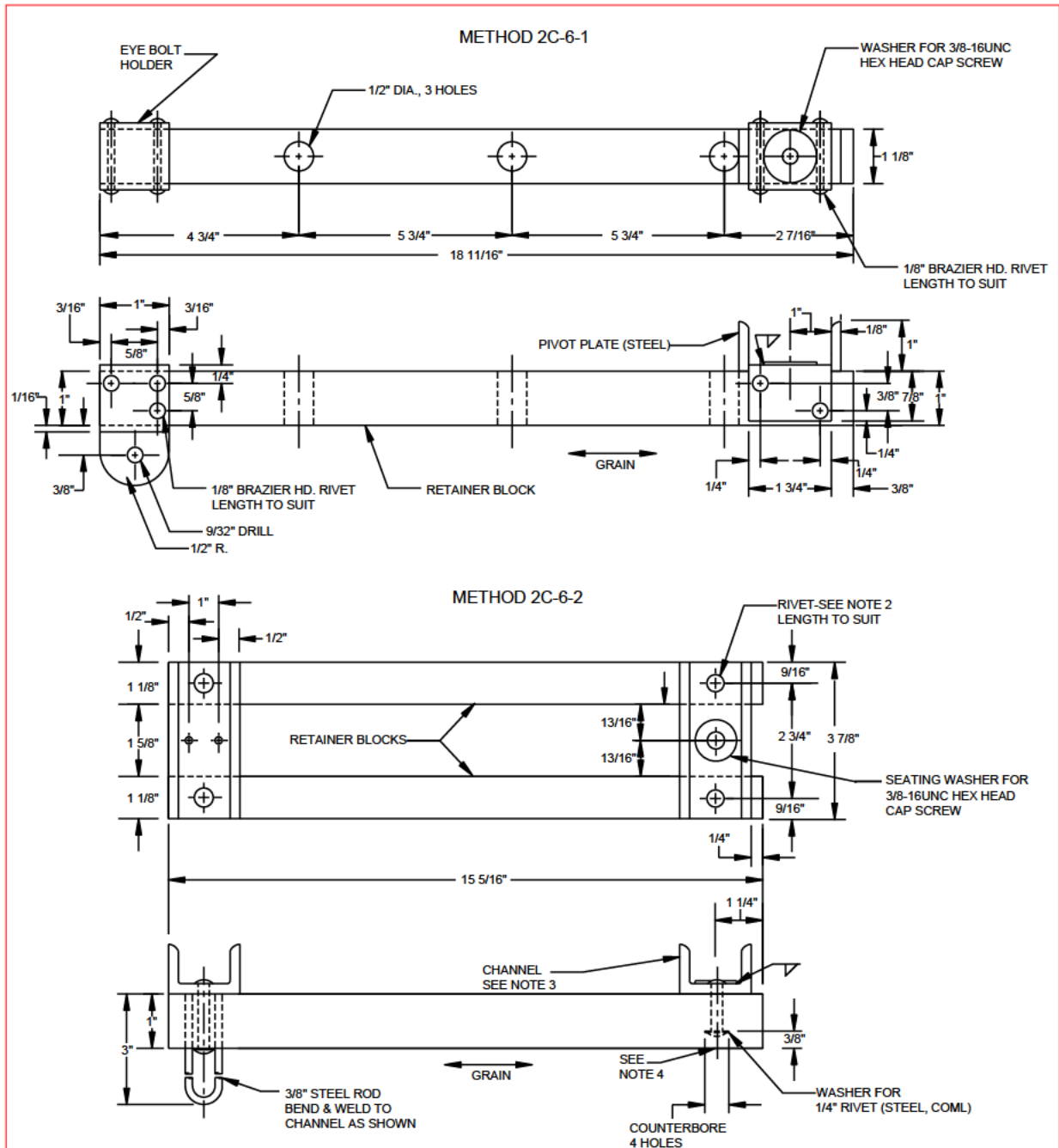
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NOTES:

1. All components shall be coated with epoxy in accordance with MIL-DTL-24441 before assembly. After cleaning all surfaces of grease, 2-4 mils each of formula 150 primer, formula 156 paint, and formula 153 black paint shall be applied.
2. Retainer blocks shall be clean hard maple in accordance with MM-L-736.

FIGURE 2C5. Details of wood spacer blocks for battery racks.

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NOTES:

1. All components shall be coated with epoxy in accordance with MIL-DTL-24441 before assembly. After cleaning all surfaces of grease, 2-4 mils each of formula 150 primer, formula 156 paint, and formula 153 black paint shall be applied.
2. Rivet shall be $\frac{1}{4}$ brazier head, high tensile steel.
3. Channel shall be steel, ASTM A36/A36M, type 1, size 2 by 1 by $\frac{3}{16}$.
4. Retainer blocks shall be clean hard maple in accordance with MM-L-736.
5. See 4.1.2 for mounting fastener requirements.
6. See 4.1.1 for welding requirements.

FIGURE 2C6. Battery clamp details.

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NOTES:

1. All components shall be coated with epoxy in accordance with MIL-DTL-24441 before assembly. After cleaning all surfaces of grease, 2-4 mils each of formula 150 primer, formula 156 paint, and formula 153 black paint shall be applied.
2. Rivet shall be $\frac{1}{4}$ brazier head, high tensile steel.
3. Channel shall be steel, ASTM A36/A36M, type 1, size 2 by 1 by $\frac{3}{16}$.
4. Retainer blocks shall be clean hard maple in accordance with MM-L-736.
5. For weld size and welding requirements, see 4.1.1.
6. See 4.1.2 for mounting fastener requirements.

FIGURE 2C7. Battery clamp details – Continued.

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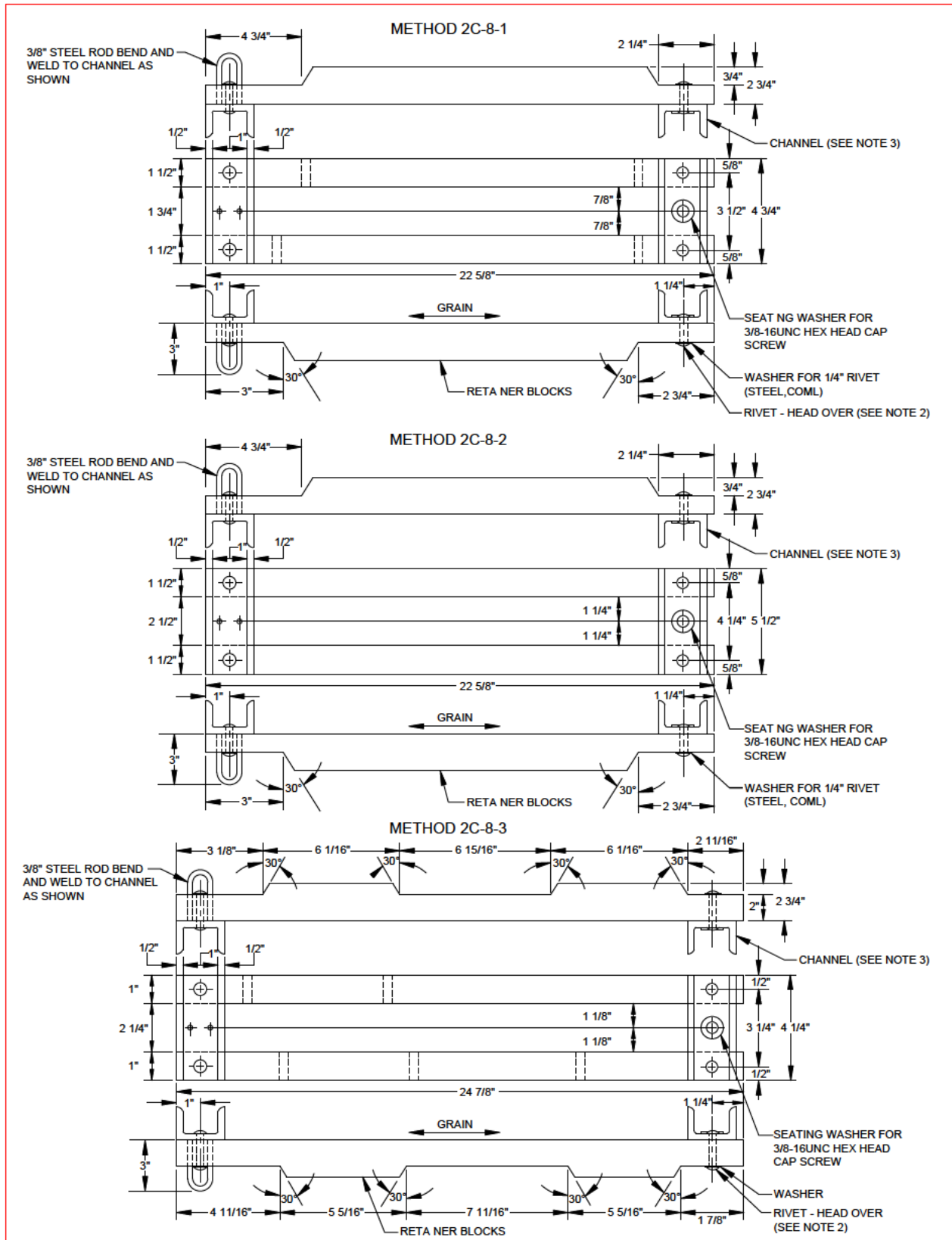


FIGURE 2C8. Battery clamp details.

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NOTES:

1. All components shall be coated with epoxy in accordance with MIL-DTL-24441 before assembly. After cleaning all surfaces of grease, 2-4 mils each of formula 150 primer, formula 156 paint, and formula 153 black paint shall be applied.
2. Rivet shall be $\frac{1}{4}$ brazier head, high tensile steel.
3. Channel shall be steel, ASTM A36/A36M, type 1, size 2 by 1 by $\frac{3}{16}$.
4. Retainer blocks shall be clean hard maple in accordance with MM-L-736.
5. For weld size, see 4.1.1.
6. See 4.1.2 for mounting fastener requirements.

FIGURE 2C8. Battery clamp details – Continued.

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APPENDIX 2D – CASUALTY POWER

D.1 SCOPE

D.1.1 Scope. This section describes procedures for the proper installation of casualty power. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

D.2 APPLICABLE DOCUMENTS

D.2.1 General. The documents listed in this section are specified in this appendix. This section does not include documents cited in other sections of this standard 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 this appendix, whether or not they are listed.

D.2.2 Government documents.

D.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.

FEDERAL SPECIFICATIONS

T-R-650 - Rope, Yarn and Twine, Bast Fiber (see 4.11)

DEPARTMENT OF DEFENSE SPECIFICATIONS

- | | |
|------------------|--|
| MIL-DTL-901 | - Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for |
| MIL-DTL-5516 | - Packing, Preformed, Petroleum Hydraulic, Fluid Resistant, 160 °F (71 °C) (see 4.11) |
| MIL-DTL-15024 | - Plates and Tags for Identification of Equipment, General Specification for |
| MIL-I-15265 | - Insulation, Electrical, Plastic (Submarine Bus Bar Covering) |
| MIL-S-24235 | - Stuffing Tubes, Metal, and Packing Assemblies for Electric Cables, General Specification for |
| MIL-DTL-24552 | - Terminals and Seals, Plugs and Switch, Casualty Power Systems, Receptacle Type, General Specification for |
| MIL-DTL-24552/1 | - Terminals and Seals, Plugs and Switch, Casualty Power, Receptacle Type, Back Connected 200-Ampere, 450-Volt, Alternating Current, Three-Phase, Symbol No. 1046 |
| MIL-DTL-24552/2 | - Terminals and Seals, Plugs and Switch, Casualty Power, Receptacle Type, Upper and Lower Riser, 200-Ampere, 450-Volt, Alternating Current, Three-Phase, Symbol No. 1047 |
| MIL-DTL-24552/3 | - Terminals and Seals, Plugs and Switch, Casualty Power, Seal, Symbol No. 1048 |
| MIL-DTL-24552/4 | - Terminals and Seals, Plugs and Switch, Casualty Power, Plug, 100-Ampere, 450-Volt, Alternating Current, Three-Phase, Symbol No. 1049 |
| MIL-DTL-24643/3 | - Cable, Electrical, -20 °C to +90 °C, 600 Volts, Types LSSHOF, LSDHOF, LSTHOF, and LSFHOF |
| MIL-DTL-24643/16 | - Cable, Electrical, -20 °C to +105 °C, 1000 Volts, Type LSTSGU |

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

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

ASTM INTERNATIONAL

- ASTM A36/A36M - Standard Specification for Carbon Structural Steel
- ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- ASTM B211 - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire
- ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- ASTM F1836M - Standard Specification for Stuffing Tubes, Nylon, and Packing Assemblies (Metric)

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- ANSI/NEMA HP 6 - Electrical and Electronic Silicone and Silicone-Braided Insulated Hook-Up Wire Types S (600 V), ZHS (600 V), SS (1,000 V), ZHSS (1,000 V) and SSB Braided (1,000 V)

(Copies of this document are available online at www.nema.org.)

SAE INTERNATIONAL

- SAE-AMS-QQ-A-250/8 - Aluminum Alloy 5052, Plate and Sheet
- SAE-AS23053/5 - Insulation Sleeving, Electrical, Heat Shrinkable, Polyolefin, Flexible, Crosslinked
- SAE-AS23053/18 - Insulation Sleeving, Electrical, Heat Shrinkable, Modified Fluoropolymer, Crosslinked

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

D.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.

D.3 REQUIRED EQUIPMENT AND MATERIALS

D.3.1 Required equipment and materials. The equipment and materials required for the proper installation of casualty power components are specified on figures [2D1](#) through [2D7](#).

D.4 NOTES AND PROCEDURES

D.4.1 Dimensions. For figures and tables in this appendix, all dimensions are in inches unless otherwise noted.

D.4.2 Figures. [Table 2DI](#) provides information for the figures in this appendix.

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APPENDIX 2DTABLE 2DI. Figures for the installation of casualty power components.

Figure number	Casualty power installation	Page
2D1	Casualty power distribution system	117
2D2	Casualty power riser terminal	119
2D3	Casualty power bulkhead terminal	121
2D4	Casualty power cable stowage rack	123
2D5	Casualty power jumper cable assembly	125
2D6	Casualty power terminal preparation	127
2D7	Identification and end preparation of casualty power cables used with equipment in accordance with MIL-DTL-24552	128

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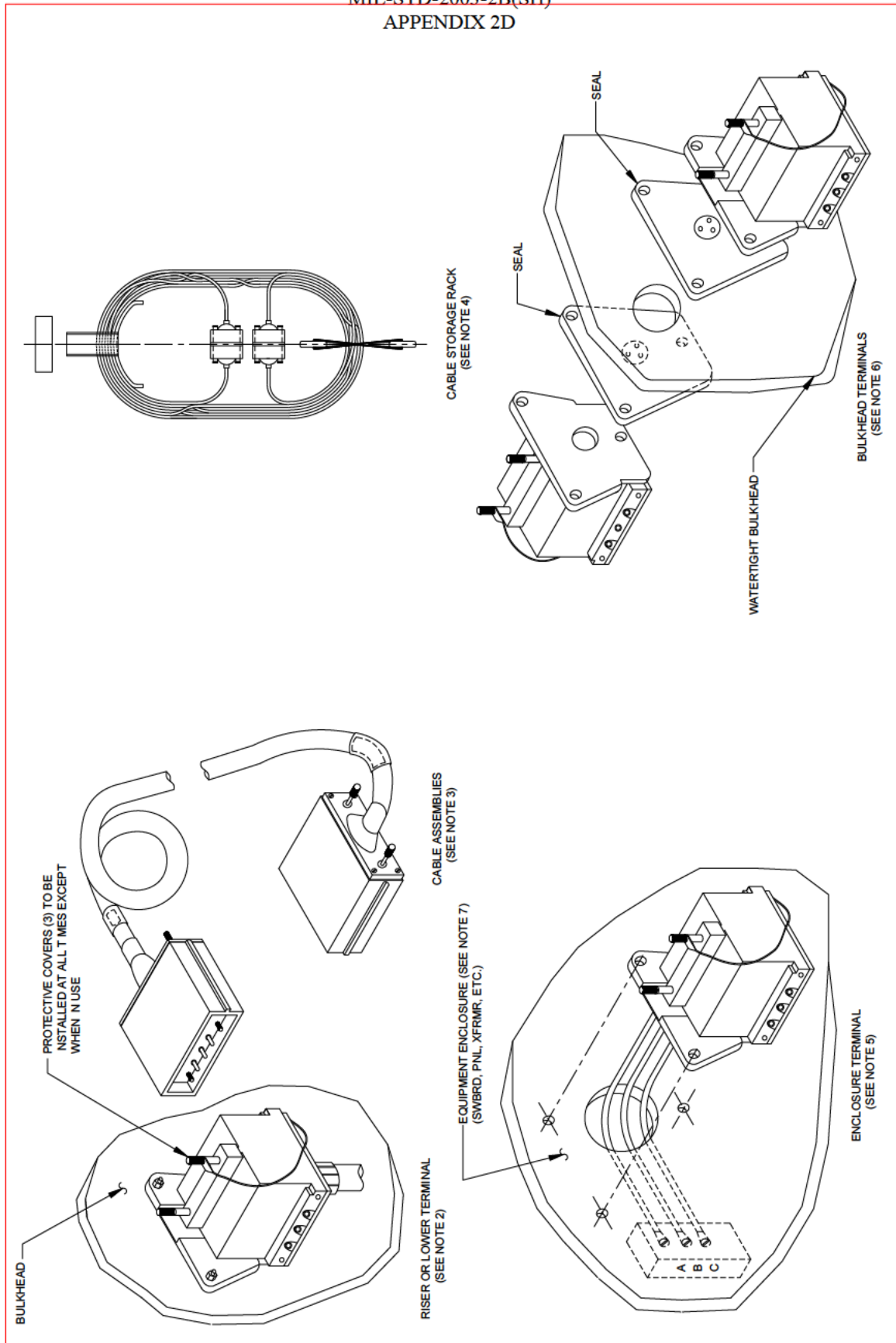


FIGURE 2D1. Casualty power distribution system.

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NOTES:

1. The casualty power distribution system shall be arranged to provide temporary transmission of power to span damaged areas.
2. Vertical risers for transmission of power to a deck above or below shall be installed in accordance with [figure 2D2](#).
3. Portable jumper cable assemblies shall be provided for connecting riser terminals to horizontal run bulkhead terminals and to terminals on switchboards, panels, and controllers in accordance with [figure 2D5](#).
4. Cable storage racks shall be installed to stow the portable jumper cable assemblies in compartments where the cable is used in accordance with [figure 2D4](#).
5. Equipment terminals shall be mounted on equipment enclosures in accordance with method 2D-3-2.
6. Bulkhead terminals for horizontal fore-and-aft casualty power runs shall be installed in accordance with methods 2D-3-1 and 2D-3-3.
7. When equipment enclosure is watertight, the seal MIL-DTL-24552/2 shall be used.

FIGURE 2D1. Casualty power distribution system – Continued.

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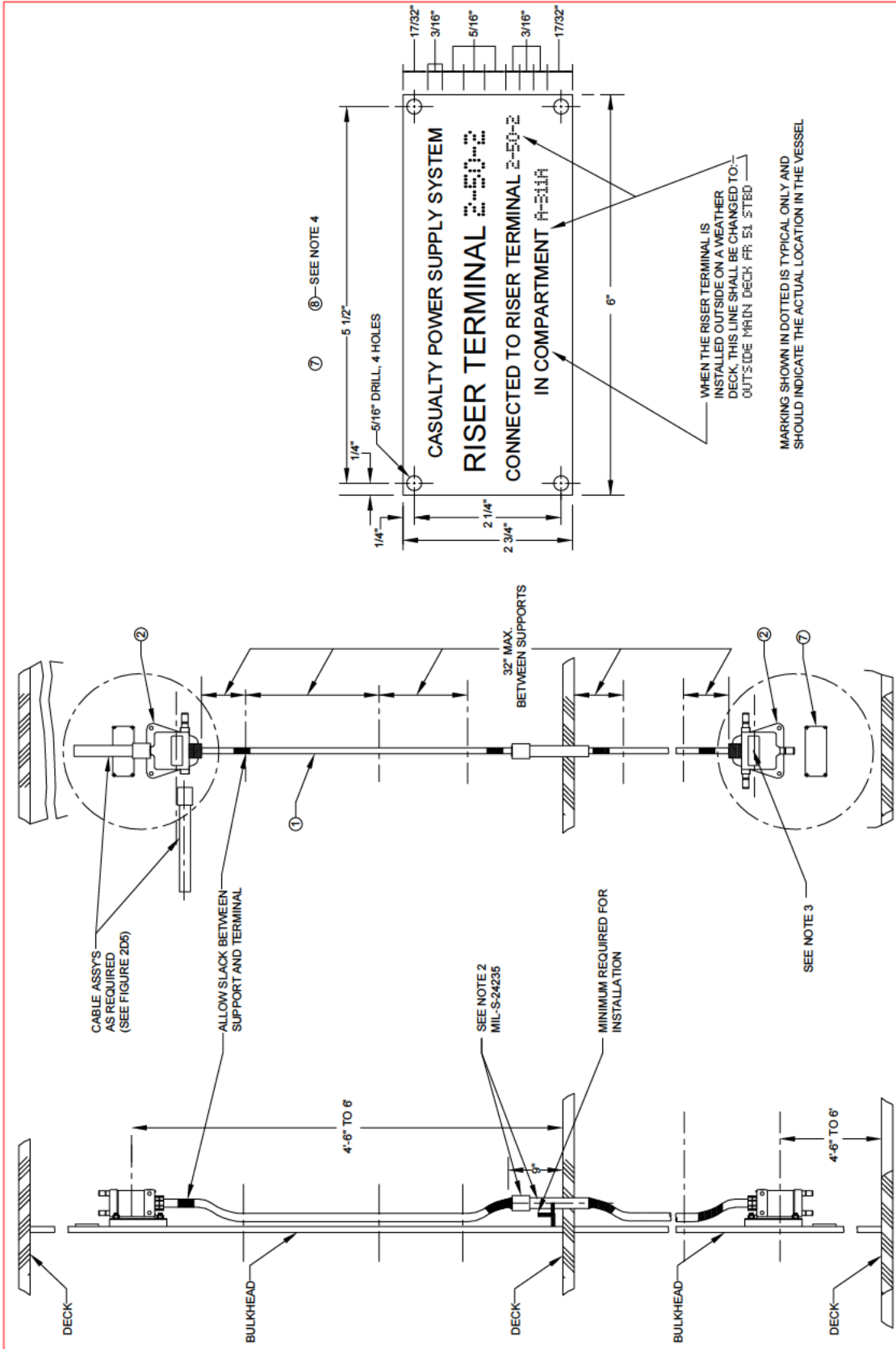


FIGURE 2D2. Casualty power riser terminal.

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TABLE 2D2-I. List of materials for casualty power.

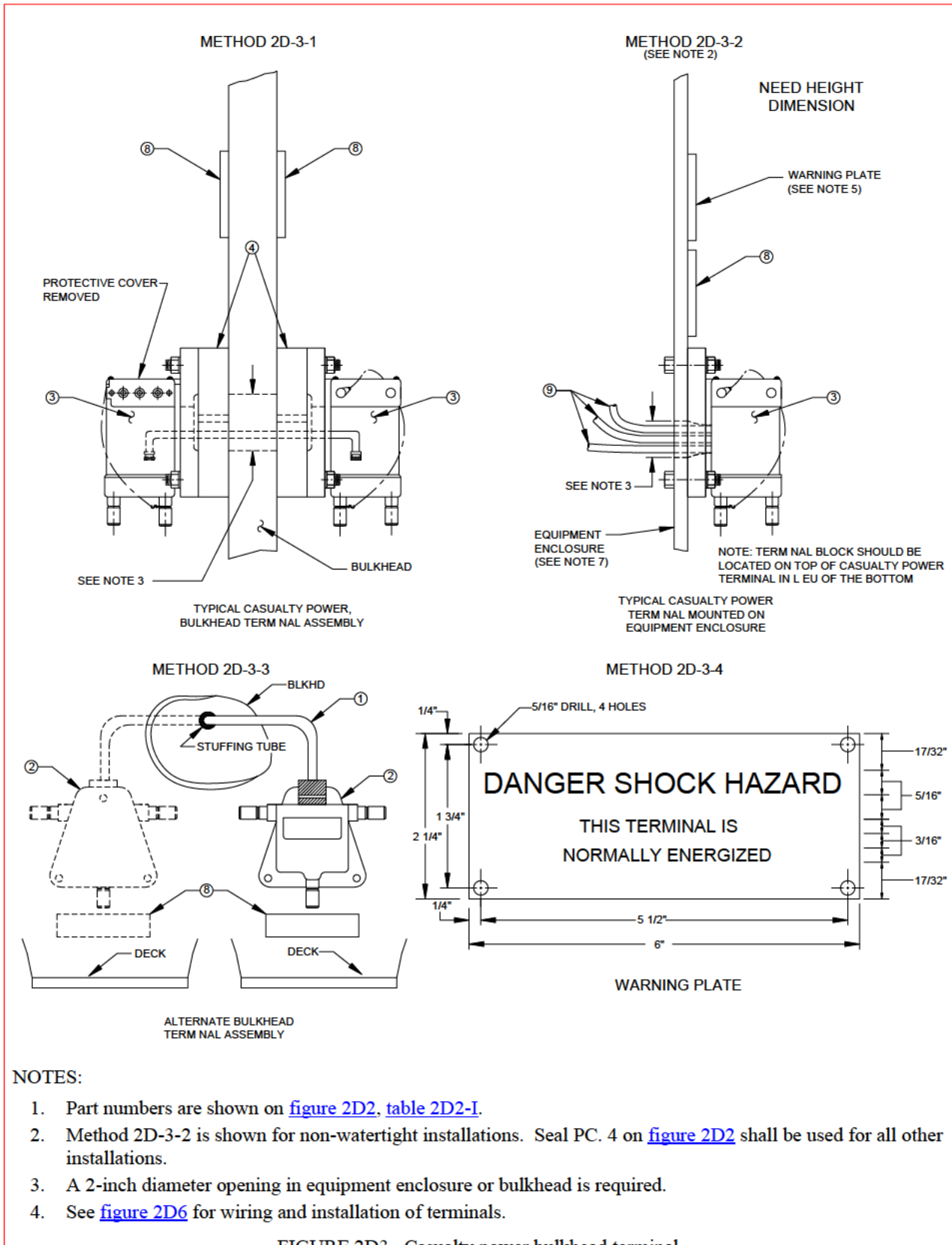
Part no.	Quantity	Casualty power component	Material	Material specification or reference
1	--	Cable, LSTSGU-75	--	MIL-DTL-24643/16
2	--	Terminals, Casualty Power. Receptacle Type, Upper and Lower Riser, Sym. No. 1047	--	MIL-DTL-24552/2
3	--	Terminals, Casualty Power. Receptacle Type, Back Connected, Sym. No. 1046	--	MIL-DTL-24552/1
4	--	Terminals, Casualty Power, Seal, Sym. No. 1048	--	MIL-DTL-24552/3
5	--	Terminals, Casualty Power, Plug, Sym. No. 1049	--	MIL-DTL-24552/4
6	--	Cable, LSTHOF-42	--	MIL-DTL-24643/3
7	2	Nameplate - Riser	Brass	See note 4
8	As required	Nameplate - BHD	Brass	See note 4
9	--	Wire		ANSI/NEMA HP 6, type SSB, 392 °F (200 °C) See note 3 of figure 2D3 .

NOTES:

1. The riser shall be installed as shown or in accordance with specifically approved deviations.
2. Stuffing tube shall be of the type required for the particular deck construction where installed.
3. A 12-inch radius minimum handling clearance shall be maintained about center of riser terminals as shown.
4. Nameplates shall comply with MIL-DTL-15024, type B, and be marked as shown. PC 8 is the same as PC 7 except marked "bulkhead terminal" in lieu of "riser terminal".
5. See [figure 2D6](#) for wiring and installation of terminals.
6. Part numbers correspond to the entries in [table 2D2-I](#).

FIGURE 2D2. Casualty power riser terminal – Continued.

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NOTES (continued):

5. Normally energized casualty power terminals (those connected to transformers, power panels, or motor controllers) shall have a warning plate installed inscribed as shown in method 2D-3-4. Plate shall be type B (brass) of MIL-DTL-15024.
6. A 12-inch radius minimum handling clearance shall be maintained center of bulkhead terminal.
7. When equipment enclosure is watertight, then seal MIL-DTL-24552/3 shall be used.
8. See applicable switchgear specification for casualty power wiring requirements inside switchgear.

FIGURE 2D3. Casualty power bulkhead terminal – Continued.

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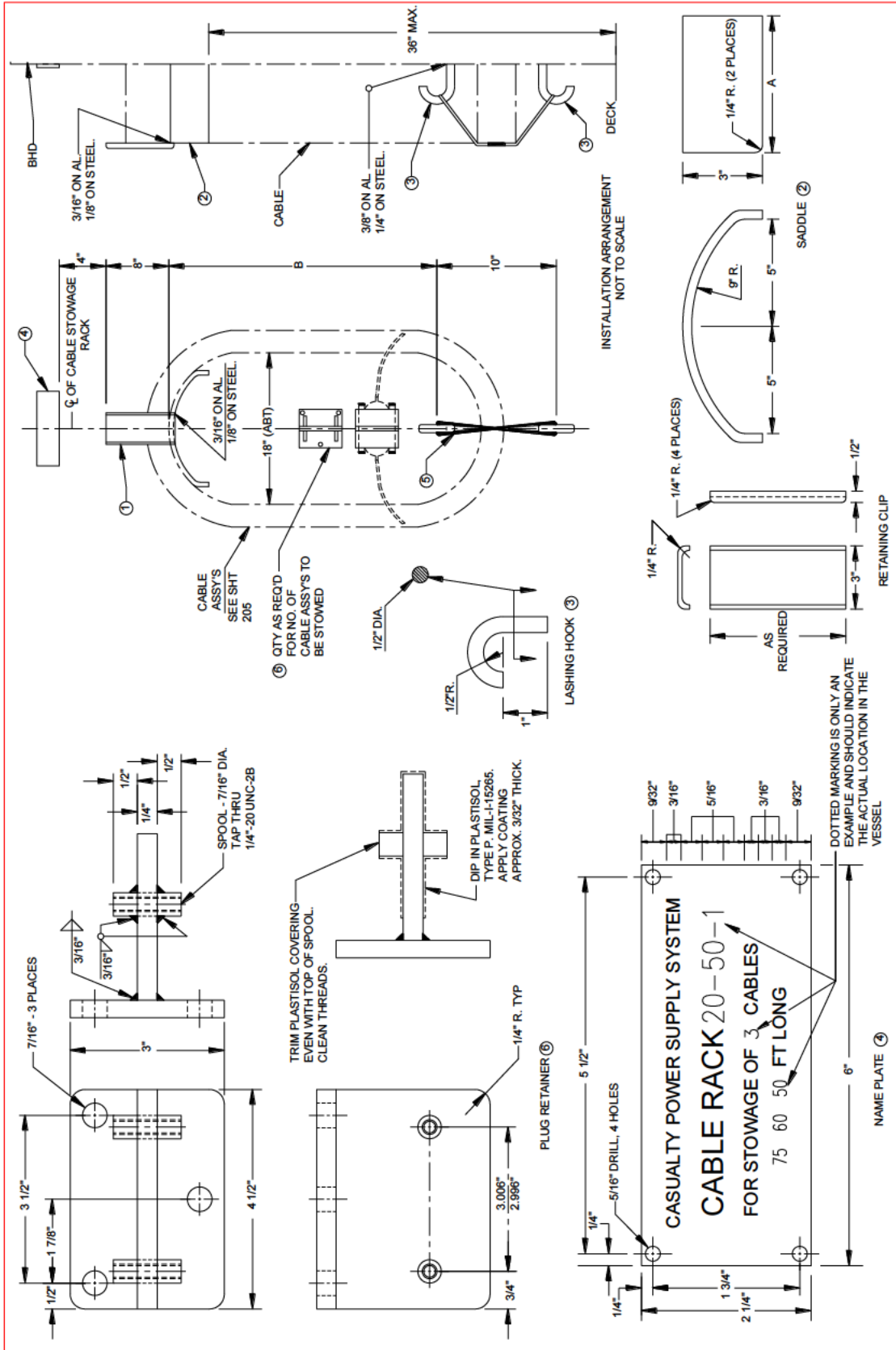


FIGURE 2D4. Casualty power cable storage rack.

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TABLE 2D4-I. Table of dimensions.

Length of cable stowed	A	B
Up to 150'	6"	26"
150' to 325'	9"	40"

TABLE 2D4-II. List of materials – quantities for one rack.

Part no.	Quantity	Name	Material	Material specification or reference
1	1	Retaining clip	Note 1	See notes 1 & 10
2	1	Saddle	Note 1	See notes 1 & 8
3	2	Lashing hook	Note 10	See notes 8 & 10
4	1	Name plate	Brass	See note 9
5	1	Lashing 36" long, ¼" thick	Hemp	T-R-650 (see 4.11); see note 7
6	As required	Plug retainer	Steel	--

NOTES:

- Saddle and retaining clip to be mild steel of weldable and drawable quality for steel bulkheads and aluminum alloy SAE-AMS-QQ-A-250/8 (or if applicable, ASTM B209), for aluminum bulkheads.
- Depth of saddle and location of lashing hooks to be determined by amount of cable stowed.
- Brackets shall not be welded on aluminum bulkheads less than ⅛-inch thick without proper reinforcement.
- After installation, the entire fixture shall be painted to match surrounding structure.
- See 4.1.1 for welding requirements.
- All sharp corners shall be slightly rounded.
- Both ends of lashing shall be served. Lashing not furnished.
- When rack assembly is mounted on steel ends, all steel parts should be zinc-plated to conform to the requirements of ASTM B633, type I, class 2.
- Identification plates shall be type B (brass) of MIL-DTL-15024 and shall be marked as shown.
- Lashing hook shall be a ½-inch diameter mild steel rod in accordance with ASTM A36/A36M on steel bulkheads or a ½-inch diameter aluminum alloy rod in accordance with ASTM B211 on aluminum bulkheads.
- Stowage rack shall pass high-impact shock test in accordance with MIL-DTL-901 while supporting coil of 75 feet of LSTHOF-42 cable or 72-pound equivalent dummy weight.
- Part numbers correspond to [table 2D4-II](#).

FIGURE 2D4. Casualty power cable stowage rack – Continued.

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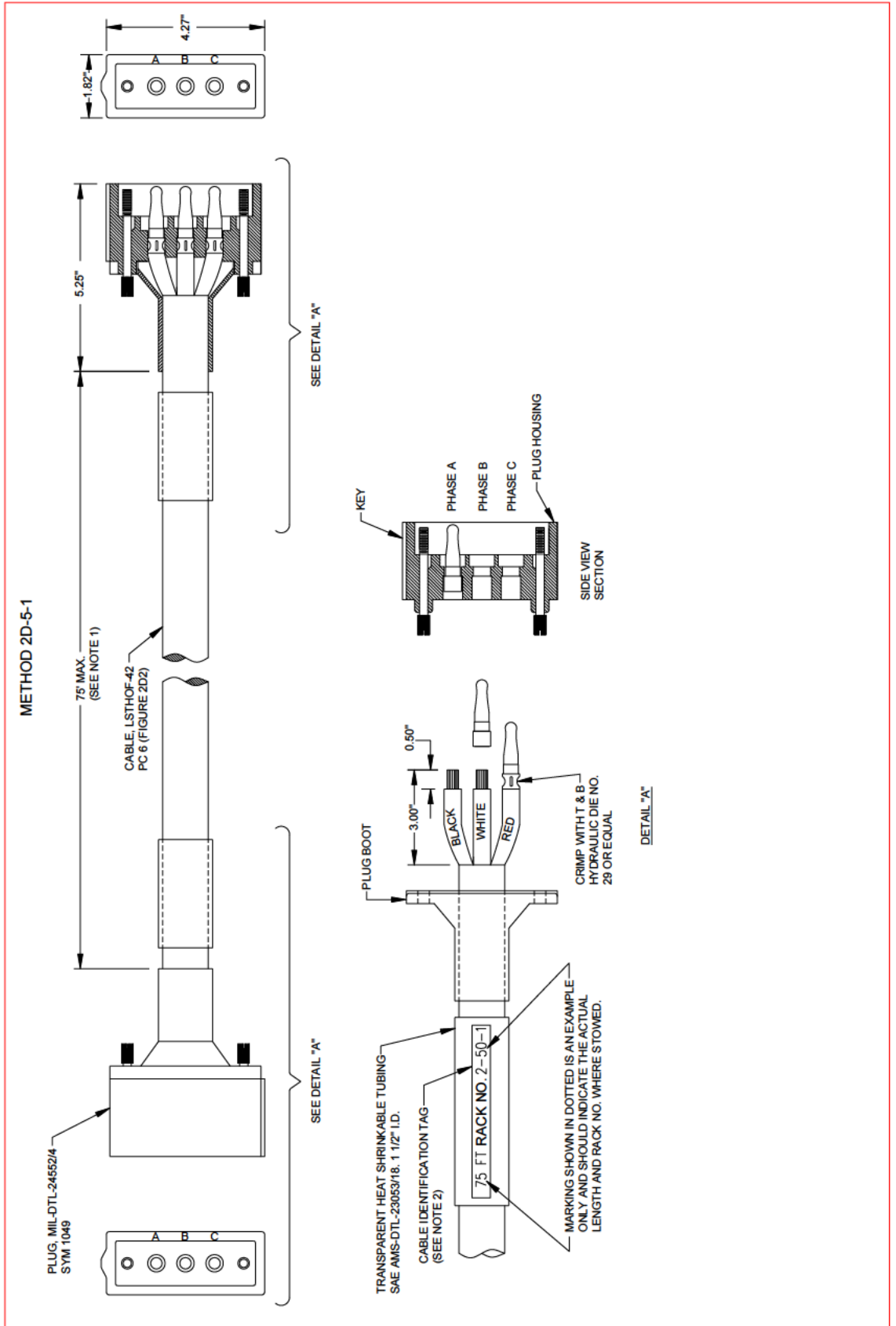


FIGURE 2D5. Casualty power jumper cable assembly.

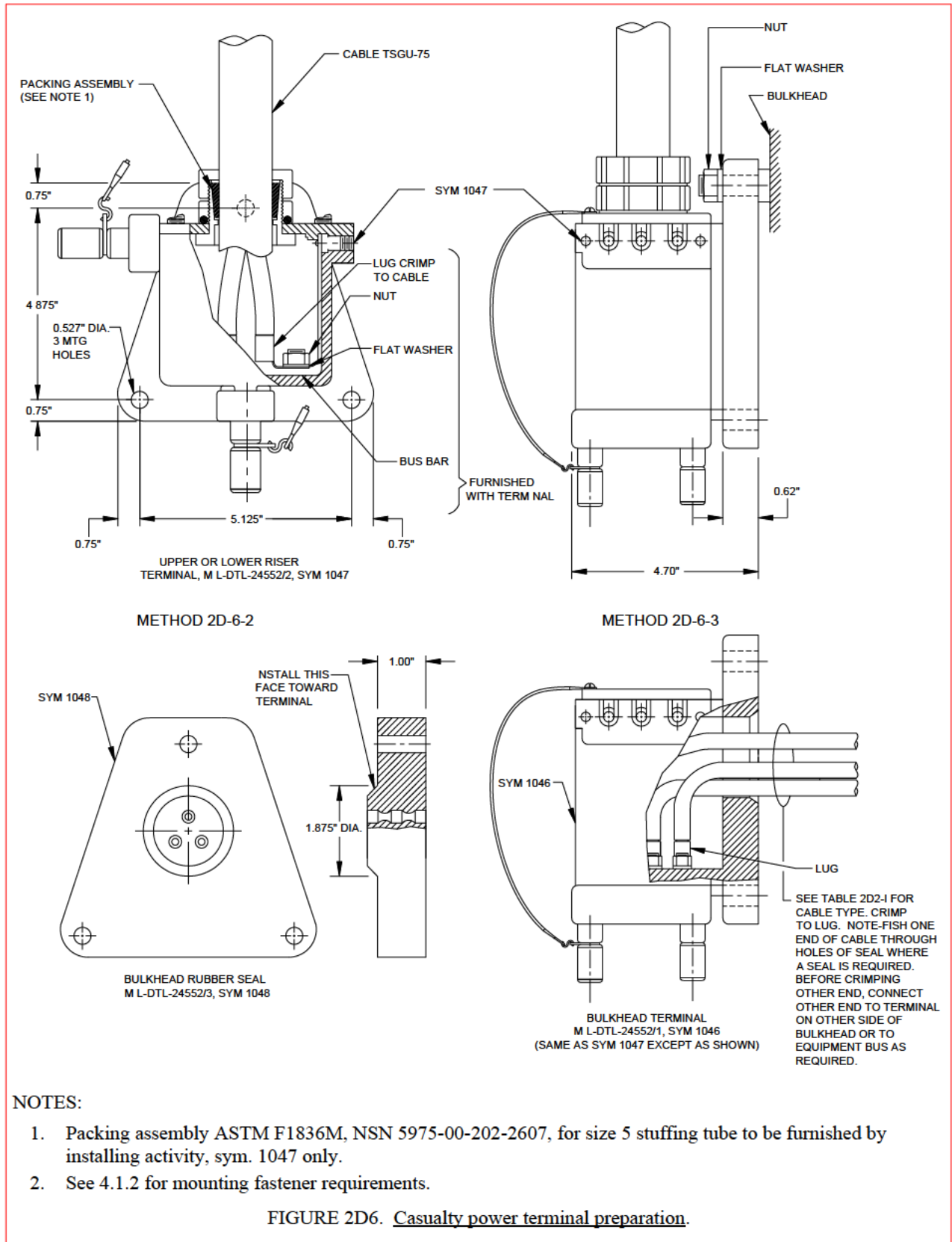
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NOTES:

1. Cable length shall not exceed 75 feet in length, unless approved by NAVSEA.
2. Each cable end shall be marked as shown.
3. See list of material on [figure 2D4](#).

FIGURE 2D5. Casualty power jumper cable assembly – Continued.

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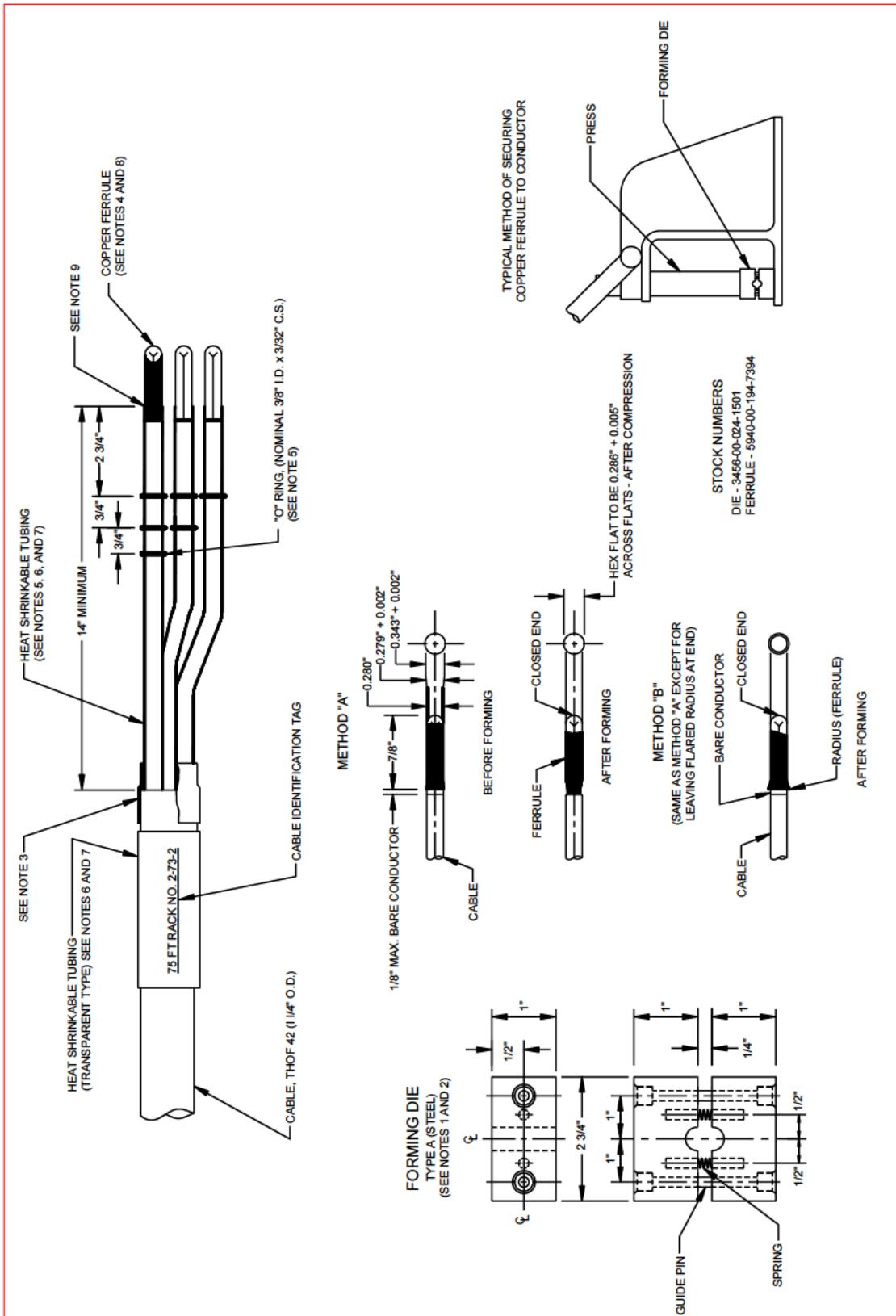


FIGURE 2D7. Identification and end preparation of casualty power cables used with equipment in accordance with MIL-DTL-24552.

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NOTES:

1. Forming die shall be so constructed as to prevent disassembly while handling.
2. Springs shall be of a type and design that will hold the die halves normally in the open position.
3. Exposed end of cable sheath insulation at crotch shall be made effectively watertight by use of heat shrinkable boot.
4. Place round copper ferrule on conductor and secure by forming as shown in detail by method "A" or "B".
5. For phase identification by touch, install heat shrink tubing. See notes 6 and 7 and non-metallic "O" rings, NSN 5330-00-050-1211, MIL-DTL-5516 black wire (see 4.11).
Black wire ("A" phase) 1 "O" ring, black heat shrinkable tube
White wire ("B" phase) 2 "O" rings, white heat shrinkable tube
Red wire ("C" phase) 3 "O" rings, red heat shrinkable tube
6. Phase and cable identification: Heat shrinkable tubing for phase identification shall be flexible type, SAE-AS23053/5, class 1, and for cable identification shall be transparent SAE-AS23053/18.
7. Tubing size as supplied:
 - a. For cable identification - 1½ I.D.
 - b. For phase identification - ¾ I.D.
 - c. ½-inch and 2¾-inch lengths
8. Pull out strength of ferrule shall be at least 150 pounds. If this cannot be accomplished by forming of ferrule directly over conductor, add a few copper strands in space between conductor and ferrule before forming. After the ferrules are formed on the conductors, remove any sharp fins and edges, replace ferrules cracked in forming.
9. Heat shrink tubing shall extend over the ferrule approximately ⅛ inch for watertight effectiveness.

For repair only; not for new construction.

FIGURE 2D7. Identification and end preparation of casualty power cables used with equipment in accordance with MIL-DTL-24552 – Continued.

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APPENDIX 2E – SHORE POWER

E.1 SCOPE

E.1.1 Scope. This section describes procedures for the proper installation of 450 VAC shore power. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

E.2 APPLICABLE DOCUMENTS

E.2.1 General. The documents listed in this section are specified in this appendix. This section does not include documents cited in other sections of this standard 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 this appendix, whether or not they are listed.

E.2.2 Government documents.

E.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.

A-A-59296 - Insulating Compound, Electrical (for Field Splicing Applications)

DEPARTMENT OF DEFENSE SPECIFICATIONS

- MIL-DTL-915/6 - Cable, Power Electrical, 600 Volts, for Outboard Use Only (Not for Inboard Use), Type THOF
- MIL-T-16366 - Terminals, Electrical Lug and Conductor Splices, Crimp-Style
- MIL-S-24235 - Stuffing Tubes, Metal, and Packing Assemblies for Electric Cables, General Specification for
- MIL-C-24368/1 - Connector Assemblies; Plug, Power Transfer, Shore to Ship and Ship to Ship, 500 Volts, 500 Amperes, 60 Hertz, Symbol Number 1160
- MIL-C-24368/2 - Connector Assemblies; Receptacle, and Receptacle – Cabled, Power Transfer, Shore to Ship and Ship to Ship, 500 Volts, 500 Amperes, 60 Hertz, Symbol Number 1161
- MIL-C-24368/4 - Connector Assemblies; Plugs and Receptacles, Electric, Power Transfer, Shore to Ship and Ship to Ship, 500 Volts, 500 Amperes, 60 Hertz, Symbol Numbers 1162.1, 1162.2 and 1162.3
- MIL-C-24368/5 - Connector Assemblies; Plug, Submarine Shore Power Transfer, Shore to Ship and Ship to Ship, 500 Volts, 400 Amperes, 60 Hertz, Three-Phase, Symbol Number 1149
- MIL-C-24368/6 - Connector Assemblies; Dual Purpose, Submarine Shore Power Transfer (AC) and DSRV Battery Charging (DC), 500 Volts, 400 Amperes, 60 Hertz, Three-Phase, Symbols 1150 and 1150.1
- MIL-I-24768/1 - Insulation, Plastic, Laminated, Thermosetting, Glass-Cloth, Melamine-Resin (GME)

DEPARTMENT OF DEFENSE STANDARDS

- MIL-STD-2003-1 - Electric Plant Installation Standard Methods for Surface Ships and Submarines (Cable)
- MIL-STD-2003-3 - Electric Plant Installation Standard Methods for Surface Ships and Submarines (Penetrations)

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- MIL-STD-2003-4 - Electric Plant Installation Standard Methods for Surface Ships and Submarines (Cableways)
- MIL-STD-3007 - Unified Facilities Criteria, Facilities Criteria and Unified Facilities Guide Specifications

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

E.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.

CIVIL ENGINEERING LABORATORY PUBLICATIONS

- TN No. N-1503 - Shrinkable Splice Covers for Shore-to-Ship Cables

(Copies of this document are available online at <https://dtic.mil> by searching for ADA049244.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

- 815-1197055 - Connection Box - WT, for Ship to Ship Power 800 AMP, 450 Volt, 3 Phase, Symbol 490
- 815-1197056 - Connector Plug, 500 AMP, Symbol 762 - 500 Volt D.C., Symbol 762.1 - 250 Volt D.C., Symbol 762.2 - 125 Volt D.C.
- 815-1197071 - Shore Terminal Box - WT. 3 Phase, 400 AMP, 450 Volt-SYM 492.3, D.C. - 500 AMP, 500 Volt-SYM 492.4
- 815-1197074 - Connector, Plug, 400 Amp. 450 Volts, 3 Phase A.C., Symbol 761.1
- 815-1197217 - Shore Terminal Box-SBM15,493.3-493.4

(Copies of these documents are available from the applicable repositories listed in S0005-AE-PRO-010/EDM, which can be obtained online via Technical Data Management Information System (TDMIS) at <https://mercury.tdmis.navy.mil/>. Copies of these documents may also be obtained from the Naval Ships Engineering Drawing Repository (NSED) online at <https://199.208.213.105/webjedmics/index.jsp>. To request an NSED account for drawing access, send an email to NNSY_JEDMICS_NSED_HELP_DESK@navy.mil.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

- T9070-AN-DPC-010/100-1 - Reinforcement of Openings in Structure of Surface Ships, Other Than in Protective Plating

(Copies of this document are available online via Technical Data Management Information System (TDMIS) at <https://mercury.tdmis.navy.mil/> by searching for the document number without the suffix. Refer questions, inquiries, or problems to: DSN 296-0669, Commercial (805) 228-0669. This document is available for ordering (hard copy) via the Naval Logistics Library (NLL) at <https://nll.navsup.navy.mil>. For questions regarding the NLL, contact the NLL Customer Service at nllhelpdesk@navy.mil, (866) 817-3130, or (215) 697-2626/DSN 442-2626.)

E.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.

SAE INTERNATIONAL

- SAE-AS23053/4 - Insulation Sleeving, Electrical, Heat Shrinkable, Polyolefin, Dual-Wall, Outer Wall Crosslinked
- SAE-AS23053/15 - Insulation Sleeving, Electrical, Heat Shrinkable, Polyolefin, Heavy-Wall, Coated, Flexible, Outer Wall Crosslinked

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SAE-AS81765/1 - Insulating Components, Molded, Electrical, Heat Shrinkable Polyolefin,
Crosslinked, Semi-Rigid and Flexible

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

E.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.

E.3 REQUIRED EQUIPMENT AND MATERIALS

E.3.1 Required equipment and materials. The equipment and materials required for the proper installation of 450 VAC shore power components are specified on figures [2E1](#) through [2E19](#).

E.4 NOTES AND PROCEDURES

E.4.1 Dimensions. For figures and tables in this appendix, all dimensions are in inches unless otherwise noted.

E.4.2 Figures. [Table 2EI](#) provides information for the figures in this appendix.

TABLE 2EI. Figures for the installation of shore power components.

Figure number	Shore power installation	Page
2E1	Shore power installations	133
2E2	450 VAC shore power installations	135
2E3	Mounting shore receptacles with 90-degree potting inside of bulkhead	137
2E4	Mounting 450 VAC shore power receptacles inside of bulkhead	139
2E5	Stagger mounting of 450 VAC shore power receptacles with 90-degree potting inside of bulkhead	141
2E6	Mounting 450 VAC shore power receptacles outside of bulkhead	143
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2E15	Termination and potting ship-or-450 VAC shore power plug MIL-C-24368/1	161
2E16	Termination and potting ship-or-450 VAC shore power receptacle MIL-C-24368/2	164
2E17	Alongside power in-line connectors MIL-C-24368/4 (tenders and repair ships)	167
2E18	Installation details for 450 VAC shore power receptacle MIL-C-24368/2	169
2E19	Typical 450 VAC shore power cable supports	171

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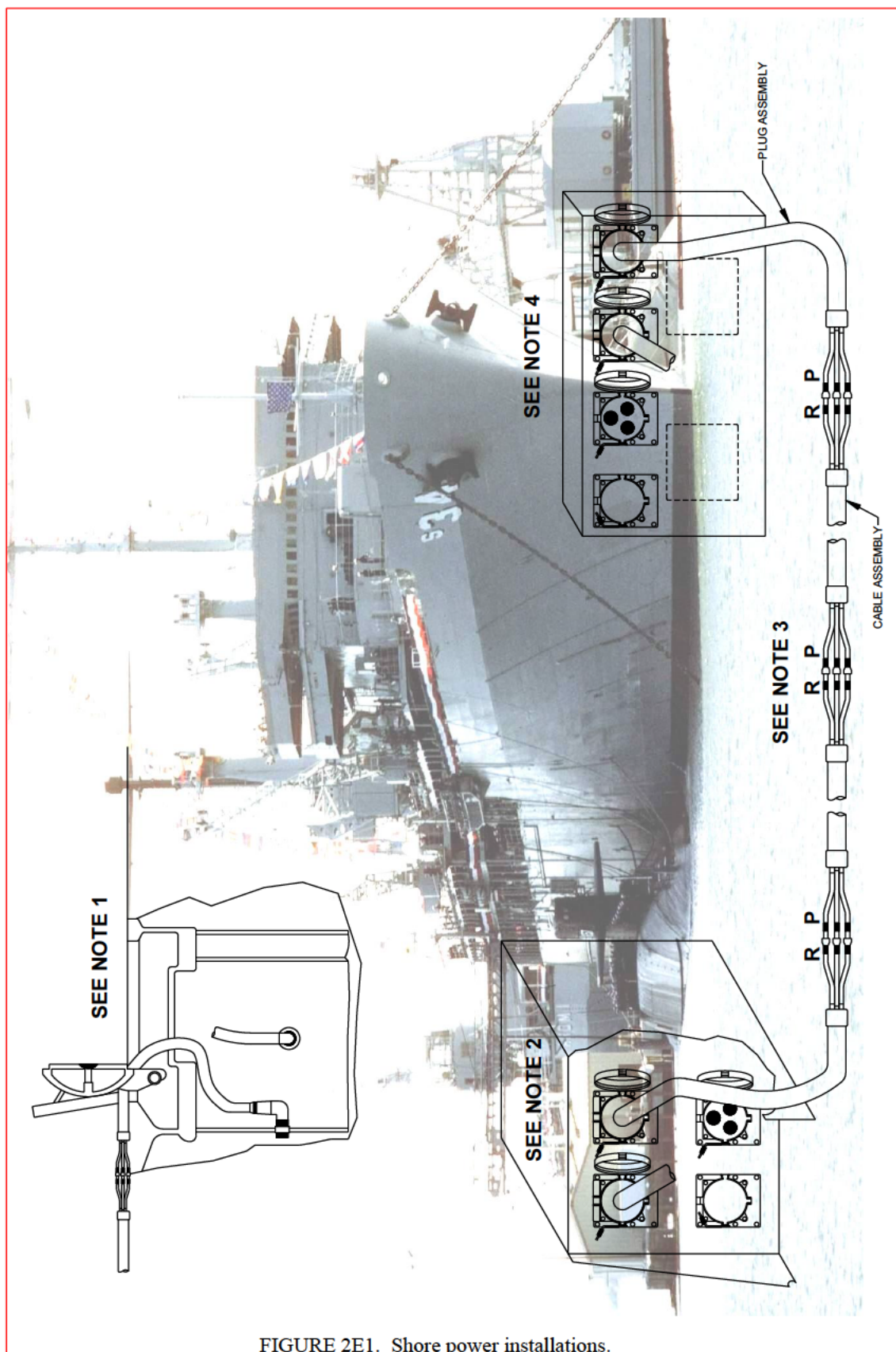


FIGURE 2E1. Shore power installations.

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LEGEND:

- P - Plugs (See figures [2E13](#) and [2E17](#))
R - Receptacles

NOTES:

1. Typical 450 VAC shore power installations for submarines are shown on figures [2E13](#) and [2E14](#).
2. Reference should be made to MIL-STD-3007 for typical shore power installations for shore activities.
3. In-line connector installations in accordance with [figure 2E17](#) are used to connect cable assemblies to shore power plugs. For ease of handling, approximately 10 feet of THOF-500 cable (15 feet of THOF-500 cable for submarines) is used for each plug assembly and approximately 150 feet of THOF-500 for each cable assembly. In-line connectors shall not be used in lieu of a splice of short run cables. Further, in-line connectors may be omitted in favor of a continuous length of cable.
4. Typical 450 VAC shore power installations for surface ships are shown on figures [2E1](#) through [2E13](#).
5. Portable shore-to-ship power cables are the responsibility of the shore activity. Portable ship-to-ship or ship-to-shore cables onboard ship (tenders, repair ships, etc.) are the responsibility of the ship. Splicing of 450 VAC shore power cables is not recommended. If they cannot be avoided, splices and cable jacket repair should be in accordance with the hot splice vulcanized neoprene method described in the Civil Engineering Laboratory Technical Note TN No. N-1503.
6. Provide ungrounded electrical power at the ship's shore power connection. Power shall be ungrounded from a dedicated transformer secondary serving only the ship and no industrial grounded type loads. The transformer ampere rating is not to have demand factor or diversity factor applied.
7. Voltage shall not exceed the steady state voltage, ± 5 percent, as measured at the ship's main switchboard (i.e., for a 450-volt nominal ship system, the allowable range is 427.5 to 472.5 volts).
8. Current rating requirement shall be achieved via multiple 400-amp shore power cabling circuits.
9. Install safety devices at dockside capable of automatically maintaining services during power surges and equipped with circuit breakers to de-energize the electrical power during overloads. A 400-amp circuit breaker (100 KAIC rating) shall be provided for each portable 450 VAC shore power cable circuit serving ship. Ensure circuit breaker KAIC rating equals or exceeds (450 volt) transformer and cabling system capability.
10. Portable shore power cabling and connectors serving ship shall have a total current carrying capacity equal to or exceeding the specified shore power current requirements.
11. Type and condition of portable cabling and connectors shall be in accordance with this appendix.
12. Spliced portable cabling shall not be used for shore power service above 450 VAC.
13. All portable cable circuits are to be of equal lengths (within 10 percent).
14. Cabling shall not be allowed to droop into river/sea.
15. Route excess lengths of portable cabling along length of pier and not in coils.
16. Post safety barriers at ship and shore connections.
17. Connect the portable shore power cabling and connectors to the ship.
18. Comply with the ship's polarity requirements.
19. Shore power cables shall be wrapped with protective covering at locations where chafing may occur.
20. PE-stamped power system one-line diagram shall be reviewed/accepted by government electrical engineer prior to award of contract or connection of ships power to commercial facilities. The drawing is to show both permanent and portable conductors (size/type), switchgear bus ratings, other disconnects, pier connections, circuit breaker ratings, or other features from utility (source) to ships terminals.

FIGURE 2E1. Shore power installations – Continued.

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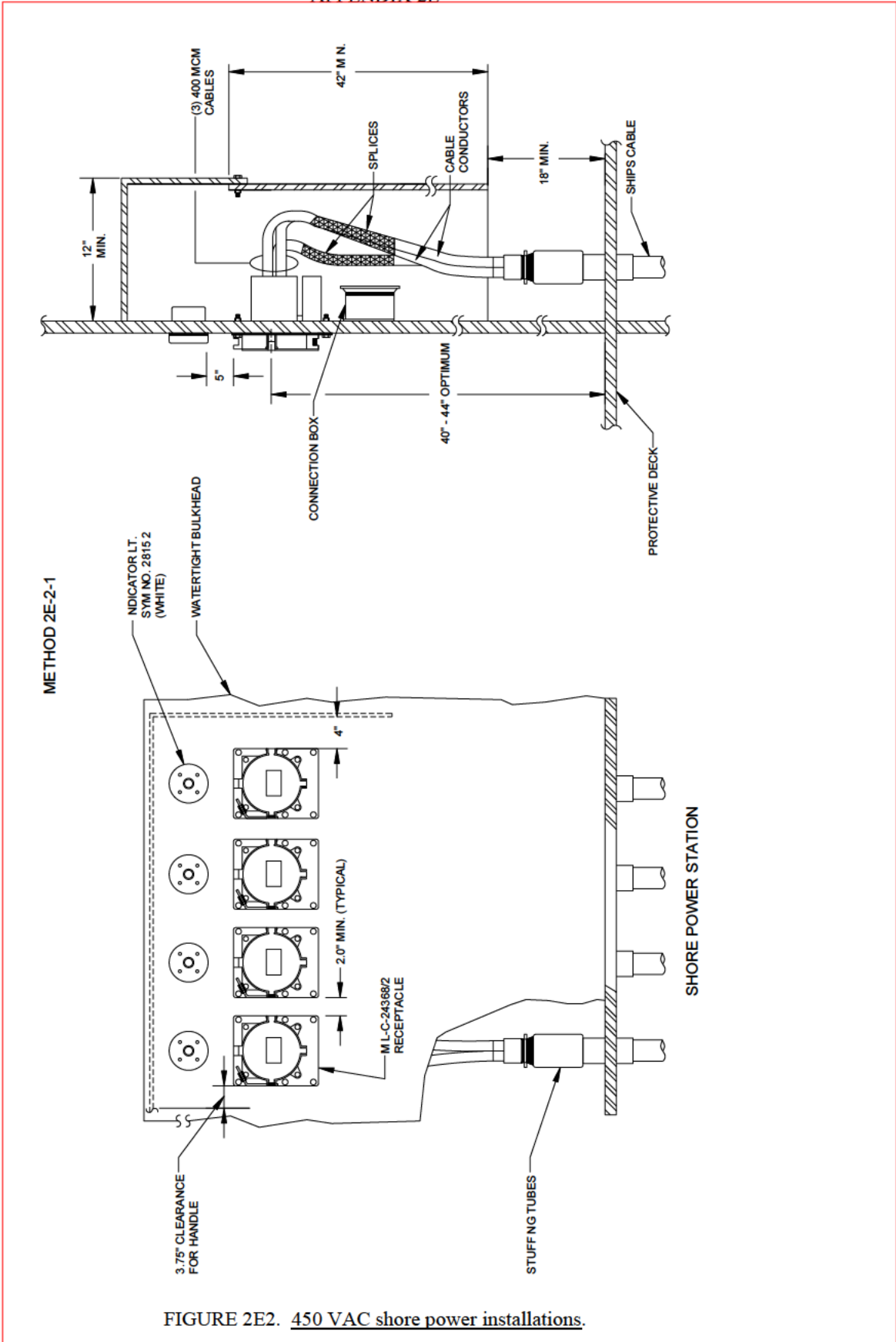


FIGURE 2E2. 450 VAC shore power installations.

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NOTES:

1. See figures [2E16](#) and [2E18](#) for installation details of receptacles.
2. Configuration of 450 VAC shore power station shown herein is optimum and should be followed to the greatest extent possible.

FIGURE 2E2. 450 VAC shore power installations – Continued.

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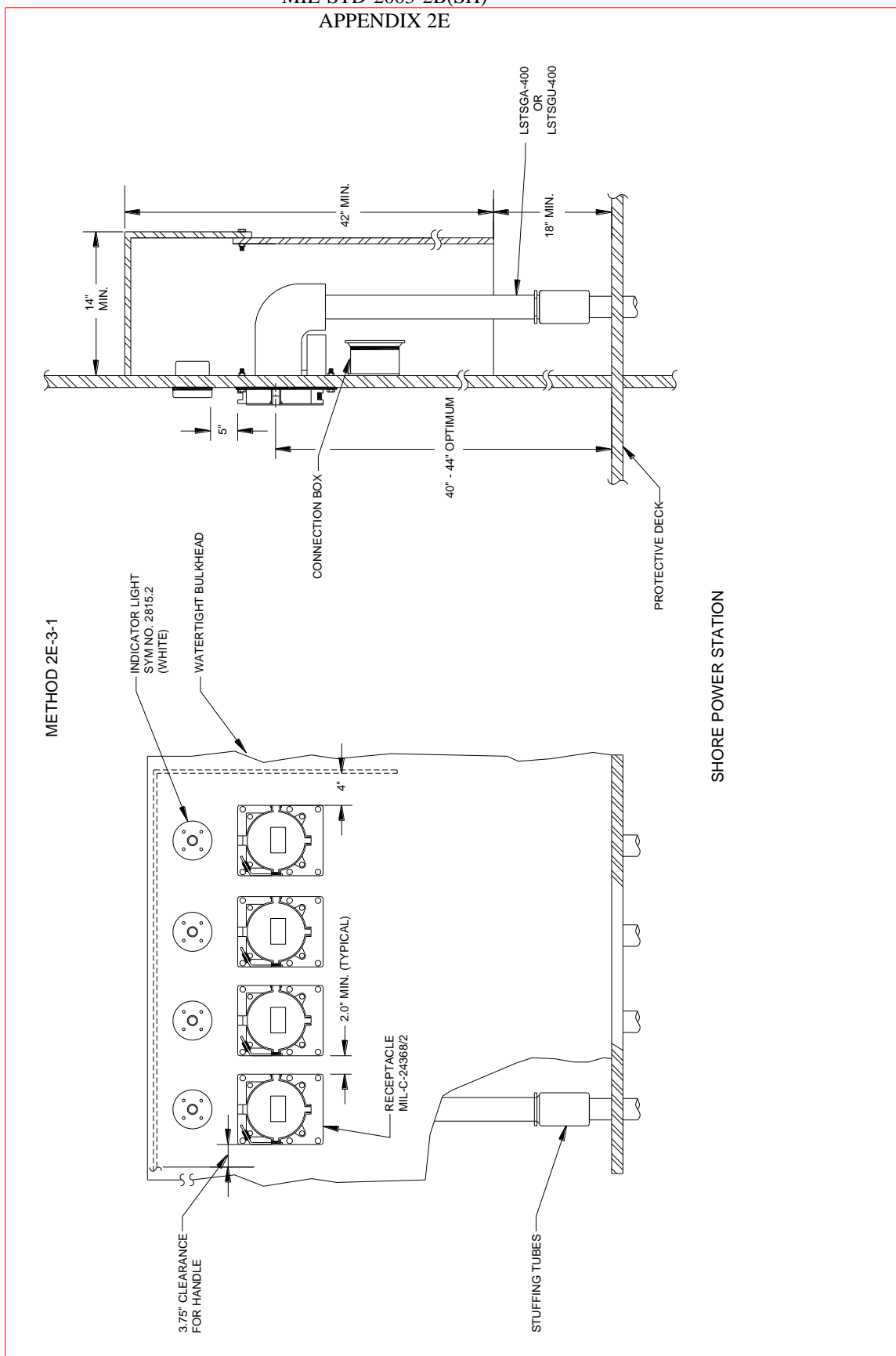


FIGURE 2E3. Mounting shore receptacles with 90-degree potting inside of bulkhead.

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NOTES:

1. See figures [2E16](#) and [2E18](#) for installation details of receptacles.
2. Configuration of 450 VAC shore power station shown herein is optimum and should be followed to the greatest extent possible.

FIGURE 2E3. Mounting shore receptacles with 90-degree potting inside of bulkhead – Continued.

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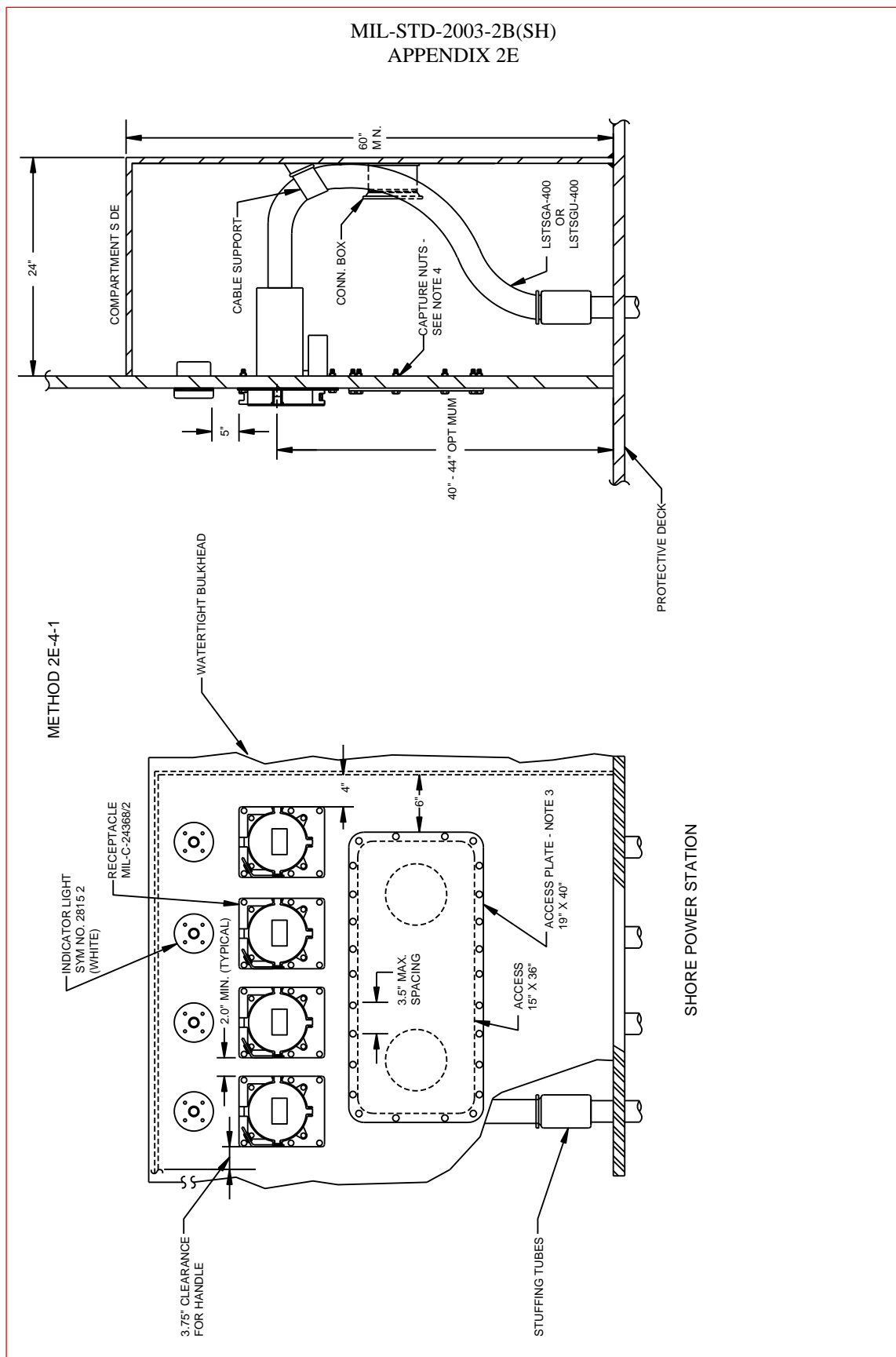


FIGURE 2E4. Mounting 450 VAC shore power receptacles inside of bulkhead.

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NOTES:

1. See figures [2E16](#) and [2E18](#) for installation details of receptacles.
2. Configuration of 450 VAC shore power station as shown herein is optimum and should be followed to the greatest extent possible.
3. Strength of access plate shall be equivalent to bulkhead. Front access shall be provided only when access from the compartment side cannot be provided.
4. Nuts shall be captured to allow removal of access cover. Nuts may be tack welded if fastener and structure materials are compatible in accordance with 4.1.1 and 4.1.2. If the materials are not compatible, the cap screws shall be threaded into the structure.

FIGURE 2E4. Mounting 450 VAC shore power receptacles inside of bulkhead – Continued.

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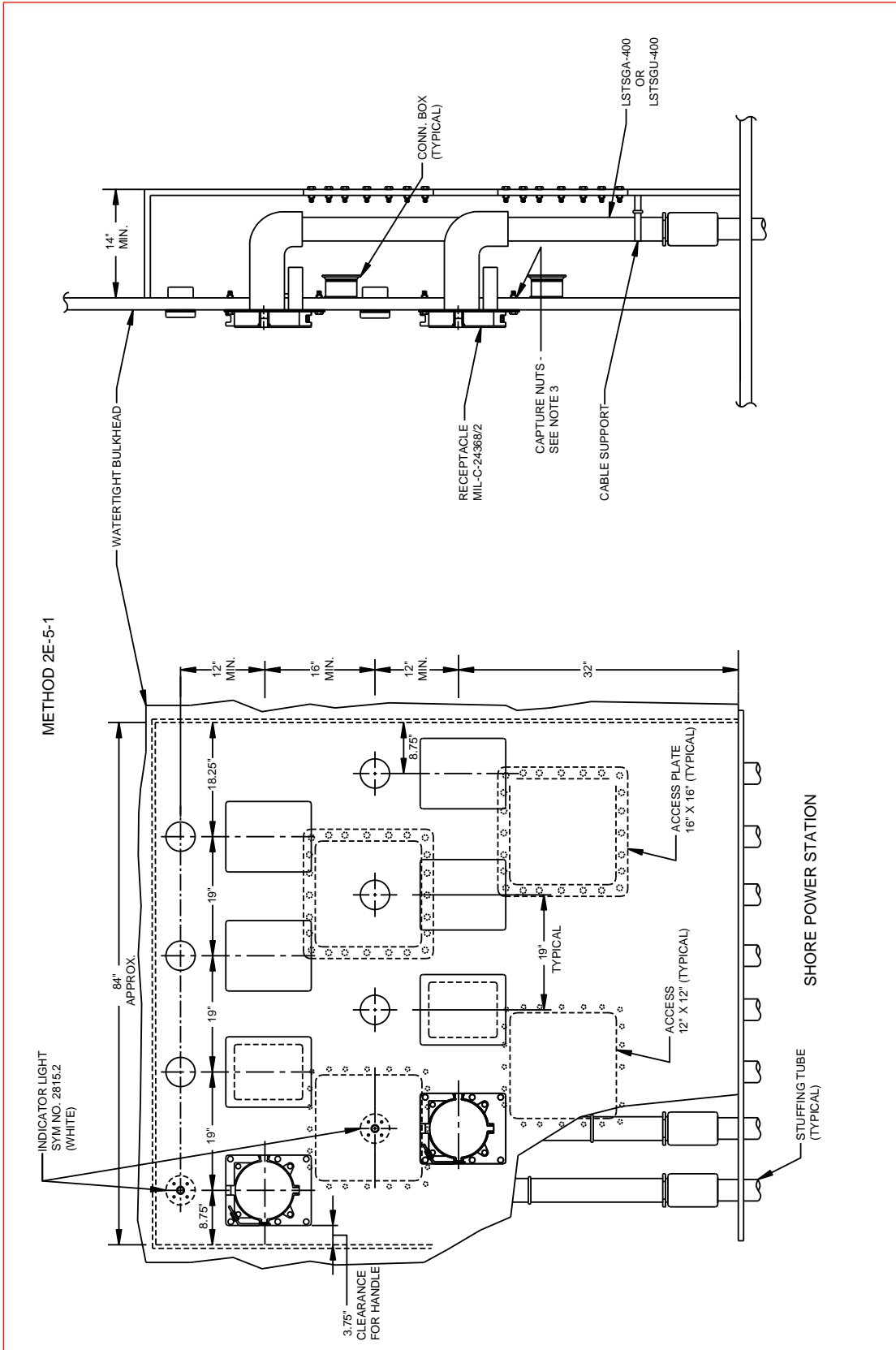


FIGURE 2E5. Stagger mounting of 450 VAC shore power receptacles with 90-degree potting inside of bulkhead.

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NOTES:

1. See figures [2E16](#) and [2E18](#) for installation details of receptacles.
2. Configuration of 450 VAC shore power station shown herein is optimum and should be followed to the greatest extent possible.
3. Nuts shall be captured to allow removal of access cover. Nuts may be tack welded if fastener and structure materials are compatible in accordance with 4.1.1 and 4.1.2. If the materials are not compatible, the cap screws shall be threaded into the structure.

FIGURE 2E5. Stagger mounting of 450 VAC shore power receptacles with 90-degree potting inside of bulkhead –
Continued.

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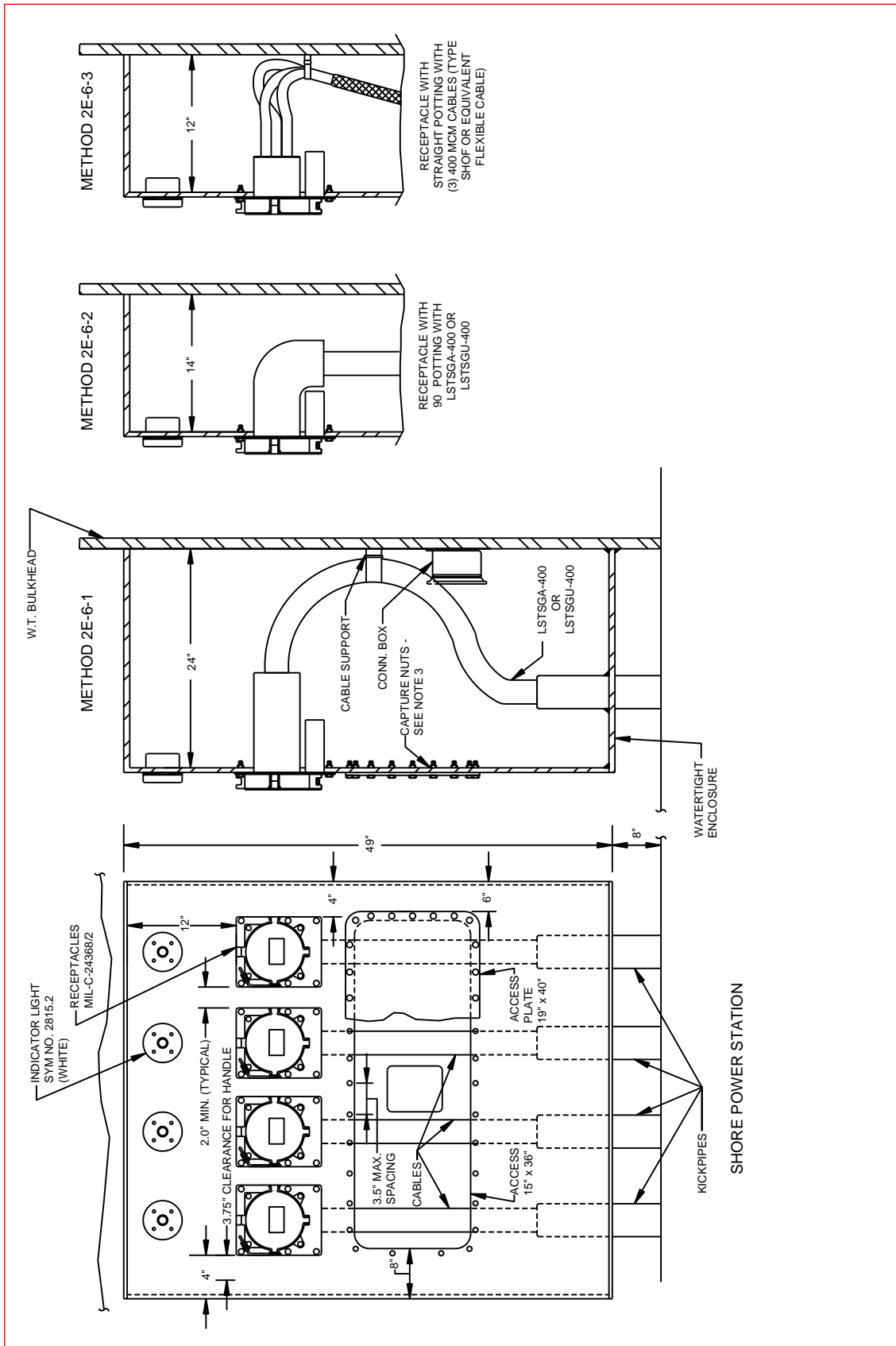


FIGURE 2E6. Mounting 450 VAC shore power receptacles outside of bulkhead.

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NOTES:

1. See figures [2E16](#) and [2E18](#) for installation details of receptacles.
2. Configuration of 450 VAC shore power station shown herein is optimum and should be followed to the greatest extent possible.
3. Nuts shall be captured to allow removal of access cover. Nuts may be tack welded if fastener and structure materials are compatible in accordance with 4.1.1 and 4.1.2. If the materials are not compatible, the cap screws shall be threaded into the structure.

FIGURE 2E6. Mounting 450 VAC shore power receptacles outside of bulkhead – Continued.

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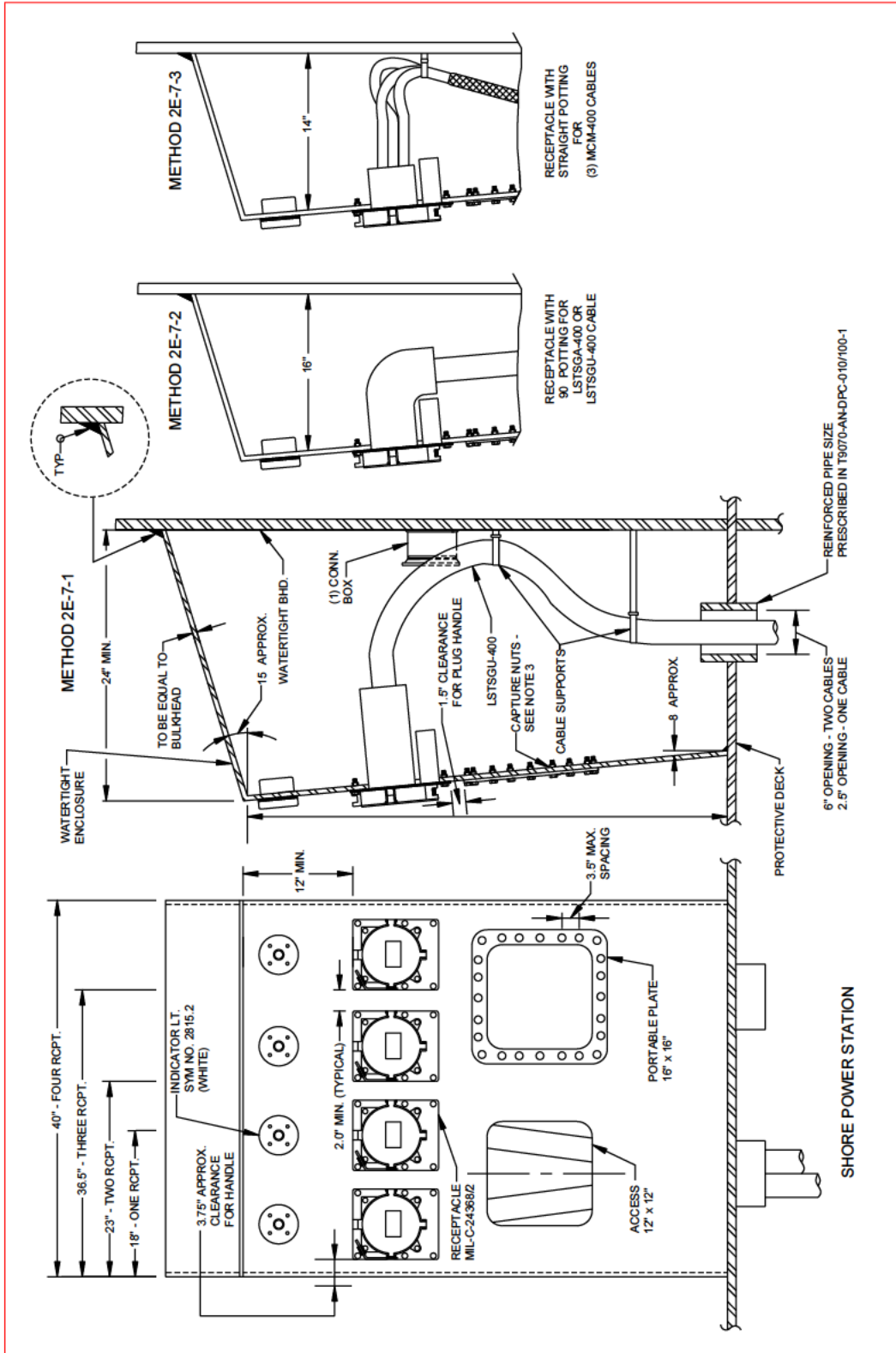


FIGURE 2E7. Mounting 450 VAC shore power receptacles outside of bulkhead.

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NOTES:

1. See figures [2E16](#) and [2E18](#) for installation details of receptacles.
2. Configuration of 450 VAC shore power station shown herein is optimum and should be followed to the greatest extent possible.
3. Nuts shall be captured to allow removal of access cover. Nuts may be tack welded if fastener and structure materials are compatible in accordance with 4.1.1 and 4.1.2. If the materials are not compatible, the cap screws shall be threaded into the structure.

FIGURE 2E7. Mounting 450 VAC shore power receptacles outside of bulkhead – Continued.

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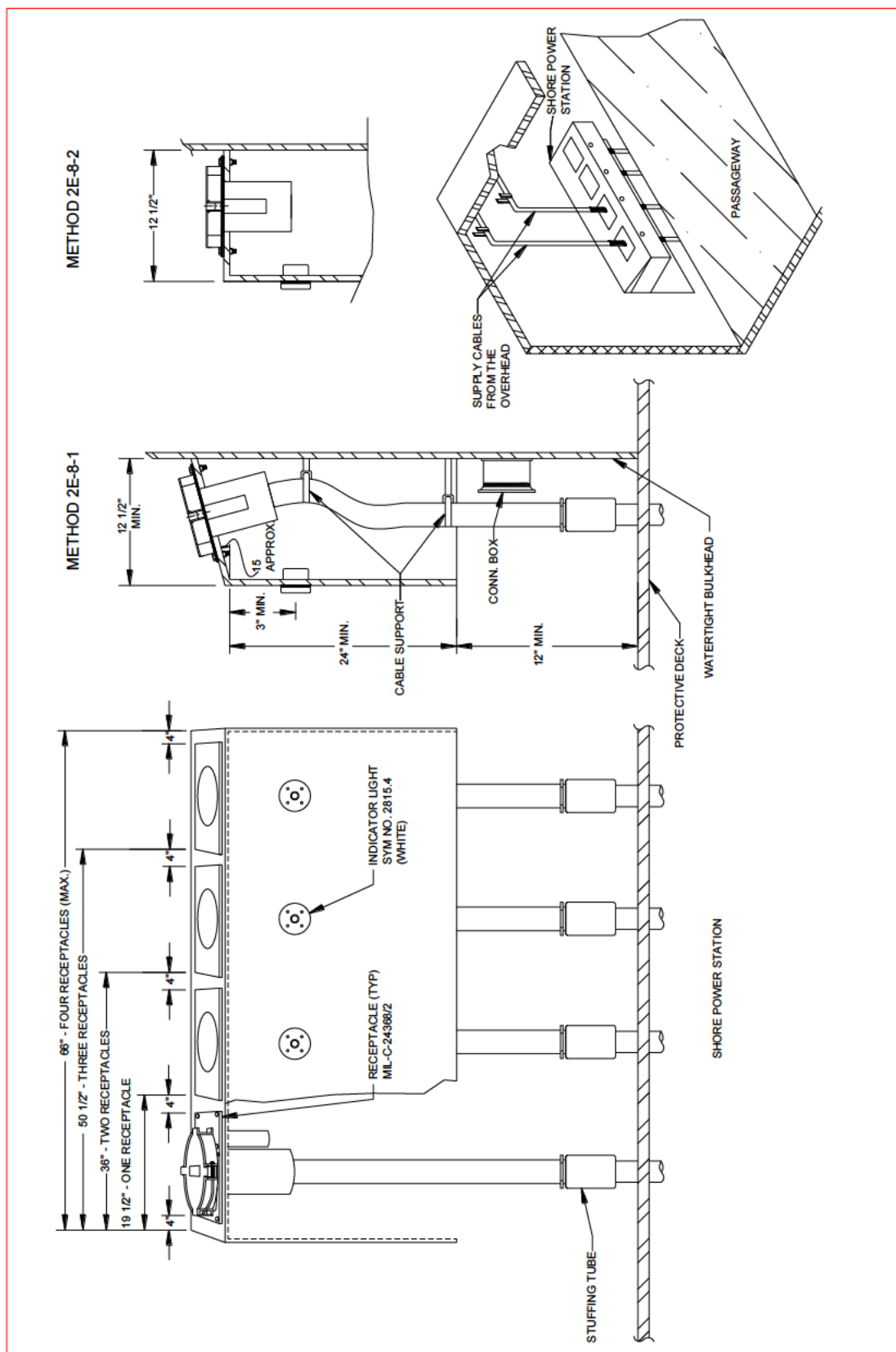


FIGURE 2E8. Incline mounted 450 VAC shore power receptacles in protected areas.

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NOTES:

1. See figures [2E16](#) and [2E18](#) for installation details of receptacles.
2. Configuration of 450 VAC shore power station shown herein is optimum and should be followed to the greatest extent possible.
3. This method shall be used only in protected areas such as passageways, storerooms, and similar compartments not exposed to the weather.

FIGURE 2E8. Incline mounted 450 VAC shore power receptacles in protected areas – Continued.

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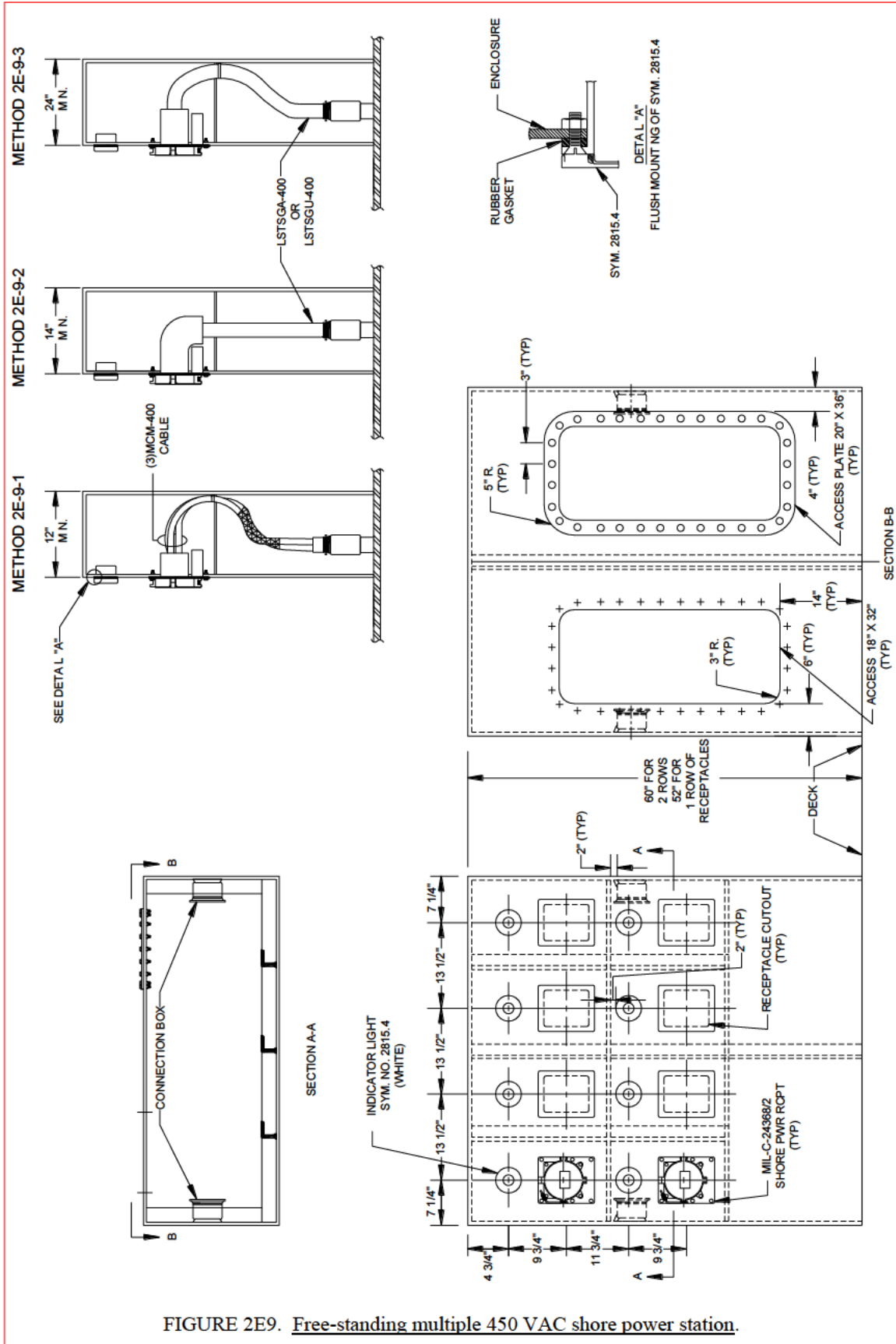


FIGURE 2E9. Free-standing multiple 450 VAC shore power station.

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NOTES:

1. See figures [2E16](#) and [2E18](#) for installation details of receptacles.
2. Configuration of 450 VAC shore power station shown herein is optimum and should be followed to the greatest extent possible.

FIGURE 2E9. Free-standing multiple 450 VAC shore power station – Continued.

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APPENDIX 2E

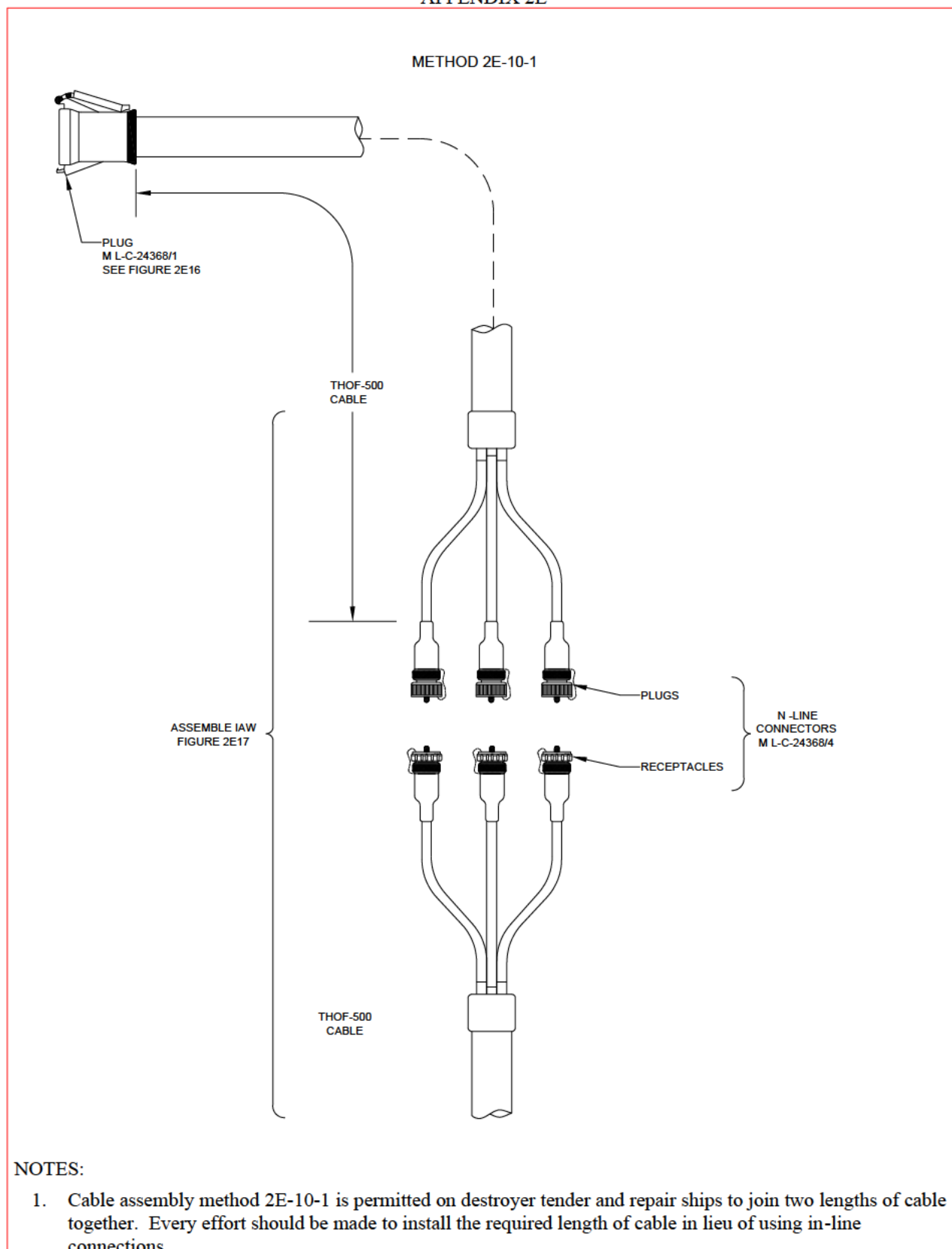


FIGURE 2E10. In-line connectors on alongside power cables (surface ships only).

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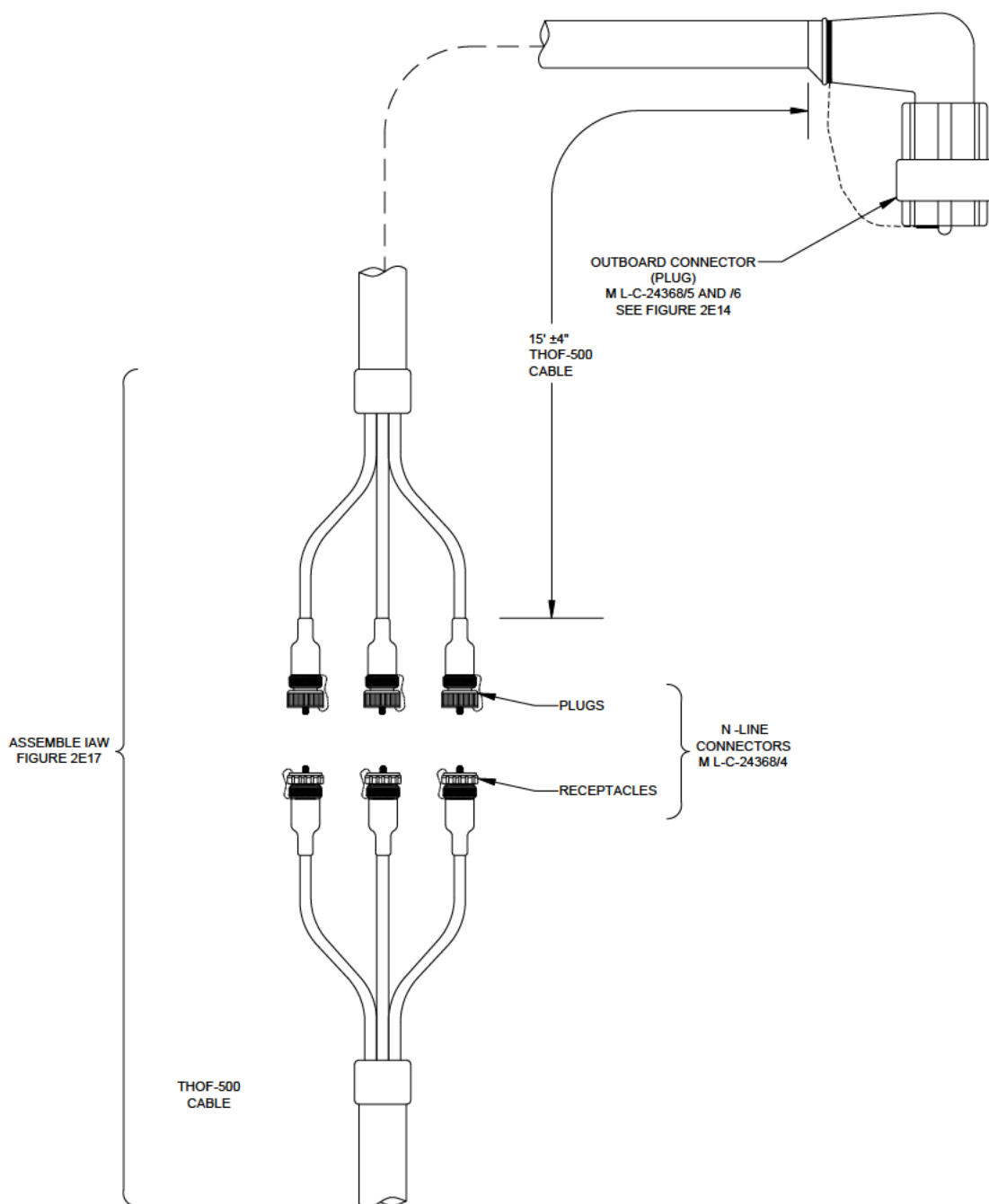
NOTES (continued):

2. Shore facilities may utilize available commercial single-phase or three-phase in-line connectors to facilitate 450 VAC shore power connection to ship. The type of connector used shall be determined by responsible shore facility. For non-MIL-Spec in-line connectors, installation methods shall be in accordance with manufacturers' instructions.
3. This figure shows minimum shore power cable lengths. The cable lengths may be increased based on requirements of specific ship or class drawings or requirements of applicable ship specifications.

FIGURE 2E10. In-line connectors on alongside power cables (surface ships only) – Continued.

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METHOD 2E-11-1
SUBMARINE
TENDERS



NOTES:

1. Cable assembly method 2E-11-1 is permitted on submarine tenders when it is necessary to replace a damaged MIL-C-24368/5 or /6 type plug connector. The tender may purchase a 15-foot length of cable with a MIL-C-24368/5 or /6 type plug connector at one end. This cable may be connected to the alongside power cable via in-line connectors.

FIGURE 2E11. In-line connectors on alongside power cables (for submarine tenders only).

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NOTES (continued):

2. Shore facilities may utilize available commercial single-phase or three-phase in-line connectors to facilitate 450 VAC shore power connection to ship. The type of connector used shall be determined by responsible shore facility. For non-MIL-Spec in-line connector, installation shall be in accordance with manufacturers' instructions.
3. This figure shows minimum shore power cable lengths. The cable lengths may be increased based on requirements of specific ship or class drawings or requirements of applicable ship specifications.

FIGURE 2E11. In-line connectors on alongside power cables (for submarine tenders only) – Continued.

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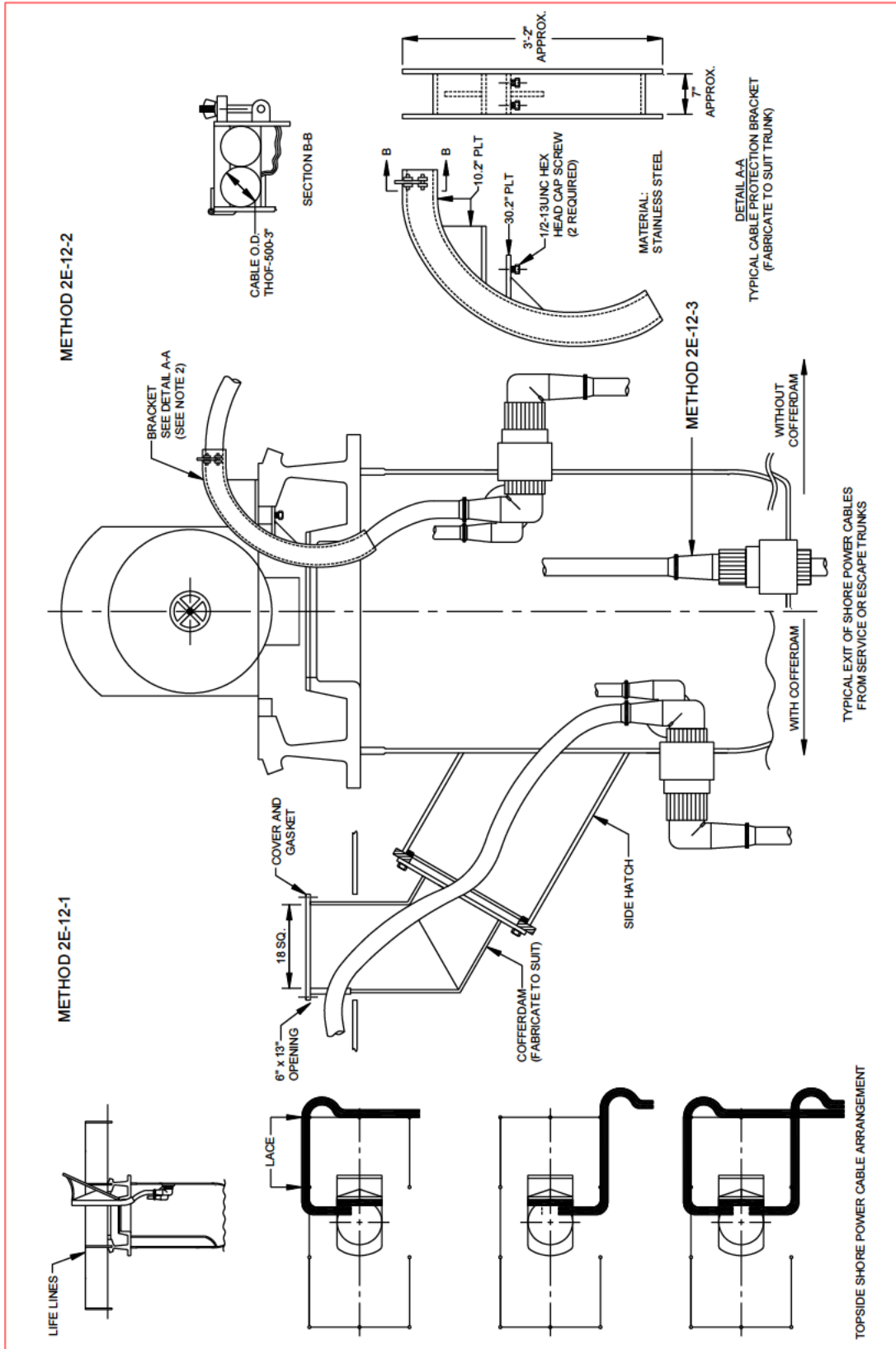


FIGURE 2E12. Protection of 450 VAC shore power cable when exiting trunks (submarines).

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NOTES:

1. Location and arrangement of cables in trunks shall facilitate their exit.
2. Cables shall be protected against cuts resulting of personnel traffic through the trunk, and of cable resting against sharp edges. Sharp bend radius of cables shall be avoided.
3. See 4.1.2 for mounting fastener requirements.

FIGURE 2E12. Protection of 450 VAC shore power cable when exiting trunks (submarines) – Continued.

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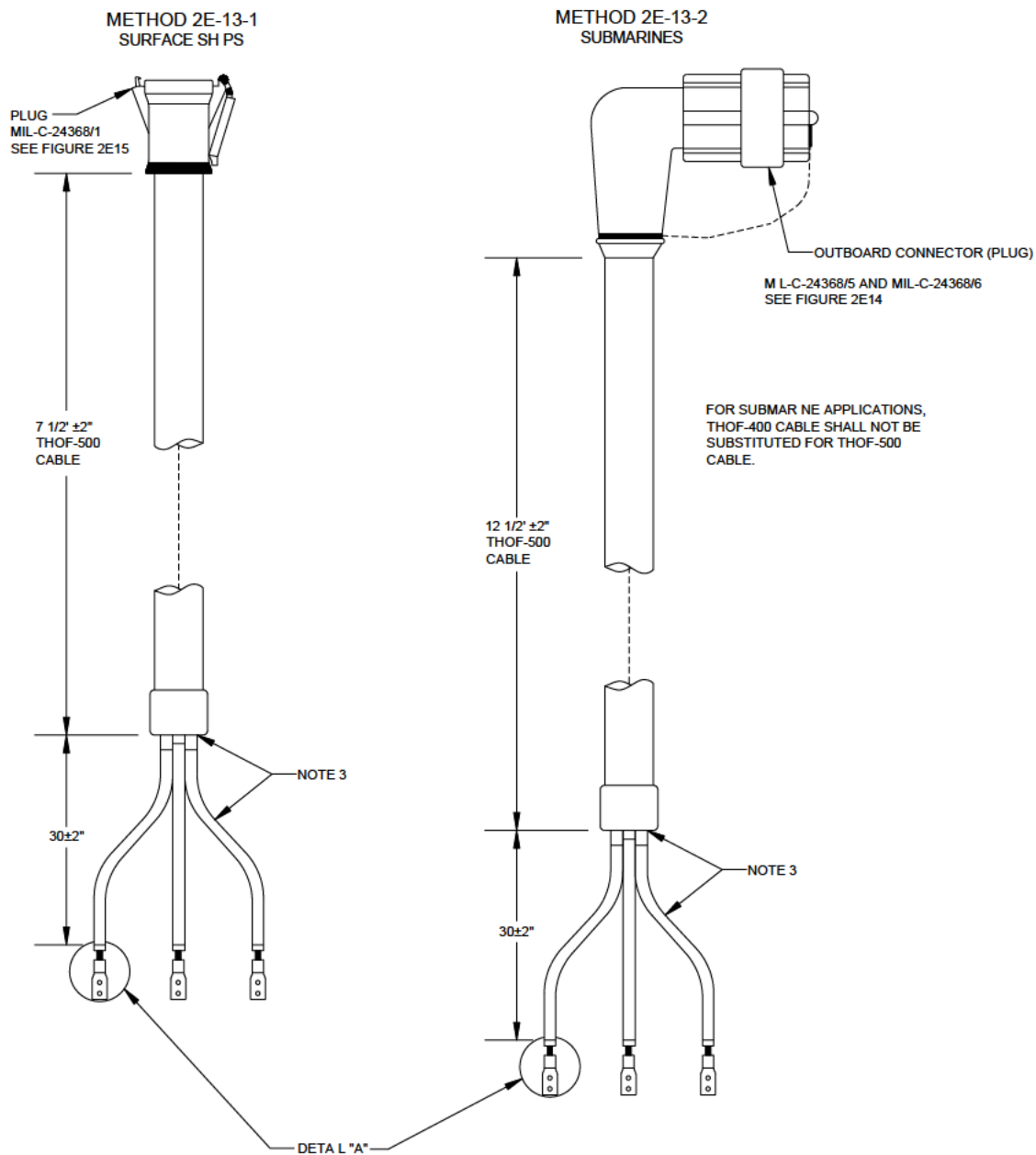
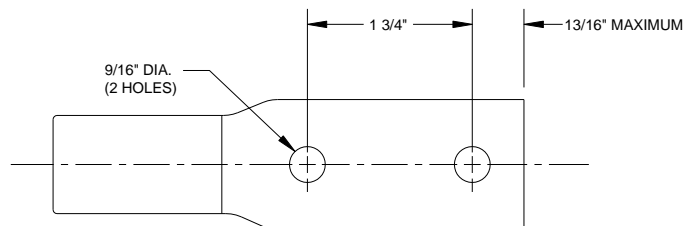


FIGURE 2E13. Portable 450 VAC shore power cable jumper assemblies.

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APPENDIX 2E



COPPER CRIMP LUG (SILVER-PLATED),
TYPE CLC, MIL-T-16366. CRIMP LUG TO
CABLE. SEE CRIMP LUG TABLE.

DETAIL "A"

TABLE 2E13-I. Crimp lugs.

Cable type	Nominal diameter of conductor (inch)	Lug size*	Crimp lug (MIL-T-16366) Thomas & Betts (now ABB), or equal (see 4.8)
THOF-500	0.960	500 MCM	256-30695-555
		600 MCM	54289
THOF-400	0.850	400 MCM	256-30695-535
		500 MCM	256-30695-555

Equivalent (see 4.8) crimp lugs may be substituted for the ones specified above. Order lugs (silver-plated) with blank tongue and drill (two holes) as shown in Detail A.
* Flexible cable, such as THOF (MIL-DTL-915/6), may require the next larger size lug due to the larger outside diameter of the flexible conductors (see MIL-T-16366).

NOTES:

- Portable 450 VAC shore power cable jumper assemblies are a NATO requirement. They are furnished onboard ships to connect to shore cable assemblies in foreign ports or in places where the proper plugs are not available. Normally, the supply activity provides both the cable assembly and the appropriate plugs.
- Stowage facilities shall be furnished for these assemblies.
- Install a crotch boot and tubing in accordance with [figure 2E17](#).
- The NATO required adapter cables should not include in-line connectors.
- Jumper cables for in-service vessels may be type THOF-400. However, there shall be no mixing of jumper cable sizes for each installation. For submarine applications, THOF-400 cable shall not be substituted for THOF-500 cable.
- This figure shows minimum shore power cable lengths. The cable lengths may be increased based on requirements of specific ship or class drawings or requirements of applicable ship specifications.
- The +2-inch/-2-inch tolerance shown for the shore power cable end assembly applies for new cable installations. If the lugs need to be replaced once, the tolerance may be changed to +2 inches/-4 inches. If additional lug replacements are necessary, the entire cable assembly shall be replaced.

FIGURE 2E13. Portable 450 VAC shore power cable jumper assemblies – Continued.

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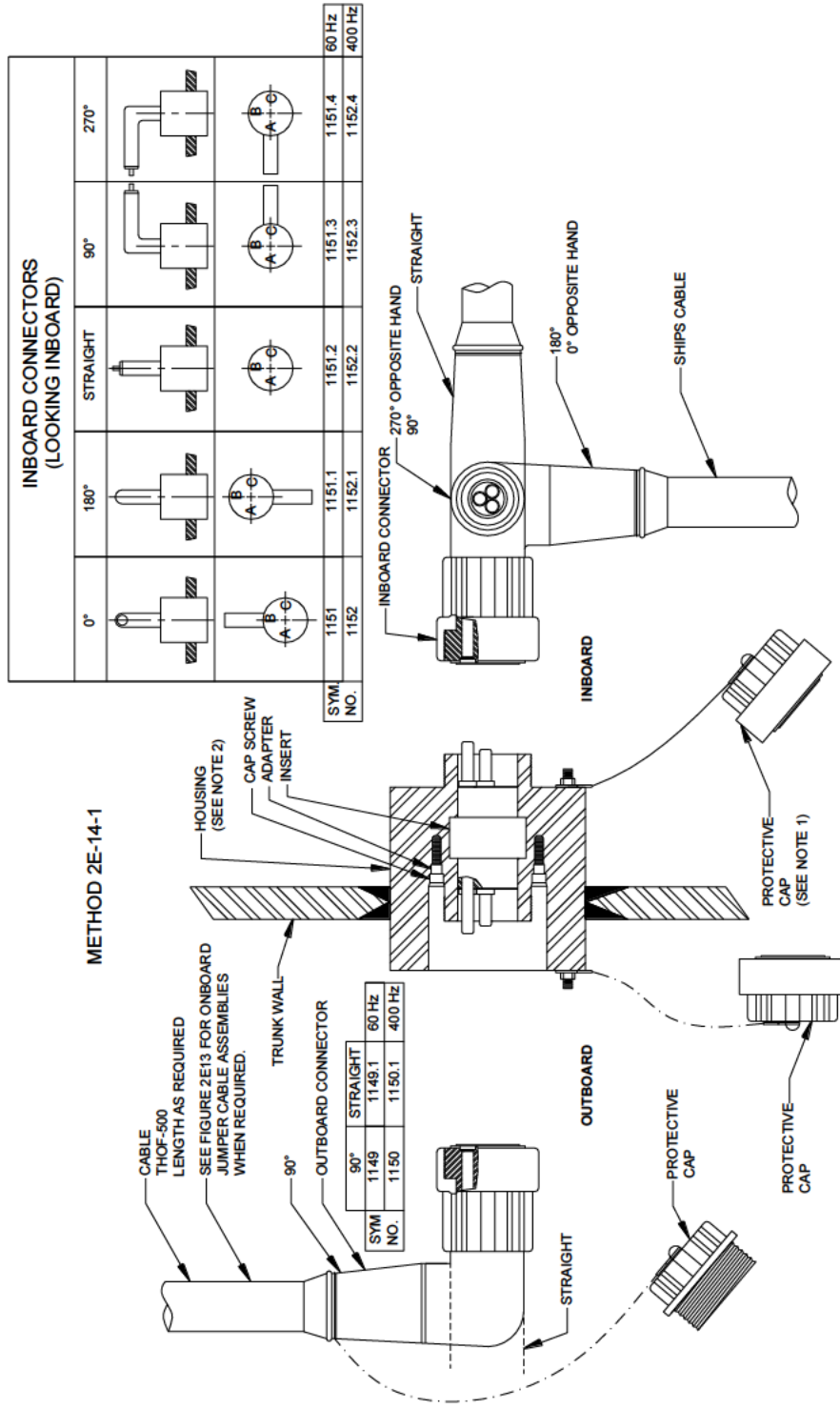


FIGURE 2E14. 450 VAC shore power installation for submarines.

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NOTES:

1. Protective caps are not necessary inboard unless required by the installing activity.
2. Housing shall be made of steel matching that of the submarine hull by the supplier in accordance with MIL-C-24368/5.
3. A spanner wrench shall be used for the installation of protective caps on connectors.
4. Hardware shown herein is in accordance with MIL-C-24368/5.

FIGURE 2E14. 450 VAC shore power installation for submarines – Continued.

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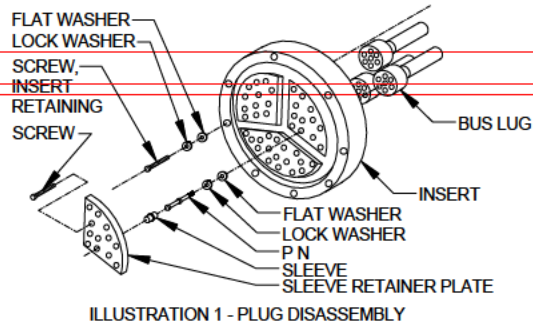


ILLUSTRATION 1 - PLUG DISASSEMBLY

Step 1 – Plug disassembly:

If plug is received partially assembled, remove insert retaining screws and remove insert by pushing from rear. Remove sleeve retaining plates, sleeves, pins, and bus lugs.

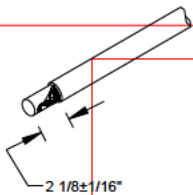


ILLUSTRATION 2A - SINGLE CONDUCTOR CABLE
- FOR RECEPTACLE ONLY -
FIGURE 2E16

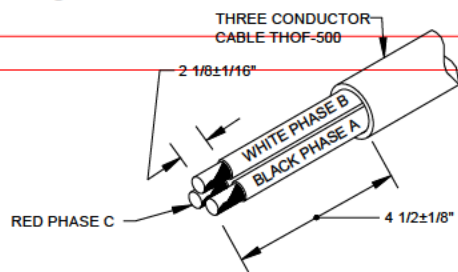


ILLUSTRATION 2B - 3 CONDUCTOR CABLE

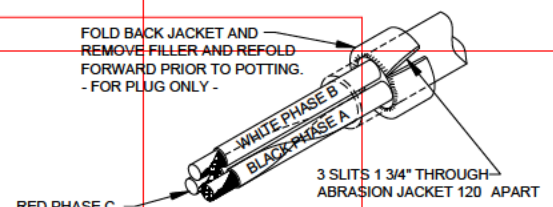


ILLUSTRATION 2C: TO BE USED WHEN
CABLE LAY IS OUT OF PHASE WITH
BUS BAR ORIENTATION. (ILLUS. 3)

ILLUSTRATION 2C - 3 CONDUCTOR CABLE

Step 2 – Cable end preparation:

Remove abrasion jacket and insulation as shown in illustrations 2A, 2B, or 2C as applicable.

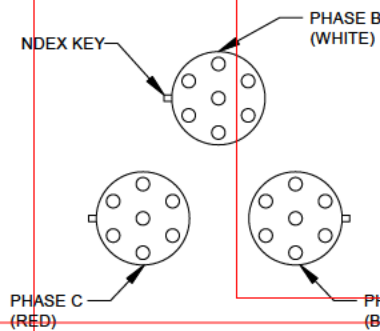


ILLUSTRATION 3 - FRONT VIEW BUS LUG AND CABLE
CONDUCTOR ORIENTATION

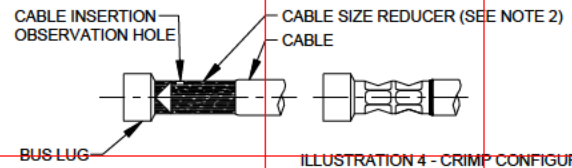


ILLUSTRATION 4 - CRIMP CONFIGURATION

Step 3 – Cable termination:

Prior to crimping, position bus lugs on conductors as shown in illustration 3. Note position of index keys. Insert cable into bus lugs and crimp as shown in illustration 4. Crimp using Thomas & Betts (now ABB) hydraulic power crimp and die set, or equal (see 4.8).

FIGURE 2E15. Termination and potting ship-or-450 VAC shore power plug MIL-C-24368/1.

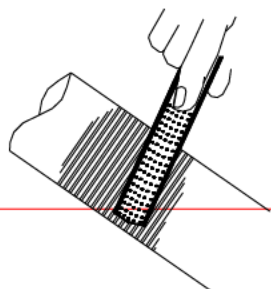
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ILLUSTRATION 5 - CABLE INSULATION SCRAPING

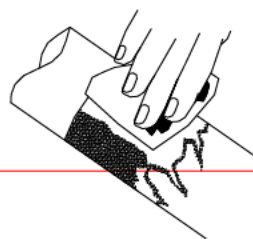


ILLUSTRATION 6 - CABLE INSULATION CLEANING

Step 4 – Cable scraping and cleaning:

Thoroughly scrape and roughen the outside insulation at the conductors and cable jacket with a scraper. Coarse file or emery cloth for a length to be potted to ensure adhesion with the potting compound. Abrade the rear face of the insert (bus lug side) and the inside surface of the plug in the same manner. Clean abraded area with a lint-free cloth wetted with acetone or methyl ethyl ketone, and allow to dry.

NOTE: Avoid touching or handling of roughened area to eliminate any contamination of surface.

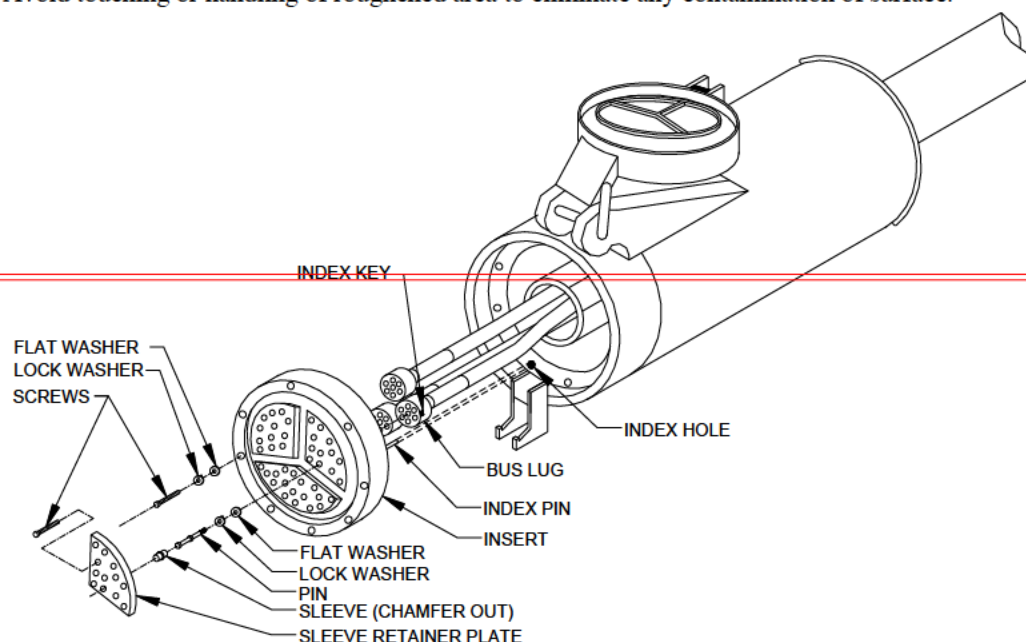


ILLUSTRATION 7 - PLUG ASSEMBLY

Step 5 – Potting:

Slide plug housing over cable and assemble as follows (see illustration 7):

- Position insert on the bus lugs so index keys fit in their respective slots.
- Apply a light coat of non-insulated lubricant (not silicone grease) to the threads of the 21 pins and install through the insert so lugs and insert are “locked” together. Lockwashers and flat washers are used with each pin. Flat washers are installed next to the insert.
NOTE: Do not over-tighten pins (30 inch-pounds maximum) as they are copper.
- Install 21 sleeves, chamfer facing out, by snapping them onto the ball-tipped pins (see note 4).
- Install sleeve retainer plates (4 screws each).
- Attach insert to plug housing with eight screws, the index pin, and hole pattern. Assure proper position. Assure that the eight screws are tight prior to potting.

FIGURE 2E15. Termination and potting ship-or-450 VAC shore power plug MIL-C-24368/1 – Continued.

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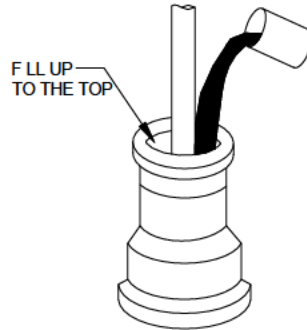


ILLUSTRATION 8

- f. Set plug on end and secure the cable to a suitable overhead support. Position plug so that the cable is centered in hole at rear of the housing (see illustration 8).
- g. Weigh out the specified ratio of the stycast 2741 potting compound and the catalyst 16 hardener and mix thoroughly (see note 3). Pour the mixed compound slowly from one side of the plug housing until the void area is filled. Allow the compound to cure eight hours at room temperature.
- h. Assemble.

Step 6 – The plug is now ready for use.

NOTES:

1. When the plug MIL-C-24368/1 is furnished without cable, it shall be prepared for use as shown herein.
2. Unless otherwise specified in the applicable ship specification or applicable ship drawings, bus lugs are furnished for LSTHOF-500 cable or 3 LSSHOF-500 cables. Cable size reducers, Part M24368/4-033 of MIL-C-24368/4, shall be used if LSTHOF-400 cable is used.
3. Potting compound shall be 100 parts by weight of stycast 2741 cured with 50 parts by weight of catalyst 16 as manufactured by Emerson Cuming, Inc., Canton, Massachusetts 02021, or equal (see 4.8). To fill the plug, $\frac{3}{4}$ of a gallon (5 pounds) is required.
NOTE: Verify that manufacturer's potting compound expiration date is still current.
4. **Caution:** If sleeve chamfer is not facing out, a hazardous condition will exist.

FIGURE 2E15. Termination and potting ship-or-450 VAC shore power plug MIL-C-24368/1 – Continued.

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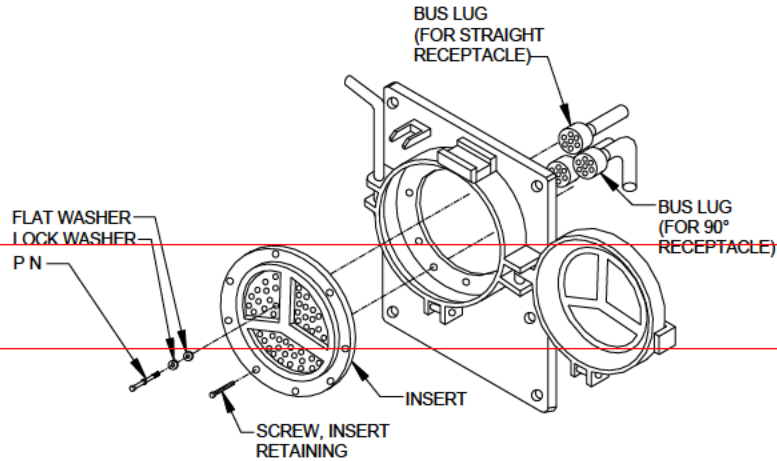


ILLUSTRATION 1 - RECEPTACLE ASSEMBLY

Step 1:

If receptacle is received partially assembled, remove insert retaining screws and remove insert by pushing from rear. If crimping of cable to bus lugs cannot be done while bus lugs are still assembled in the insert, remove them by removing the pins.

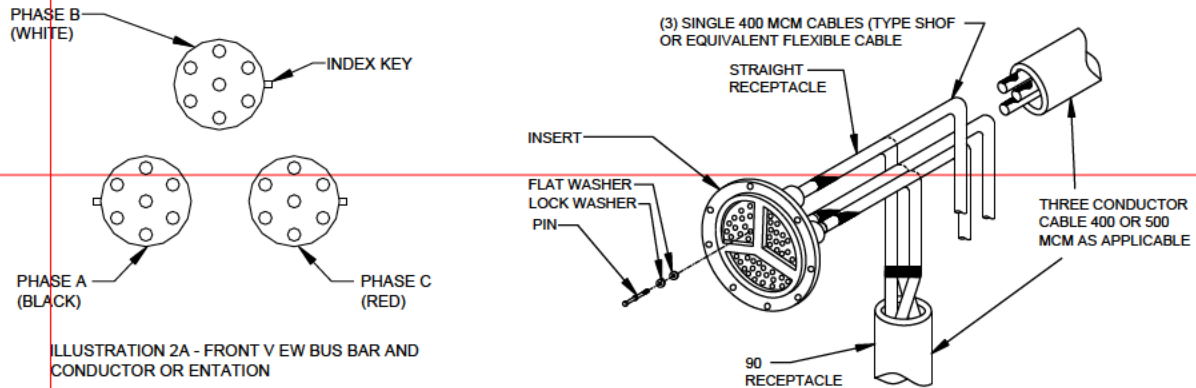


ILLUSTRATION 2A - FRONT VIEW BUS BAR AND CONDUCTOR ORIENTATION

ILLUSTRATION 2B - INSERT AND CABLE ASSEMBLY

Step 2:

Prepare and terminate cable same as steps 2, 3 (modified as shown herein), and 4 on [figure 2E15](#). Prior to crimping, position bus lugs on conductors as shown in illustration 2A. Note position of index keys. Position insert on the bus lugs so index keys fit in their respective slots. Apply a light coat of non-insulating lubricant (not silicone grease) to threads of the 21 pins and install through the insert so lugs and insert are "locked" together as shown in illustration 2B. If cable is long or installed in ship, slide mounting plate over cable first.

NOTE: Do not over-tighten pins (30 inch-pounds maximum) as they are copper.

FIGURE 2E16. Termination and potting ship-or-450 VAC shore power receptacle MIL-C-24368/2.

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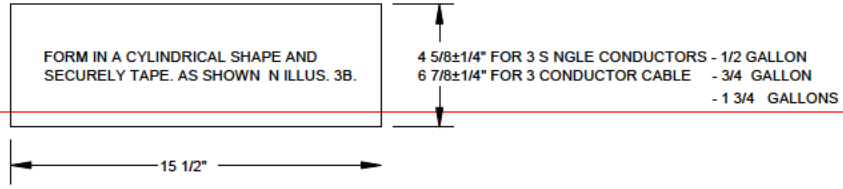


ILLUSTRATION 3A

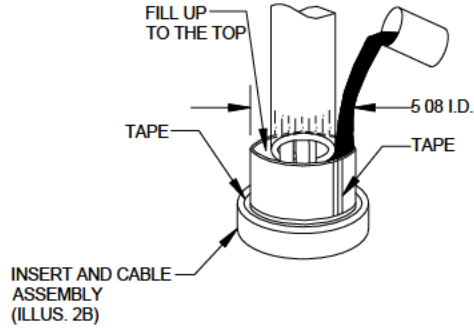


ILLUSTRATION 3B - MOLD FOR STRAIGHT RECEPTACLE

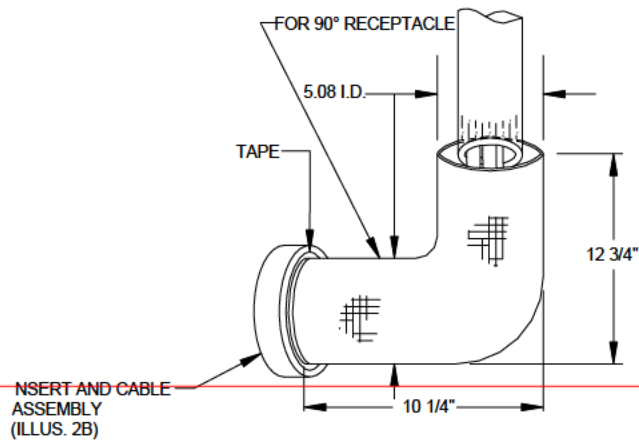


ILLUSTRATION 4 - MOLD FOR 90° RECEPTACLE

FIGURE 2E16. Termination and potting ship-or-450 VAC shore power receptacle MIL-C-24368/2 – Continued.

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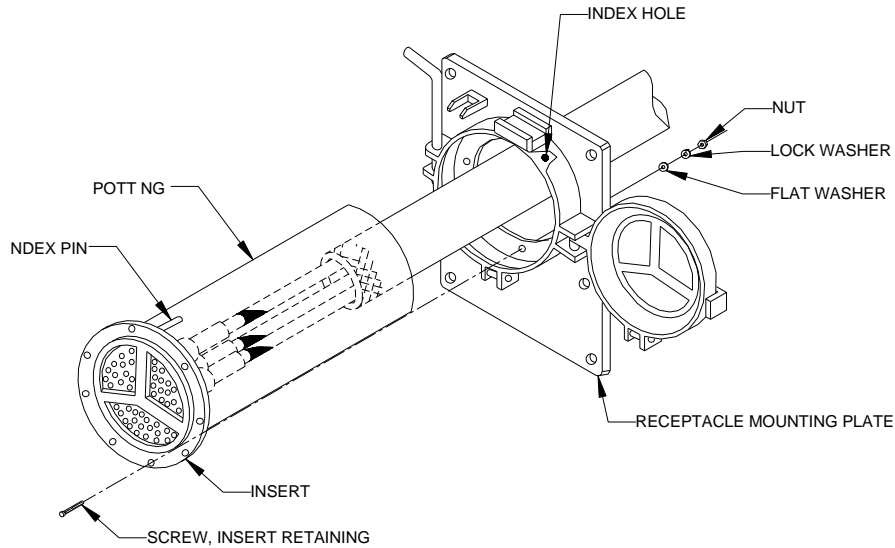


ILLUSTRATION 5 - RECEPTACLE ASSEMBLY

Step 3 – Potting:

- a. Fabricate a mold to the dimensions shown in illustrations 3 and 4 from a material such as 0.03 thick plastic sheet. A cellulose acetate material has been shown to be satisfactory. Center and secure mold to insert with tape.
- b. Position insert and secure cable to a suitable overhead support. Center cable in mold.
- c. Weigh out the specified ratio of the stycast 2741 potting compound and the catalyst 15 hardener and mix thoroughly (see note 3). Pour the mixed compound slowly from one side of the receptacle housing until the void area is filled. Allow the compound to cure 8 hours at room temperature.
- d. Remove tape holding mold to insert. The mold may be removed if desired.
- e. Slide cable through the hole (see illustration 5) in the receptacle mounting plate and attach insert with eight screws and nuts. The index pin and hole pattern will assure proper position.

Step 4 – The receptacle is now ready for use.

NOTES:

1. When the receptacle MIL-C-24368/2 is furnished without cable, it shall be prepared for use as shown herein.
2. Unless otherwise specified in the applicable ship specification or applicable ship drawings, bus lugs are furnished for 400 MCM cable.
3. Potting compound shall be 100 parts by weight of stycast 2741 cured with 50 parts by weight of catalyst 15 as manufactured by Emerson Cuming, Inc., Canton, Massachusetts 02021, or equal (see 4.8). The material required to fill the mold is shown next to illustration 3A.

FIGURE 2E16. Termination and potting ship-or-450 VAC shore power receptacle MIL-C-24368/2 – Continued.

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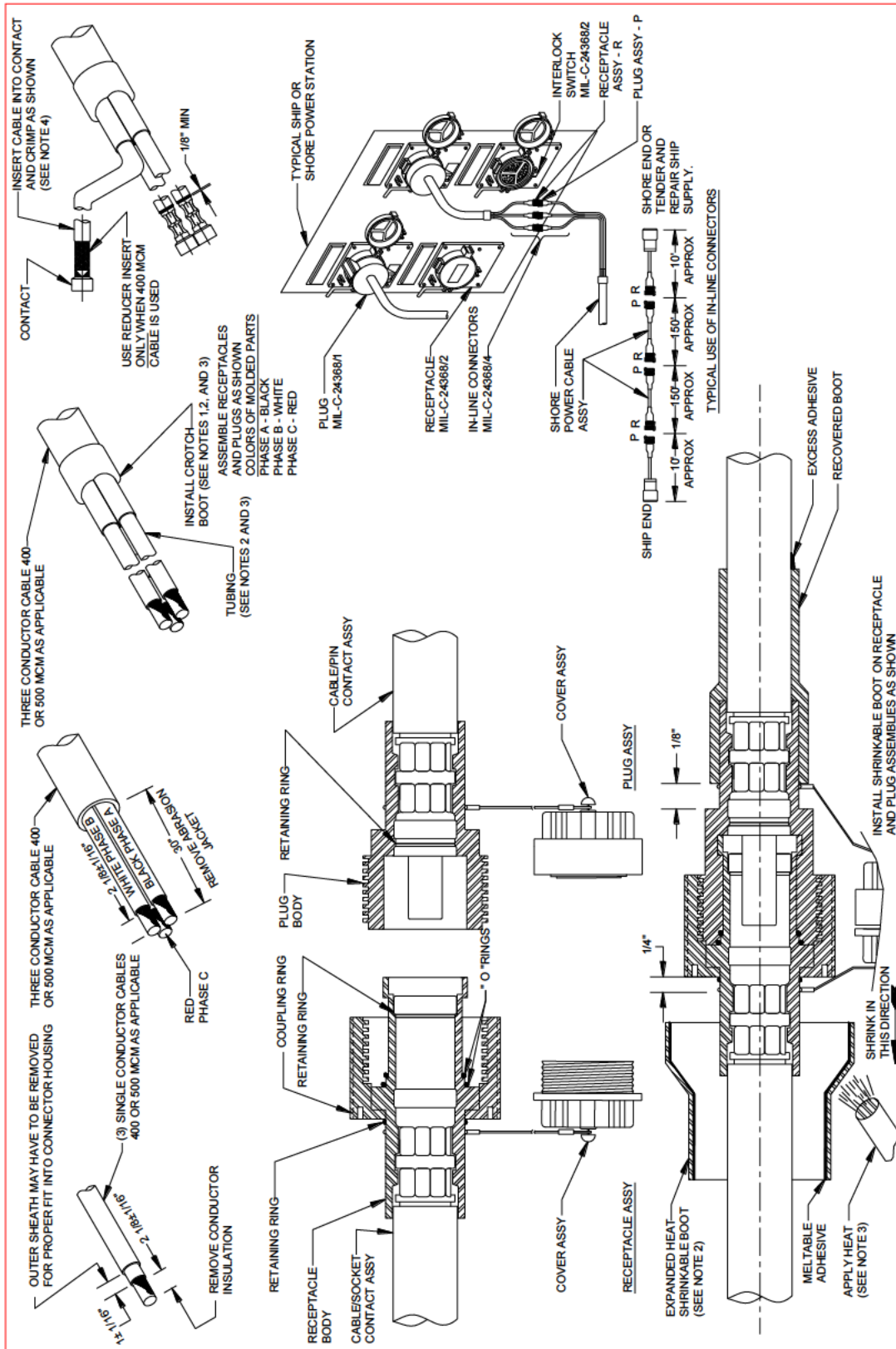


FIGURE 2E17. Alongside power in-line connectors MIL-C-24368/4 (tenders and repair ships).

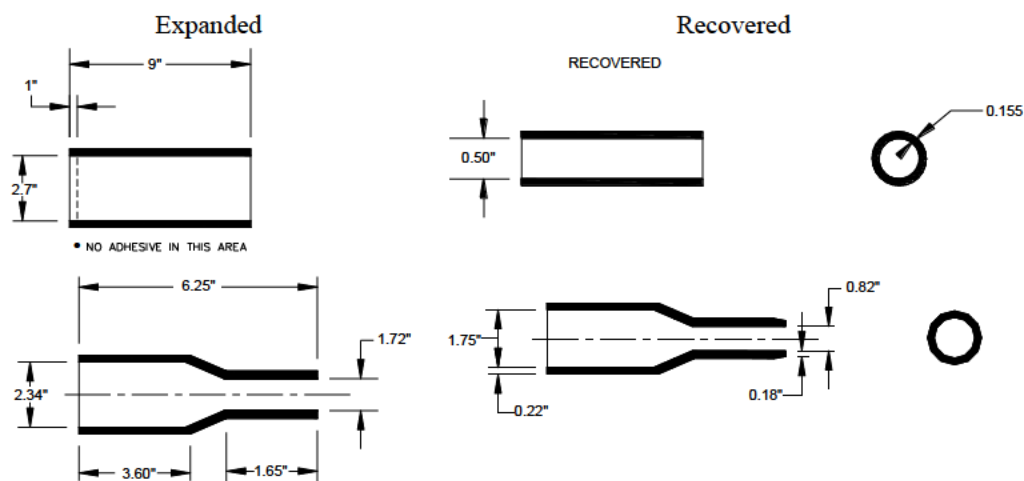
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Notes and installation instructions:

- Clean cable jacket and conductor insulation. First, slide tubing over individual conductors and shrink in place (prior to removal of insulation for crimping). Next, slide crotch boot over cable conductors and cable jacket. Press firmly into crotch of conductors and shrink on place (method 1A-6-1).
- Shrink on the materials shall be as follows:

2E171-1	Crotch boot	See table 1A6-I, "Cable crotch boot dimensions", of MIL-STD-2003-1
2E171-2	Tubing (27" long)	M23053/15-104-0 of SAE-AS23053/15
2E171-3	Boot	1/
2E171-4	Kit	2/

- 1/ Boot, Part 2E171-3, shall be either a heavy duty tubing or a molded boot as shown below. Either part shall have adhesive on the internal wall which meets the adhesive requirements described in MIL-STD-2003-1, appendix 1A. Material for the tubing shall meet the performance requirements of SAE-AS23053/15, class 1. Material for the molded boot shall meet the performance requirements of SAE-AS81765/1.



- 2/ A kit shall contain 1 crotch boot (2E171-1), 3 tubing (2E171-2), 3 boots (2E171-3), 1 abrasion device, and pertinent installation instructions.

- Shrink part by applying heat using a hot air blower or other heat source. Minimum recovery temperature is 350 °F.
As heat is applied, move heat source back and forth over part to be shrunk. For crotch boot and tubing, shrink from center to ends to avoid trapping air.
When part has recovered enough to assume the configuration of the item covered and excess adhesive appears at the ends, discontinue heating. Additional heat will not make the part shrink more tightly.
- Crimp using Thomas & Betts (now ABB) die no. 94H, or equal (see 4.8).
- Shore facilities may utilize available commercial single- or three-phase in-line connectors to facilitate the 450 VAC shore power connection to ship. Type of connectors used shall be determined by the responsible shore facility. For non-MIL-Spec in-line connectors, installation methods shall be in accordance with manufacturer's instructions.

FIGURE 2E17. Alongside power in-line connectors MIL-C-24368/4 (tenders and repair ships) – Continued.

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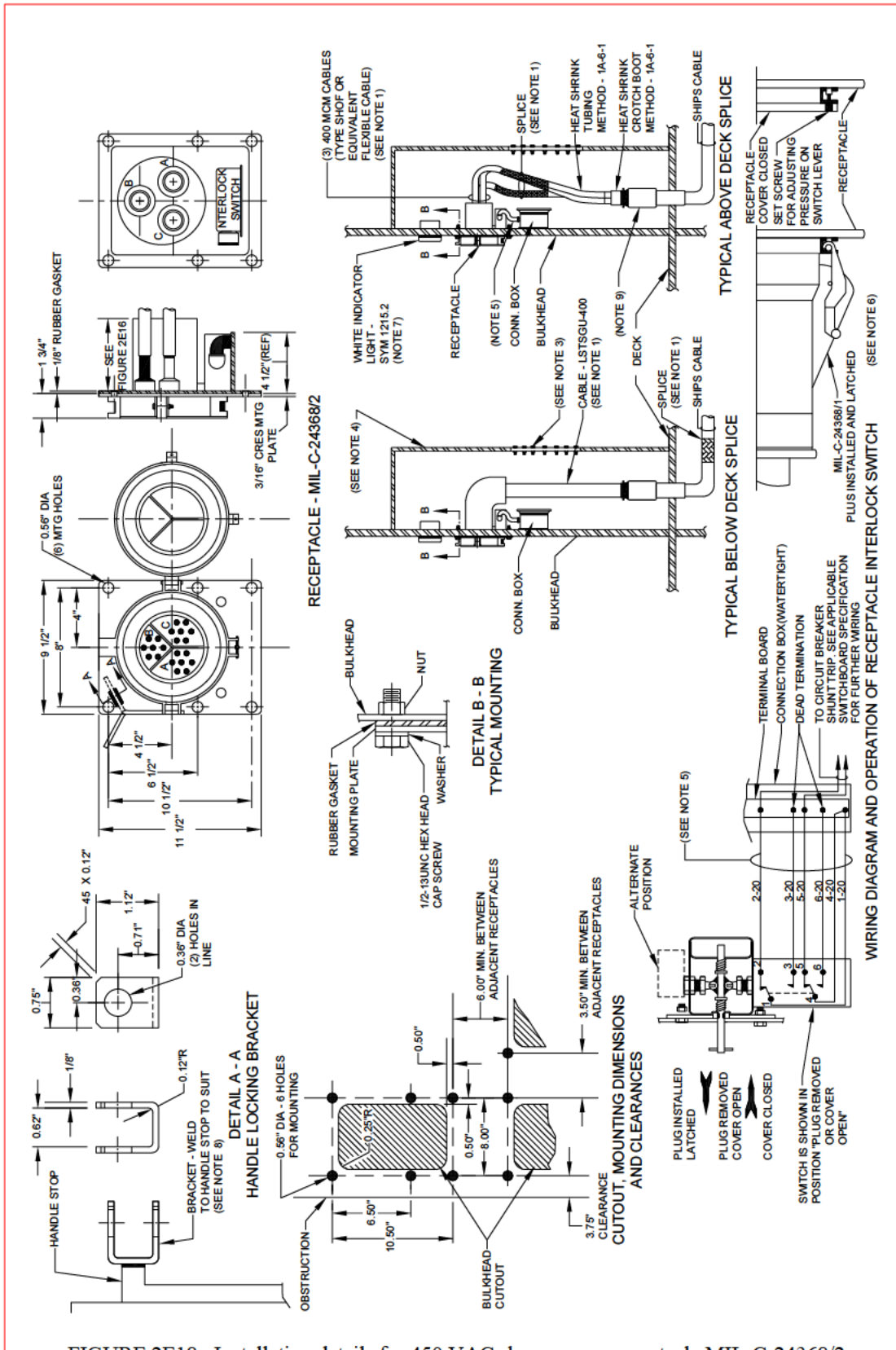


FIGURE 2E18. Installation details for 450 VAC shore power receptacle MIL-C-24368/2.

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NOTES:

1. Where receptacles are potted by a manufacturer to a short length of cable, splice shall be in accordance with MIL-STD-2003-1. For greater accessibility, splice may be located below deck. Ship's cable may be terminated and potted directly onto the receptacle as shown on [figure 2E16](#) by the installing activity. Where the receptacle pigtail is type SHOF-400 (or equal [see 4.8] flexible type cable), a reducing CCBC splice connector may be required to splice the receptacle pigtail to the existing ships cabling (typically type LSTSGU-400) to accommodate the different conductor diameters. See [table 2E18-I](#) for cable and connector information.
2. For suitable cable support, see MIL-STD-2003-4.
3. Access to terminal, boxes, and receptacles shall be provided.
4. Protective enclosure is required to provide protection and personnel safety and shall be of a tightness required per compartment location. Proper gasketing and drainage for condensation shall be provided for watertight enclosures.
5. Six no. 20 AWG wire leads, 36 inches long are provided with each switch marked with circuit identification and wire size (1-20, 2-20, etc.). Heat shrinkable tubing (in accordance with SAE-AS23053/4, class 2) shall be installed over the wire leads between the switch and connection box.
6. Opening of cover or unlatching of plug activates the shunt trip of circuit breaker, opening the breaker to "trip" position. Cover shall be closed or plug latched before circuit breaker can be closed.
7. See applicable switchboard specification for wiring of the indicator lights. The alternate connection of the indicator lights as shown in the applicable switchboard specification can be made when crimping the conductors at the cable splice. Flush mounting of indicator lights is preferred for greater protection (see detail "A", [figure 2E9](#)).
8. A handle locking bracket shall be installed when receptacles are furnished without brackets.
9. Deck or bulkhead cable penetrations shall be in accordance with MIL-STD-2003-3.
10. See 4.1.2 for mounting fastener requirements.

TABLE 2E18-I. Cable and connector information.

Mating cable types	Nominal cable conductor diameter	MIL-T-16366 CCBC connector no.	Reducing connector
LSTSGU-400	0.742	400	400 TO 500 reducer (Greaves PN ND 500R400 ^{1/} , or equal (see 4.8))
LSTHOF-400/LSSHOF-400	0.850	500	
NOTE:			
^{1/} For silver plating, specify when ordering.			

FIGURE 2E18. Installation details for 450 VAC shore power receptacle MIL-C-24368/2 – Continued.

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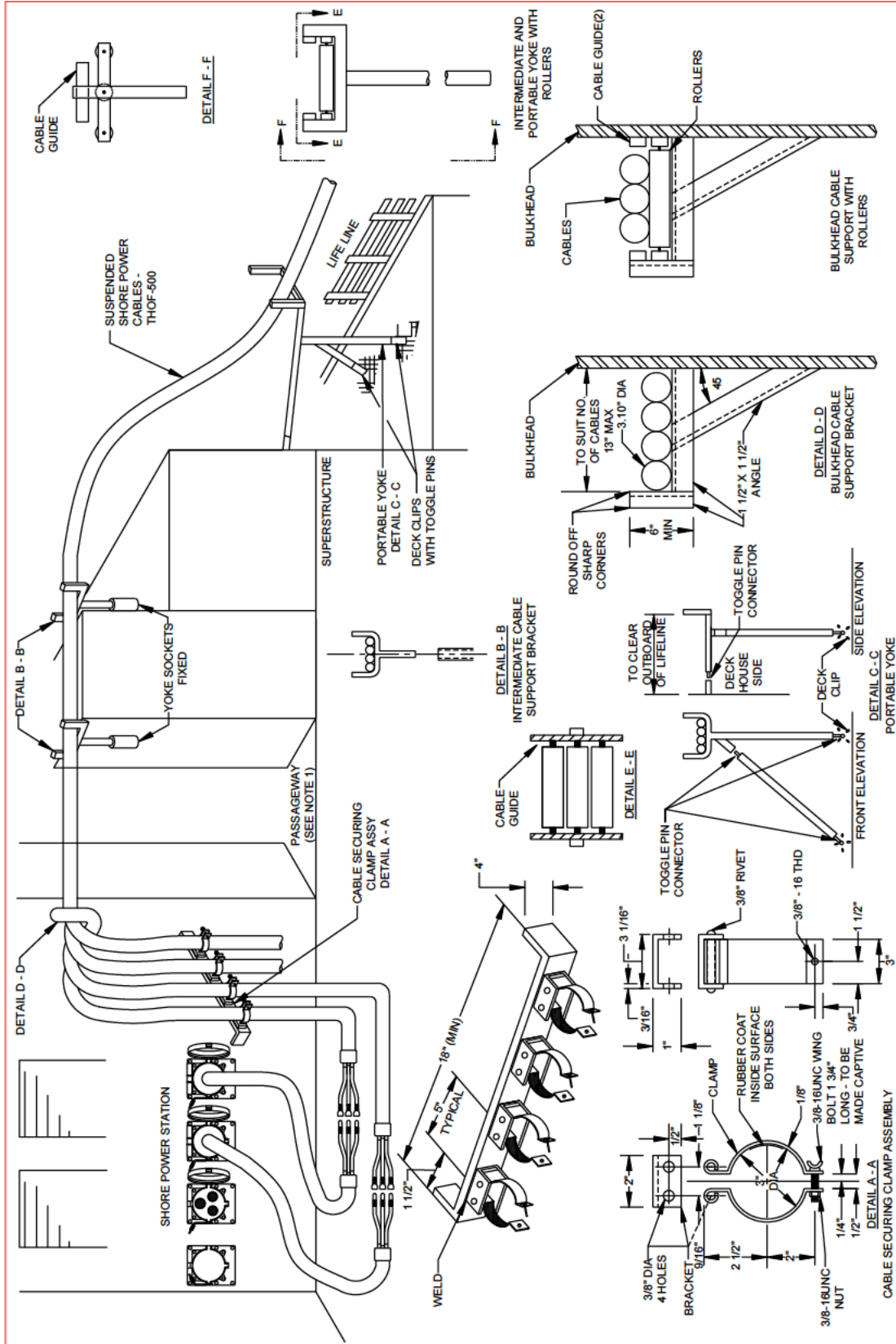


FIGURE 2E19. Typical 450 VAC shore power cable supports.

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NOTES:

1. The location of the 450 VAC shore power station shall be determined with respect to the lay of the portable 450 VAC shore power cables over the ship with due consideration given to securing of cables away from personnel traffic on deck.
2. Surface of cable contact to brackets shall be smooth to minimize cable damage.
3. A cable securing clamp assembly in accordance with detail "A-A" shall be installed on a suitable location to provide cable strain relief on the plugs.
4. Rollers may be added to the intermediate bulkhead and portable yokes to improve cable handling capabilities.
5. See 4.1.2 for mounting fastener requirements.

FIGURE 2E19. Typical 450 VAC shore power cable supports – Continued.

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CONCLUDING MATERIAL

Preparing activity:
Navy – SH
(Project SESS-2015-028)

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>.