WELDING AND ALLIED PROCESSES

1. SCOPE

1.1 Intent. This standard specification and appendices describe the general requirements for welding, fabrication, brazing, inspection, and associated processes on Coast Guard boats and cutters.

1.2 Appendices.

PROCESS STANDARD	APPENDIX
Welding and Inspection – Commercial Standards	A
Welding and Inspection –Military Standards	B
Structural Boundary Tests and Nondestructive Examination	C
Bimetallic Bonded Joint Welding Requirements	D
Stray Current Protection	E

1.3 Definitions. The following definitions are applicable to this document or referencing work items:

- **American Welding Society (AWS)**. Information concerning certification of welding inspectors, welders, and accredited test facilities for AWS welder certification is available on the World Wide Web internet at http://www.aws.org.
- **Approved (approval)**. Approval refers to when the American Welding Society (AWS), American Bureau of Shipping (ABS), United States Coast Guard or authorized representatives have accepted the item under consideration.
- **Applicable data sheets**. Refers to welding process data sheets or welding procedure specifications approved by ABS, Mechanical Contractors Association of America National Certified Pipe Welding Bureau (NCPWB) established welding regulatory code or their authorized representative.
- **Authorized representative**. Authorized representative is any representative specifically authorized to approve equipment, material, or procedures for the referenced regulatory agency.
- **Brazer**. A person who performs manual or semiautomatic brazing. In this specification, any reference to a brazer is also applicable to a brazing operator.
- **Critical welds**. Critical welds include welds on primary structure (including hull plate, tank tops, structural decks and bulkheads, transverse frames), watertight closures on the bulkhead deck and below, load bearing members, life-saving equipment, weight handling equipment, tank and void boundaries, pressurized vessels (including piping, tubing and fittings), machinery that transmit thrust or torque, foundations, propulsion shafting, propellers, water jets, special purpose (including flight deck, buoy deck), special materials (including high yield, monel), and ordnance.
- **Certified**. The term “certified” indicates that there is written proof of qualification.
- **Continuity**. Documentation for each welder that their certification has been properly maintained in accordance with the appropriate welding code or military standard.
- **Corrugated plate**. Plate with a repetitive pattern utilizing bends in the plate as stiffeners, usually used in structural bulkheads.

- **Flat plate**. A flat plate is considered as any plate that does not require pre-forming before installation.
- **Government inspector**. Government inspector is a Government official who is charged with the responsibility for assuring that the materials, processes, fabrication techniques, inspections, tests, and testing personnel meet specification and contractual requirements. In this regard, they must be the COR or delegated representative.
- **Nondestructive Examination (NDE)**. The act of determining the suitability of a material or a component for its intended purpose using techniques not affecting its serviceability. NDE is the standard term used by AWS. Nondestructive inspection (NDI), nondestructive testing (NDT), and nondestructive evaluation are interchangeable terms for NDE.
- **Procedure qualification**. The demonstration that the use of prescribed joining processes, materials, and techniques will result in a joint exhibiting specified soundness and mechanical properties, and evaluated either by destructive or nondestructive tests or both.
- **Procedure qualification record (PQR)**. A document providing the required process variables for a specific application to assure repeatability by properly trained welders, brazers, or solderers.
- **Qualified**. The term "qualified" means that the item under consideration has been approved as required by the applicable regulatory agency or authorized representative.
- **Qualifier**. The qualifier is an individual or test facility designated by the applicable welding regulatory agency or contractor as responsible for conducting, supervising and accepting welder qualification testing. The qualifier must be certified by the regulatory agency as a Certified Weld Inspector (CWI) or at a minimum be a competent individual meeting all the education and experience requirements of a CWI as defined by AWS QC1.
- **Shaped plate**. A shaped plate is a plate that requires mechanical or other manipulation to pre-form the shape prior to the installation procedure.
- **Shell plate**. A shell plate is a plate forming the outer skin of the hull.
- **Sheet metal**. A sheet metal is any material identified by the Manufacturers' Standard Gage for Sheet Steel, at a weight of 41.82 pounds per square foot per inch of thickness (e.g., 5.23 pounds per square foot per 1/8 inch of thickness) whose thicknesses are below 1/4 inch.
- **Solderer**. A person who performs manual or semiautomatic soldering. In this specification, any reference to a solderer is also applicable to a soldering operator.
- **Welder**. A person who performs manual or semiautomatic welding. In this specification, any reference to a welder is also applicable to a welding operator.
- **Welding operator**. A person who operates adaptive control, automatic, mechanized, or robotic welding (also brazing and soldering) equipment.
- **Welding Procedure Specification (WPS)**. A document providing the required welding variables for a specific application to assure repeatability by properly trained welders and welding operators. Brazing procedure specifications (BPS) and soldering procedure specifications (SPS) are similarly defined.

2. REFERENCES

COAST GUARD DRAWINGS

None

COAST GUARD PUBLICATIONS

Surface Forces Logistics Center Standard Specification 0450 (SFLC Std Spec 0450), Latest Edition, Electrical Power for Contractor's Tools & Equipment

Surface Forces Logistics Center Standard Specification 5000 (SFLC Std Spec 5000), Latest Edition Auxiliary Machine Systems

Surface Forces Logistics Center Standard Specification 6310 (SFLC Std Spec 6310), Latest Edition, Requirements for Preservation of Ship Structures

OTHER REFERENCES

American Bureau of Shipping (ABS), 2011, Guide for Nondestructive Inspection of Hull Welds

American Society for Nondestructive Testing (ASNT) SNT-TC-1A, 2011, Recommended Practice for Nondestructive Testing Personnel Qualification and Certification

American Society for Nondestructive Testing (ASNT) CP-189-2011, ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

ASTM Internationals (ASTM) E94, 2010, Standard Guide for Radiographic Examination

ASTM Internationals (ASTM) E114, 2010, Standard Practice for Ultrasonic Pulse-Echo Straight-Beam Contact Testing

ASTM Internationals (ASTM) E164, 2013, Standard Practice for Contact Ultrasonic Testing of Weldments

ASTM Internationals (ASTM) E165, 2012, Standard Practice for Liquid Penetrant Examination for General Industry

ASTM Internationals (ASTM) E587, 2010, Standard Practice for Ultrasonic Angle-Beam Contact Testing

ASTM Internationals (ASTM) E709, 2014, Standard Guide for Magnetic Particle Testing

ASTM International (ASTM) E797, 2010, Standard Practice for Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact Method

ASTM Internationals (ASTM) E1417, 2013, Standard Practice for Liquid Penetrant Testing

ASTM Internationals (ASTM) E1444, 2012, Standard Practice for Magnetic Particle Testing

ASTM Internationals (ASTM) F1076, Reapproved 2004, Standard Practice for Expanded Welded and Silver Brazed Socket Joints for Pipe and Tube

ASTM Internationals (ASTM) G46, 1994, Standard Guide for Examination and Evaluation of Pitting Corrosion

American Society of Mechanical Engineers (ASME) B31, 2012, Power Piping

American Society of Mechanical Engineers (ASME) B31.5, 2013, Refrigeration Piping and Heat Transfer Components

American Society of Mechanical Engineers (ASME) Section V, 2013, Nondestructive Examination

American Society of Mechanical Engineers (ASME), Section IX, 2013, Welding, Brazing, and Fusion Qualifications

American Welding Society (AWS) A2.4, 2007, Standard Symbols for Welding, Brazing, and

Nondestructive Examination

American Welding Society (AWS) A3.0, 2010, Standard Welding Terms and Definitions

American Welding Society (AWS) A5.8M/A5.8, 2011, Specification for Filler Metals for Brazing and Braze Welding

American Welding Society (AWS) A5.12/A5.12M, 2009, Specification for Tungsten and Oxide Dispersed Tungsten Electrodes for Arc Welding and Cutting

American Welding Society (AWS) B1.10M/B1.10, 2009, Guide for Nondestructive Examination of Welds

American Welding Society (AWS) B1.11, 2000, Guide for the Visual Examination of Welds

American Welding Society (AWS) B2.1/B2.1M:2014, Specification for Welding Procedure and Performance Qualification

American Welding Society (AWS) B2.2/B2.2M:2010, Specification for Brazing Procedure and Performance Qualification

American Welding Society (AWS) B2.3/B2.3M:2012, Specification for Soldering Procedure and Performance Qualification

American Welding Society (AWS) B4.0: 2007, Standard Methods for Mechanical Testing of Welds

American Welding Society (AWS) B4.0M:2000 (R2010), Standard Methods for Mechanical Testing of Welds (Metric Customary Units)

American Welding Society (AWS) D1.1/D1.1M, 2010, Structural Welding Code - Steel

American Welding Society (AWS) D1.2/D1.2M, 2008, Structural Welding Code – Aluminum

American Welding Society (AWS) D1.3/D1.3M:2008, Structural Welding Code – Sheet Steel

American Welding Society (AWS) D1.6/D1.6M:2007, Structural Welding Code – Stainless Steel

American Welding Society (AWS) D1.9/D1.9M: 2007, Structural Welding Code - Titanium

American Welding Society (AWS) D3.5:1993 (R2000), Guide for Steel Hull Welding

American Welding Society (AWS) D3.6M:2010, Underwater Welding Code

American Welding Society (AWS) D3.7, 2004, Guide for Aluminum Hull Welding

American Welding Society (AWS) D9.1M/D9.1:2012, Sheet Metal Welding Code

American Welding Society (AWS) D10.12M/D10.12, 2000, Guide for Welding Mild Steel Pipe

American Welding Society (AWS) QC1, 2007, Standard for AWS Certification of Welding Inspectors

American Welding Society (AWS) QC7, 1995, Standard for AWS Certified Welders

Federal Specification (Fed Spec) BB-C-101, Jan 2004, Carbon Dioxide (CO2): Technical and USP

Federal Specification (Fed Spec) QQ-B-654, Feb 1991, Brazing Alloys, Silver

Federal Specification (Fed Spec) BB-H-1168, Jul 2006, Helium, Technical

MIL-STD-22, Mar 1991, Welded Joint Design

MIL-STD-777, Jul 2002, Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships

MIL-STD-1627, Sep 1994, Bending of Pipe or Tube for Ship Piping Systems

MIL-STD-1688A (SH), Dec 1990, Fabrication, Welding and Inspection of HY80/100 Submarine Applications

MIL-STD-1689A, Nov 1990, Fabrication, Welding, and Inspection of Ships Structure

MIL-STD-2191 (SH), Nov 1992, Repair Welding, Weld Cladding, Straightening, and Cold Rolling of Main Propulsion Shafting

MIL-STD-2035, May 1995, Nondestructive Testing Acceptance Criteria

MIL-A-18455, Jun 1991, Argon, Technical

National Fire Protection Association (NFPA) 70, 2011, National Electrical Code (NEC)

National Aerospace Standard (NAS), 410, Nondestructive Testing Personnel Qualification and Certification, Revision 3, March 2008.

Naval Sea Systems Command (NAVSEA) 0900-LP-001-7000, May 1979, Fabrication and Inspection of Brazed Piping Systems

Naval Sea Systems Command (NAVSEA) 0900-LP-060-4010, Jan 1971, Fabrication, Welding and Inspection of Metal Boat and Craft Hulls

Naval Sea Systems Command (NAVSEA) S0300-BB-MAN-010, Jun 2002, US Navy Underwater Cutting & Welding Manual

Naval Sea Systems Command (NAVSEA) S9074-AQ-GIB-010/248, Aug 1995, Requirements for Welding and Brazing Procedure and Performance Qualification

Naval Sea Systems Command (NAVSEA) S9074-AR-GIB-010/278, Aug 1995, Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels

Naval Sea Systems Command (NAVSEA) T9074-AS-GIB-010/271, Feb 1999, Requirements for Nondestructive Testing Methods

Naval Sea Systems Command (NAVSEA) T9074-BD-GIB-010/0300, Aug 2002, Base Materials for Critical Applications: Requirements for Low Alloy Steel Plate, Forgings, Castings, Shapes, Bars, and Heads of HY-80/100/130 and HSLA-80/100

The Society for Protective Coatings (SSPC), 01 June 1996, Paint Application Specification No. 2 (PA-2), Measurement of Dry Coating Thickness with Magnetic Gages

3. REQUIREMENTS

3.1 General. The Contractor must perform all welding on cutters and boats, including any associated system, equipment or part, whether permanently attached or not, using certified welders and approved welding procedure specifications.

3.1.1 Any requirement for certified welders and welding procedure specifications (WPS) is also applicable to certified brazers and solders and to brazing and soldering procedure specifications (BPS and SPS).

3.1.2 Compliance. The Contractor must select a welding code or military welding standard and adhere to all requirements of the selected document for each welding procedure specification, as well as the requirements of this standard specification and applicable appendices. The Contractor may select different regulating codes for different weld procedures; however, all documentation, welding and welder requirements for each procedure (for example, the WPS, the Procedure Qualification Records (PQRs) and the welder qualification and testing of the welds) must follow the same code.

3.1.3 Welding documentation. The Contractor must provide to the KO copies of the following information for all intended work to be performed:

- All welding procedure specifications (WPS) applicable to the solicitation, along with a

summary list and current revision dates.

- Welder certification documentation, including at a minimum welder name and WPS(s) certified to perform.
- Welder continuity documentation which provides proof of proper certification maintenance. The Contractor must ensure welder certifications are maintained to the applicable code.
- Supporting PQRs if requested by the KO.

NOTE

Continuity periodicity for welder certification is dictated by commercial welding codes and military welding standards.

3.1.4 Stray current protection. The Contractor must meet all requirements for stray current protection as specified in Appendix E - Stray Current Protection.

3.1.4.1 Grounds. The Contractor must meet all requirements for electrical power of Contractor's tools and equipment in accordance with Appendix E below and SFLC Std Spec 0450 while the ship is waterborne at any facility to protect the hull from electrolysis and the ship's force from injury.

3.1.4.2 Electronic equipment protection. The Contractor must work with the COR to safeguard electronic equipment before welding to prevent damage from stray current and electromagnetic interference. Electrically isolate or disconnect ungrounded or sensitive equipment as necessary. Welding ground connections must be made as close to the work area as possible, but no further than 10 feet away.

3.2 Advance notice. The Contractor must provide the COR with 24 hours advance written notice of all work planned including the welding procedures to be used.

3.3 Joints. The Contractor must ensure the following:

3.3.1 Dimensions. Joint design and fit-up dimensions are in accordance with the applicable drawings, work item, welding code or requirements of MIL-STD-22.

3.3.2 Welding nomenclature and symbols. Welding terms, definitions, and symbols must be interpreted in accordance with AWS A2.4 and AWS A3.0.

3.4 Welding in Way of Wetted Surfaces. The contractor must not, under any circumstances, weld on any member where water, oil, or other similar liquid is in direct contact with the surface opposite the side to be welded, or when there is less than 3 inches of base material between the weld area and the side in contact with the liquid.

3.5 Fairness. Permissible unfairness in steel and welded structures, including hull insert plates, must be in accordance with Section 12.3, Alignment and Fairness, of MIL-STD-1689A.

CAUTION

Contractors are encouraged to develop thorough plans for renewal of hull plate and supporting structure. Inappropriate reductions in structural member height and poor fit-up of insert plates leads to warping the shell plate, bulkheads or framing, as well as waviness and distortions in excess of allowables. Any damage resulting from failure by the Contractor to meet alignment and fairness requirements must be repaired at the Contractor's expense.

3.6 Filler material restrictions. The Contractor must be aware that low ductility shielded metal arc welding electrodes, including AWS classification E6010, E6011, E6012, E6013, E7014 and E7024, are not approved for joints in any welds, including critical welds (see 1.3.6 (Critical welds)).

3.7 Temperature-indicating crayons. The Contractor must not use temperature crayons that contain elements such as lead, sulfur, zinc, cadmium, or mercury.

3.8 Process restrictions. The Contractor must not use gas metal-arc welding (GMAW) utilizing short circuiting arc transfer technique (the consumable electrode is deposited during repeated short circuits) for welds in ship structure above 0.25-inch material thickness, unless the process and application are specifically approved by the KO.

3.9 Surface preparation. Contractor must clean to bare metal all surfaces out to one inch on both sides of the weld joint to remove all foreign materials, unless otherwise directed by the work item or appendix. Scale and metallic oxides must be removed from surfaces on which weld metal is to be deposited.

3.10 Nondestructive evaluation (NDE). When inspecting welds using any NDE method, such as visual inspection (VT), liquid penetrant inspection (PT), or magnetic particle inspection (MT); the Contractor must ensure that the weld surface condition be in accordance with appropriate NDE standard. Inspection must be in the final surface condition. Inspection of repairs to base materials or welds must be to the same requirements as the original base material or weld.

3.11 Surface preservation. The Contractor is responsible for creating the initial anchor profile on all newly installed metal plates, pipes, weld seams, and metal surfaces, as required by SFLC Std Spec 6310. The Contractor must prepare and touch-up coat all new and disturbed surfaces to match existing adjacent surfaces, in accordance with SFLC Std Spec 6310, paragraph 3.1.13 (Touch-ups and minor coating repairs).

3.12 Repair of holes. The Contractor may repair holes by welding closed, provided the original hole diameter follows these limits for different plating thicknesses. For up to and including 1/4 inch plate, hole diameter must not exceed 5/8 inch. For greater than 1/4 inch plate to 5/8 inch plate, hole diameter must not exceed 1 inch. For greater than 5/8 inch plating, hole diameter must not exceed 1.5 inch. For repair, the original hole diameter should be opened up to a minimum diameter equal to the plating thickness. The opening must be shaped to 20 degrees minimum included angle before welding. Holes that are prohibited from welding repair in accordance with this paragraph must be repaired by expanding the hole size for an insert with a minimum diameter of 6 inches.

3.13 Evaluation of Pitting Corrosion. The Contractor must measure (via pit gage or similar equipment), evaluate, and record pitting in accordance with ASTM G46. The evaluation and recording must include ratings of density, size and depth in accordance with ASTM G46 and include hull location. A Condition Found Report (CFR) must be submitted.

3.14 Zinc coatings. The Contractor must remove metallic zinc from all joint surfaces on which welds are to be deposited and for a distance which will be at least 1 inch from the edges of the finished welds. The localized heating technique must not be used for removing zinc coatings from HY-80/100/130, STS or similar chemistry, or quenched and tempered low alloy high strength materials.

3.15 Requirements for High Yield (HY) materials HY-80, HY-100, HY-130, and high-hardenable materials. The Contractor must not use oxyfuel gas gouging for HY-80, HY-100, HY-130, and high-hardenable materials. Torch heating for HY-80, HY-100, HY-130, and high-hardenable material must be confined to tack or temporary welding or to those applications involving welding within a localized area.

When torch heating is used for welding operations other than for tack welding, the base material must slowly be brought up to preheat temperature with sufficient time allowed for heat to penetrate the thickness of the parts being welded. The heated area should extend approximately 6 inches beyond the weld site directions. When torches are used for low temperature (60°F to 125°F) preheating, maintain metal temperature above ambient temperature for a few minutes before welding in order to minimize condensate caused by the flame.

3.15.1 HY-130 material substitution. The Contractor must be aware that HY-130 steel plating is no longer commercially available. For the purpose of performing flight deck repairs on US Coast Guard WMEC-270 "B-Class" cutters, Weldox 900 steel has been approved as a replacement for HY-130. Due to the similarity in material properties and weldability of HY-130 and Weldox 900, all welding procedures and welder qualifications for welding Weldox 900 must be the same as those outlined in MIL-STD-1688A as applicable for welding HY-130.

3.15.2 Standard specification modification. For any welding involving HY-130 on the flight deck of WMEC-270 "B-Class" cutters, perform all welding and allied processes, and non-destructive evaluation (NDE) in accordance with MIL-STD-1688A.

3.15.3 Approval to weld HY-130. To obtain Coast Guard approval to weld on HY-130 steel for WMEC-270 "B-Class" cutters, the Contractor must provide written Performance Qualification Records (PQR's) for each process to be used. The PQR's must be approved by one of the regulatory agencies affirming that the WPS meets the welding requirements of MIL-STD-1688A. In addition, the Contractor must ensure that all subcontractors, prior to performing welding operations, have qualified procedures by meeting all the requirements set forth in this document.

NOTE

NAVSEA approval is NOT required for welding procedures submitted but the procedures must be reviewed and shown to satisfy the requirements set forth in MIL-STD-1688A, by a welding regulatory agency. The requirements for welding Weldox 900 are considered the same as those for welding HY-130.

3.16 Welded enclosure installation. Prior to welded installation, all watertight and weathertight doors, hatches, and scuttles must be inspected by the Contractor to ensure the item is in proper working order and is not warped. A chalk test must be performed and all latches, fittings, and mechanisms must be operated to determine functional soundness. A separate CFR must be submitted for each enclosure. Where a scuttle is fitted to a hatch, one CFR may be submitted for the assembly but it must detail the results of both. Following installation, repeat the pre-installation inspection and chalk test to ensure the enclosure was not altered or damaged during installation. Submit a CFR, one for each enclosure, detailing the results of the post-installation inspection.

3.17 Fuel/ water stops. For new or replaced structural members that penetrate tanks that contain liquids, the Contractor must install fuel/water stops within 12 inches of the tank bulkhead on the outside of the tank.

3.18 Cut edges. The Contractor must ensure that cut edges of plate do not have gouges or irregularities unsuitable for welding. These edges must be made free of slag scale by mechanical means before welding.

3.19 Tack welds. The Contractor must ensure that tack welds are of the same grade electrode as root and final pass. Tack welds must not interfere with the smooth completion of the final weld, and do not need to be removed provided they are thoroughly cleaned before final welding and found free of defects.

3.20 Peening of welds. The Contractor must ensure that peening is not performed on single-pass welds, nor on the root or final pass of multi-pass welds. When required, peening must be performed immediately after depositing and cleaning each pass of filler metal.

3.21 Welding arc marks. The Contractor must ensure that striking an arc on any principle hull or deck plate is prohibited unless the arc site is to be incorporated into a welded joint. Marks left by an accidental arc strike must be ground smooth without reduction to surrounding plate thickness.

3.22 Documentation. The Contractor must submit to the COR, within 24 hours after completing the repair work, a written report in accordance with quality assurance requirements of the applicable appendix. For welding accomplished in accordance with Appendix A, adhere to quality assurance requirements of Appendix C. For welding accomplished in accordance with Appendix B, adhere to quality assurance requirements of the applicable military document.

APPENDIX A

WELDING AND INSPECTION COMMERCIAL STANDARDS

A1. SCOPE

A1.1 Intent. This appendix contains the general requirements for welding, fabrication, brazing, inspection, and associated processes on Coast Guard vessels and equipment in accordance with commercial practices of AWS, ASME and ASTM.

A2. REQUIREMENTS

A2.1 General.

A2.1.1 Code selection. The Contractor must select a commercial welding code and follow all requirements of the selected code for each WPS.

A2.1.2 Mixing of code requirements. The Contractor may select different regulating codes for different weld procedures; however, all associated documentation, welding and welder requirements for each procedure (e.g., the WPS, the PQR and the welder qualification and testing of the welds) must follow the same code.

A2.1.3 Code compliance. The Contractor must be aware that the Coast Guard maintains the right to review all documentation and welder performance to ensure code compliance. For contractor developed welding processes following a self-regulating code (e.g., AWS or ASME), the Coast Guard will make the final decision on code compliance.

A2.1.4 ABS documentation. When ABS approved welding procedure specifications and welder certifications are to be used, the Contractor must ensure that all documents are approved by the ABS Technical Office (located in Houston), or other ABS subject matter expert authorized by the ABS Technical Office. Be aware that the Coast Guard reserves the right for final approval of ABS approved documents.

A2.2 Welding procedures.

A2.2.1 Welding procedure specification. The Contractor must have written welding procedures that comply with their quality program for special processes and the requirements of the applicable regulatory agency code. Commercial welding codes offer sample welding forms that are industry accepted for documentation of welding processes and procedures in AWS D1.1, AWS D1.2 and ASME Section IX. The regulating code must be identified on each WPS. The format of the welding procedure specification, specification test record, procedure qualification record, welder qualification test record, and nondestructive inspection of weld documents are Contractor's choice, but must delineate all of the essential elements and guidance required to produce and inspect acceptable welds.

A2.2.2 Prequalified welding procedures. Welding procedures developed as AWS "Prequalified Welding Procedure Specifications" are authorized without procedure qualification only if prepared and approved by a welding engineering, AWS CWI, or AWS SCWI, except as amended by 3.6 (Filler material restrictions), 3.8 (Process restrictions), and all other applicable sections of this document. These AWS "PreQualified" processes must not be used on critical welds unless tested in accordance with the code.

A2.2.3 Standard weld procedures. Welding procedures developed and identified by AWS as "Standard Welding Procedures" are authorized without procedure re-qualification, except as amended by 3.6 (Filler material restrictions), 3.8 (Process restrictions), and all other applicable sections of this document.

A2.2.4 Welding filler materials. Filler materials must meet the requirements of the applicable specification essential elements. See 3.6 (Filler material restrictions) for additional limitations.

A2.3 High strength steels. Where applicable drawings specify high strength (HSS), high tensile (HTS), special treatment steel (STS), high strength low allow (HSLA), or in particular high yield (HY) material used in hull plate, structural members attached to the hull or weight handling equipment, the welding procedure specification must be specifically approved by the regulatory agency for the intended application and accepted by the government inspector prior to production welding.

A2.4 Underwater welding. Contractor must perform underwater welding and cutting in accordance with AWS D3.6.

A2.5 Welder qualification. The Contractor must ensure that all welding is accomplished by trained welders who have been certified by the applicable regulatory code performance qualification procedures. Performance qualification procedures may be in accordance with AWS or ASME, except as noted. Additionally, welders may be certified by a second tier agency, such as the Mechanical Contractors Association of America NCPWB, if such agency maintains uniform processes, and welding procedures which conform to ASME Boiler and Pressure Vessel Code Section IX, the ASME B31 Codes for Pressure Piping, or American Welding Society standards. Contractor continuity records must document the welder has been actively welding using a process in accordance with the applicable regulatory code.

A2.5.1 Method of establishing qualification. The Contractor must ensure that each welder has satisfactorily completed a performance qualification test for the welds they are to perform. Performance qualification must require completion of a standard test weldment in accordance with a qualified weld procedure, as well as evaluation and acceptance of the test weldment in accordance with applicable regulatory code. The following restrictions apply to welder performance qualification:

A2.5.1.1 Standard test weldments must be in accordance with all requirements of a qualified weld procedure. The welder is not allowed to make exception to any of the essential variables for welders.

A2.5.1.2 Qualification by workmanship test is not authorized. Workmanship weldments are normally accepted or rejected on the basis of visual examination without radiography, bend test, bend-break test or macro-examination. This process does not provide acceptable evaluation of welder performance.

A2.5.1.3 Qualification of multiple welders or welding operators on one test weldment is not authorized.

A2.5.2 Qualification by standard test is authorized on a production weld where the governing agency examination requirements permit the use of radiography in lieu of bend tests. The production weldment must be evaluated and accepted by radiography in accordance with applicable regulatory code and requirements of this document.

A2.5.3 Welding qualifier. The welding qualifier must meet the requirements of paragraph 1.3.16 (Qualifier).

NOTE

Depending upon the chosen commercial regulatory code and welding/brazing process, the documentation of continuous qualifications ranges from monthly to several years.

A2.6 Brazing requirements.

A2.6.1 Joint design. Brazed joints must be of the socket or sleeve type. The sleeve type fittings must be used only where restriction prevents the use of socket type fittings for final closure joints. Fitting dimensions must be as shown on approved drawings. Fittings for pipes and tubings larger than 0.840" O.D. must be of the type having pre-inserted rings of brazing alloy. Except in applications listed below, face-fed type fittings must not be used without specific approval of the COR.

- Joints in freon (halocarbon) refrigerant systems.
- Joints for voice tube and pneumatic tube systems.
- Joints for bellmouth to pipe for tailpipes within tanks.
- Face-fed fittings must not be used in other applications without specific approval of the COR.

A2.6.2 Brazing filler materials. The filler metals used in brazing must conform to the requirements of ASTM F1076, Section 5, or AWS 5.8 Filler Metals Specification. Filler metals must be limited to Fed Spec QQ-B-654 Grades III, IV, V and VIII. Filler metal conforming to Fed Spec QQ-B-654 Grade III must be limited to joining copper and copper based alloys.

A2.6.3 Assembly. Assembly of joints must be in accordance with ASTM F1076.

A2.6.4 Cleaning joint after brazing. Upon completion of brazing and cooling, remove excess flux and scale from the external surfaces of the brazed joint by either washing with water or wire brushing. No filing or grinding is allowed on any portion of the joint or adjacent piping except when required for preparation of surfaces for ultrasonic inspection.

A2.6.5 Cleaning and flushing. After cooling and prior to performance of pressure or leak testing, completed piping systems must be cleaned and flushed to the extent necessary to ensure satisfactory operation of the system and components in service. Special cleaning, when required, must be in accordance with specified requirements in the shipbuilding, overhaul, or component specification.

A2.6.6 Repair of joints.

A2.6.6.1 General repair process. The brazing alloy used in the repair must be the same grade as used in brazing the joint. The joint area at the face of the fitting must be re-fluxed before heating for repair brazing. All repaired joints and adjacent joints where re-flowing of the brazing alloy has occurred must be subjected to the same nondestructive tests as required for the original joint. A total of only two repair attempts are permitted on a single joint. When repairs cannot be affected after two repair attempts, the joint must be disassembled and re-brazed.

A2.6.6.2 Repairs to improve bond or align fitting. Repairs to improve percentage of bond or align a fitting may be made by re-heating and re-flowing the alloy in the joint. Joints may be repaired by rotating, adding additional flux and/or supplemental face feeding and filleting. This method is applicable to newly fabricated joints or joints which have been exposed to fresh water, cleaning solutions, refrigerant or nitrogen. No more than two repair attempts must be made.

A2.6.6.3 Repair to fix leaks or weeps. Leaks or weeps may be repaired by re-heating to re-flow the alloy in the joint and/or supplemental face feeding and filleting. This method is applicable to newly fabricated joints or joints which have been in service regardless of the fluid which the system conveyed. No more than two repair attempts must be made.

A2.6.7 Re-use of fittings and pipe.

A2.6.7.1 Re-use of fittings. Fittings may be re-used subject to the limitations of ASTM F1076 and NAVSEA 0900-LP-001-7000.

A2.6.7.2 Re-use of pipe. Unless otherwise specified, pipe may be re-used without inspection. Copper-nickel alloy pipe, intended for re-use must be inspected as follows. After sizing, liquid penetrant inspect or visually inspect at 5X magnification entire periphery of pipe for length of 2D (nominal) or 2 inches (whichever is less) plus the socket depth. Cracked pipe or tubing must not be used. If the previously brazed pipe is cut back for a distance of 2D (nominal) or 2” (whichever is less) plus the socket depth, this additional inspection is not required..

A2.6.8 Brazed joint restrictions. All heating for torch brazing must be accomplished with an oxyfuel gas. No brazing must be performed on non-ferrous piping greater than 4 inches NPS or on piping systems with wall thicknesses of 0.250 inch or greater without written Coast Guard Naval engineering approval.

A2.7 Quality assurance. Inspection of all joints must be performed by nondestructive methods such as radiographic, ultrasonic, magnetic particle, or liquid penetrant inspection in accordance with requirements of appendix C.

APPENDIX B

WELDING AND INSPECTION MILITARY STANDARDS

B1. SCOPE

B1.1 Intent. This appendix contains the general requirements for welding, fabrication, brazing, inspection, and associated processes on Coast Guard vessels and equipment in accordance with NAVSEA S9074-AR-GIB-010/278, MIL-STD-1689A, NAVSEA 0900-LP-001-7000, and NAVSEA 0900-LP-060-4010.

B2. REQUIREMENTS

B2.1 General.

B2.1.1 Machinery, piping and pressure vessels. Welding and inspection for machinery, piping, pressure vessels and components must comply with the requirements of NAVSEA S9074-AR-GIB-010/278 technical document except as amended by this appendix.

B2.1.2 Ship structure. Welding and inspection of ship structure must comply with the requirements of MIL-STD-1689A except as amended by this appendix.

B2.1.3 Boat structure. Fabrication, welding and inspection of boat structure must comply with the requirements of NAVSEA 0900-LP-060-4010, except as amended by this appendix.

B2.1.4 Piping systems. Brazing and inspection for piping systems must comply with the requirements of NAVSEA 0900-LP-001-7000 except as amended by this appendix.

B2.1.5 Responsibility. The Contractor must be responsible for submitting detailed welding procedures that comply with applicable NAVSEA technical document or military standard. In addition, the Contractor must ensure that all subcontractors have qualified procedures based on approved qualification data. Prior to production application of the welding procedures, the Contractor must obtain approval in accordance with welding procedure qualification requirements of NAVSEA S9074-AQ-GIB-010/248.

NOTE

Welding procedure approval in accordance with NAVSEA S9074-AQ-GIB-010/248 requires submittal of the welding procedure qualification test report to the authorized NAVSEA representative and submittal of the corresponding welding procedure to the authorized NAVSEA representative.

B2.1.6 Welding procedures. Welding procedure qualifications previously prepared for other Government agencies, AWS, ABS, ASME, or other established regulatory codes may be submitted for approval to the NAVSEA authorized representative in accordance with limitations of NAVSEA S9074-AQ-GIB-010/248.

B2.1.7 Welding nomenclature. All references to weld joint symbols must be interpreted in accordance with MIL-STD-22 and AWS A2.4. Welding nomenclature and definitions must be interpreted in accordance with AWS A3.0 and MIL-STD-1689A.

B2.1.8 Applicable materials.

B2.2 Base materials. Base materials must meet the requirements of the applicable material specification listed in NAVSEA S9074-AR-GIB-010/278, MIL-STD-777, or MIL-STD-1689A. The following material designators used in U.S. Coast Guard drawings and working documents are equivalent for selecting weld data sheets and filler materials.

TABLE B-1 - BASE MATERIALS DESIGNATORS

Ordinary Strength Steel	OSS
Carbon Steel, CS	OSS
Mild Steel	OSS
High Strength Steel	HSS
High Tensile Steel	HTS/HSS
High Yield Strength Steel	HY
High Strength Low Alloy Steel	HSLA
High Hardenable/Special Treatment Steel	STS

B2.2.1 Welding filler materials. Filler materials must meet the requirements of the applicable specification essential elements. See 3.6 (Filler material restrictions) for additional limitations on fillers in critical welds.

B2.2.2 Commercial filler specifications. Commercial filler materials for which there are no military specifications may be used when approved by the KO. Such materials must be procured to the designated specification and receipt inspected prior to use.

B2.2.3 Shielding gases and electrodes. Argon gas must conform to the requirements of MIL-A-18455. Helium gas must conform to the requirements of Fed Spec BB-H-1168, Grade A. Carbon dioxide gas must conform to the requirements of Fed Spec BB-C-101. Tungsten electrodes must conform to the requirements of AWS A5.12, EWTH-2, 2% thoriated.

B2.2.4 Brazing filler materials. The filler metals used in brazing must conform to the requirements of ASTM F1076, Section 5, or AWS A5.8 Filler Metals Specification. Filler metals must be limited to Fed Spec QQ-B-654 Grades III, IV, V and VIII. Filler metal conforming to Fed Spec QQ-B-654 Grade III must be limited to joining copper and copper based alloys.

B2.3 Welder qualification. All welder and weld operators must be trained and performance qualified in accordance with requirements of NAVSEA S9074-AQ-GIB-010/248. All brazing procedures, brazers, and brazing operators must be qualified in accordance with NAVEA 0900-LP-001-7000.

B2.4 Joint design and fit-up. Weld joint design and fit-up dimensions must be in accordance with the applicable drawings, specification requirements or the authorized joint design of MIL-STD-22. All brazed joint designs must be interpreted in accordance with NAVSEA 0900-LP-001-7000 except as detailed below.

B2.5 Brazed joint requirements. All new or replaced pipe and tube bends must conform to MIL-STD-1627, and brazed joints must be of the socket or sleeve types. The sleeve type fittings must be used only where restriction prevents the use of socket type fittings or for final closure joints. Fittings for pipes and tube larger than 0.840" O.D. must be of the type having pre-inserted rings of brazing alloy, except the following joints may be of the face-fed type.

- Joints in Freon (halocarbon) refrigerant systems.
- Joints for voice tube and pneumatic tube systems.
- Joints for bellmouth to pipe for tailpipes within tanks.
- Face-fed fittings must not be used in other applications without specific approval of the KO.

B2.5.1 Brazed joint restrictions. All heating for torch brazing must be accomplished with an oxyfuel gas. No brazing must be performed on non-ferrous piping greater than 4 inches NPS or on piping systems with wall thicknesses of 0.250 inch or greater without written Coast Guard Naval engineering approval.

B2.6 Joining requirements.

B2.6.1 Process restrictions. GMAW utilizing short circuiting arc transfer technique (the consumable electrode is deposited during repeated short circuits) must not be used for welds in surface ship structure, unless the process and application are specifically approved by the KO.

B2.6.2 Joint preparation. In addition to weld buildup to correct oversize root openings, weld buildup may be used on surfaces or edges of materials in way of penetrations or connections prior to making joint fit-up. In all cases involving welding to correct excessive root opening, the joint edges must not be joined until the oversize root opening is corrected to within the requirements of the applicable joint design.

B2.6.3 Joint efficiency. All welding must have a regular and uniform surface with a minimum of reinforcement and must be free from injurious defects, overlap, undercut, lack of penetration, cracks and porosity. Welds must be 100 percent efficient (full penetration) for shell plating, decks, bulkheads, supporting structures, floors and foundations. See Table XVII of MIL-STD-1689A for joint efficiency exceptions.

NOTE

When welding from both sides is required, the root of the first weld deposit must be chipped, ground or air-arc gouged to sound metal prior to welding the second side of the joint.

B2.6.4 Requirements for HY-80, HY-100, HY-130, and high-hardenable materials. The Contractor must perform all HY-80, HY-100, HY-130, and high-hardenable materials preheat and welding in accordance with MIL-STD-1689A, Section 13.5. See 3.14 (Requirements for HY-80, HY-100, HY-130 and high-hardenable materials) for additional limitations on oxyfuel gas gouging and touch heating.

B2.6.5 Removal of austenitic or nonferrous weld material. When it is necessary to make ferritic welds over areas that previously contained austenitic or nonferrous welds, ensure complete removal of the austenitic or nonferrous weld metal.

B2.6.6 Underwater repairs. Contractor must perform underwater welding and cutting in accordance with NAVSEA S0300-BB-MAN-010.

B2.7 Quality assurance.

B2.7.1 General. All inspections of ship structures must be performed in accordance with MIL-STD-1689A except as modified in this appendix. All inspections for boat structures must be performed in accordance with NAVSEA 0900-060-4010 except as modified in this appendix. All inspections of welded joints in machinery, piping and pressure vessels must be performed in accordance with NAVSEA S9074-AR-GIB-010/278 except as modified in this appendix. All inspections of brazed joints must be conducted in accordance with NAVSEA 0900-LP-001-7000 except as modified in this appendix.

B2.7.2 Qualification. Testing requirements for conducting NDE and qualification requirements for NDE personnel, procedures and NDE test equipment must be in accordance with NAVSEA T9074-AS-GIB-010/271. NDE personnel may also be qualified in accordance with NAS 410.

B2.7.3 Inspection requirements. Unless otherwise stated by NAVSEA S9074-AR-GIB-010/278, NAVSEA 0900-LP-001-7000, NAVSEA 0900-060-4010, or MIL-STD 1689A inspections must be performed in the final surface condition. Repairs to base materials or welds are to be inspected to the same requirements as the original base material or weld. Inspection must be made when the material or weld is accessible for inspection to the degree necessary to confirm the joint is acceptable.

B2.7.4 Underwater inspections must be in accordance with NAVSEA S0600-AA-PRO-070.

B2.7.5 Methods. All inspections must be as required within applicable specifications and must be accomplished in accordance with the following procedures. Unless otherwise specified all acceptance criteria must be in accordance with MIL-STD-1689A (Section 8) acceptance standards.

- Visual Inspection, NAVSEA T9074-AS-GIB-010/271
- Magnetic Particle Inspection (MT), ASTM E1444
- Liquid Penetrant Inspection (PT), ASTM E1417
- Radiographic Inspection (RT), NAVSEA T9074-AS-GIB-010/271
- Ultrasonic Inspection (UT), NAVSEA T9074-AS-GIB-010/271

B2.7.6 Visual inspection. As a minimum, all welds must be visually inspected. Welds requiring MT, PT, UT or RT must in addition be visually inspected prior to final acceptance.

B2.7.7 MT inspection.

B2.7.7.1 General. Inspection must be conducted in accordance with ASTM E1444. PT inspection may be substituted for MT where MT is impractical.

B2.7.7.2 Final inspection. Final inspection of ferritic material must be performed after all required machining or grinding has been completed, or may be performed prior to final machining when the inspected surface is within 1/32 inch of the final surface and the MT DC continuous method is used.

B2.7.7.3 MT inspection exceptions. MT inspection is not required for backgouged roots. Additionally, MT inspection is not required for arc strike removal site, fabrication scars, nicks or gouges prior to repair welding.

B2.7.8 PT inspection.

B2.7.8.1 Weight handling equipment. PT inspection must be performed on all completed welds deposited with austenitic or nonferrous electrodes in weight-handling fittings or fixtures supporting over 1 ton, unless the fitting or fixture is proof load tested after installation. Overlay or clad welding deposited on primary hull structure with austenitic or nonferrous weld metal for corrosion-resistance applications must be PT inspected.

B2.7.8.2 PT inspection exception. PT inspection is not required for clad welds used for wear-resistant applications.

B2.8 Report. The Contractor must document all weld inspections in accordance with welding surveillance inspection requirements of the applicable welding specification. All records of inspections must be submitted to the COR, within 24 hours after completing the welding work.

APPENDIX C

STRUCTURAL BOUNDARY TESTS AND NONDESTRUCTIVE EXAMINATION

C1. SCOPE

C1.1 Intent. This appendix describes the requirements for structural boundary testing and nondestructive examination, on Coast Guard vessels and equipment.

C2. REQUIREMENTS

C2.1 The Contractor must ensure that all testing equipment is current with respect to calibration. Documentation of calibrations must be provided to the KO upon request.

C2.2 Structural boundary testing.

C2.2.1 Air test.

C2.2.1.1 Precaution. The Contractor must place a sign on each access of the space to be tested that clearly states the following phrases in upper case letters: "**DANGER, DO NOT ENTER, AIR TESTING IN PROGRESS**". See C3.1 (Notices).

C2.2.1.2 Set-up. Install the following at the test connection:

- One vent valve.
- Two relief valves arranged in parallel and set at 15 percent above test pressure.
- Two independent pressure gauges, each with a range such that the test pressure is in the middle of the scale.
- An air supply of not more than 25 psig with a supply capability less than the exhaust capability of either relief valve.

C2.2.1.3 Isolation. Isolate the space to be tested by blanking and/or plugging all openings including lines and vents going to and from the space.

C2.2.1.4 Pressurization. Apply a 2.0 psig test pressure (+0.25/-0.0 psig) for 10 minutes. Observe the allowable pressure drop specified in Table C1. Hold the test pressure in the space for at least 15 minutes to allow the temperature to stabilize prior to conducting the 10 minute test. For the purpose of air testing, the allowable pressure drop for tight appendages such as rudders, bilge keels and skegs, must be the same as voids.

C2.2.1.5 Leak detection. When the allowable test pressure drop is exceeded, the Contractor must locate the leaks and repair as required. Retest space to Table C1 requirements.

TABLE C1 - ALLOWABLE TEST PRESSURE DROP

SPACE TO BE TESTED	ALLOWABLE PRESSURE DROP
Tanks, voids, cofferdams	0.00 psig
All others	0.125 psig

C2.2.1.6 Completion. After the air test, relieve the pressure and remove all blanks and plugs.

C2.2.2 Water hose test.

C2.2.2.1 Precaution. Prior to conducting a water hose test, the Contractor must ensure all adjacent equipment is protected so no damage will occur from any spray or fluid collection.

C2.2.2.2 Procedures. The Contractor must conduct a water hose test by directing fresh water against the boundary being tested. The water hose nozzle must be no less than 1/2" in diameter and the pressure at the nozzle no less than 50 psi. The nozzle must be within 10 feet of the structure being tested.

C2.2.2.3 Acceptance criteria. Successful test must be noted by no evidence of water on the opposite side of the structure.

C2.2.3 Air hose test.

C2.2.3.1 Precaution. Safety glasses must be worn at all times.

C2.2.3.2 Procedures. The Contractor must conduct an air hose test by directing an air stream against the boundary being tested in a manner most likely to disclose leaks. An air pressure of 90 psi must be supplied through a nozzle of 3/8 inch diameter. The nozzle must be held as close as possible to the joint or boundary being tested.

C2.2.3.3 Acceptance criteria. Apply a soap solution to the opposite side of the structure to detect and locate leaks. A successful test must be noted by no formation of bubbles in the soapy solution.

C2.2.4 Chalk test.

C2.2.4.1 Procedures. The Contractor must ensure the door or hatch being tested is properly adjusted prior to conducting the chalk test. Chalk the bearing surface or knife edge and close the door or hatch by normal procedures. When the door or hatch is opened, the chalk from the knife edge will have been transferred to the gasket.

C2.2.4.2 Acceptance criteria. A successful test is noted by a uniform and continuous chalk mark on the door's or hatch's gasket (100 percent gasket contact). Irregularities or breaks in the chalk mark are cause for failure.

C2.2.5 Hydrostatic test. The Contractor must make provision to relieve pressure trapped downstream of the installed system. At least one manually actuated valve must be provided for overpressure protection during all hydrostatic tests. At least one relief valve must also be provided as automatic overpressure protection.

C2.2.5.1 Welded piping system and pressure vessel hydrostatic tests. The Contractor must hydrostatically test welded piping systems and pressure vessels to 135% of the system operating pressure, but not less than 50 psi, for at least 30 minutes using clean, fresh water, except where specified in Table C2, with no allowable leakage or permanent deformation of pressure-containing parts. Operating pressure test must not be less than the pressure at the most severe condition of coincidental internal or external pressure and temperature (maximum or minimum) expected during service.

C2.2.5.2 Refrigeration system tests. The Contractor must perform system examination as defined in Chapter VI of ASME B31.5. Contractor must perform system integrity testing using a dry, inert gas, such as nitrogen or anhydrous carbon dioxide. A preliminary pressure test must be done at 25 psig as a means of locating major leaks. The pressure test of the system must be at 75% of the pressure relief or 115% of the high side discharge pressure for all refrigerant types. The pressure must be held for a minimum of 15 minutes. The Contractor must then perform a leak test by applying a soapy water solution to all accessible joints, fittings, and pipes to identify system leaks, with no allowable leakage or permanent deformation of pressure-containing parts. Contractor must subsequently evacuate the system to a vacuum equal to or less than 500-microns, hold the system at or below 500 microns of vacuum for 4-hours, secure the vacuum pump and allow the system stand for 2-hours with no allowable leakage or permanent deformation of pressure-containing parts.

C2.2.5.3 Atmospheric system tests. The Contractor must perform a hydrostatic water test of atmospheric and gravity systems including deck drains, plumbing drains, vents and overflow piping. Piping must be subjected to a 10-foot minimum head of water for 15 minutes, without leakage. If the system is tested in sections, at least 10 feet of the higher section must be retested, except the uppermost 10 feet, or less, of the system. In conjunction with the hydrostatic test, or separately, each plumbing fixture and drain must be operated to assure unobstructed flow and traps maintain the required water seal.

C2.2.5.4 Tank hydrostatic tests. The Contractor must hydrostatically test all feed tanks, storage tanks and similar vessels that contain only static head of the acquired liquid to a pressure of 2 psig and hold the pressure for 15 minutes. Use clean, fresh water, or dry air except where specified in Table C2, with no allowable leakage.

TABLE C2 - SYSTEM TEST MEDIA

SYSTEM	TEST MEDIA
Lube Oil	System fluid
Hydraulic Oil	System fluid
Contaminated Oil, Ballast, or Seawater Systems	Seawater

C2.2.5.5 Fuel filling system. Before conducting hydrostatic testing of fuel filling systems, the Contractor must ensure all manifold/stop valves, flow control valves, drain valves, and cross-connecting valves to other systems are properly closed. If any of these boundary valves to be closed have a pressure rating of 100 psi or less, they must remain open to prevent disc distortion during testing. Install a blank flange downstream of the valve to provide the required test boundary.

C2.2.5.6 Heat exchangers and fluid cooler tests. The Contractor must conform to the requirements of SFLC Std Spec 5000, Appendix C for hydraulic heat exchanger and hydraulic fluid cooler testing.

C2.3 Nondestructive inspection of welds.

C2.3.1 Inspection methods. Inspection of welded joints must be performed by nondestructive methods such as radiographic (RT), ultrasonic (UT), magnetic particle (MT), or liquid penetrant (PT) inspection. Radiographic or ultrasonic inspection, or both, is to be used when the overall soundness of the weld cross section is to be evaluated. Magnetic particle, liquid penetrant, or other AWS welding inspection methods are to be used when investigating the outer surface of welds, or may be used as a check of intermediate weld passes. Inspection of welds must be in accordance with general guides AWS B1.10, and AWS B1.11. Inspection must be in accordance with the following procedures:

C2.3.2 VT. Inspection must be in accordance with AWS B1.11 or ABS Rules for Nondestructive Inspection of Hull Welds, or code requirements.

C2.3.3 MT.

C2.3.3.1 General. Inspection must be in accordance with ASTM E709 and ASTM E1444 or ASME Section V. PT inspection may be substituted for MT where MT is impractical. MT inspection may be performed using wet or dry method, fluorescent or non-fluorescent particles and magnetic fields of circular or longitudinal method. No cracks are allowed.

C2.3.3.2 Final inspection. Final inspection of ferritic material must be performed after all required machining or grinding has been completed, or may be performed prior to final machining when the inspected surface is within 1/32 inch of the final surface and the MT DC continuous method is used. For inspection purposes, weld surface areas designed to be covered by other structural weldments (such as areas of longitudinal butt weld surfaces under frame welds or frame or stiffener weld areas covered by intercostals) are not considered finished welds until the covering weldment has been completed.

C2.3.4 PT. Inspection must be in accordance with ASTM E1417 and ASTM E165, ASME Section V, or ABS Rules for Nondestructive Inspection of Hull Welds. No cracks are allowed.

C2.3.5 RT. Inspection must be in accordance with ASTM E94, ASME Section V, or ABS Rules for Nondestructive Inspection of Hull Welds. No cracks are allowed.

C2.3.6 UT. Inspection must be in accordance with ASTM E164, ASTM E587, ASME Section V, or ABS Rules for Nondestructive Inspection of Hull Welds. No cracks are allowed.

C2.3.7 Surface preparation for NDE. Inspection of completed welds must be accomplished after slag removal and with the weld in the final surface condition. Power driven wire brushes must not be used on surfaces that are to be liquid penetrant inspected unless the resulting surface is removed using an approved abrasive material prior to performing the inspection.

C2.4 Weld examinations. The following welds must be inspected:

C2.4.1 All welds. All welds must be visually inspected. Inspection prior to welding must, at a minimum, include joint preparation, fit-up, and cleanliness. In process inspections, when required, must be in the presence of the COR.

C2.4.2 Weight handling equipment welds. PT inspection must be performed on all completed welds deposited with austenitic or nonferrous electrodes in weight-handling fittings or fixtures supporting over 1 ton, unless the fitting or fixture is proof load tested after installation.

C2.4.3 Overlay or clad welding. Overlay or clad welding deposited on primary hull structure with austenitic or nonferrous weld metal for corrosion-resistance applications must be PT inspected.

C2.4.4 Water and oil tight welds. In addition to the visual inspection requirements, the Contractor must perform NDE, in the presence of the Coast Guard inspector, on all final welds in shell plating, decks, watertight bulkheads and oil-tight bulkheads.

C2.4.5 Fillet welds 3/8 inch size and greater. The Contractor must accomplish a surface examination, by an appropriate NDE method in the presence of the Coast Guard Inspector, of fillet welds 3/8 inch size and greater.

C2.4.6 Multi pass welds. For multi-pass full penetration welds, the Contractor must examine the root pass in addition to the final surface pass by an appropriate NDE method in the presence of the Coast Guard Inspector.

C2.4.7 Loss of preheat. If the preheat temperature drops below minimum on incomplete welded joints in or to HY-80/100/130 (1-1/8 inches and over) or high hardenable materials (1" and over) the partially completed welds must be VT/MT inspected.

C2.5 Nondestructive inspection of components. Inspection of components (plate, pin, etc.) must be performed by nondestructive methods such as ultrasonic, magnetic particle, or liquid penetrant inspection.

C2.5.1 UT inspection must be used when the overall soundness of the component cross section is to be evaluated, following the following guidance:

C2.5.1.1 Ultrasonic apparatus, procedure requirements, and report must be in accordance with ASTM E797. Report results must additionally include the following information for each test point, unless otherwise stated in a work item:

- Location.
- Original metal thickness.
- Measured metal thickness.
- Percent deterioration (calculation is based on the original metal thickness).

C2.5.1.2 For plate thickness greater than .250”, the Contractor has the option of taking the UT measurements on bare metal, primed metal, or fully coated metal; however precautions must be taken to ensure that bare steel metal is not left unprotected long enough for corrosion to form. For plate thicknesses less than .250”, UT measurements must be taken on bare metal.

C2.5.1.3 When testing fully coated metal, prove calibration of the instrument on a sample of known thickness before and after testing. Actual thickness of coating may be measured in accordance with SSPC-PA 2. Ensure that film thickness measurement is taken with a suitable eddy current gauge, for non-magnetic substrate

C2.5.1.4 Ultrasonic equipment standardization must be in accordance with ASTM E797, Section 7 (Standardization of Apparatus) and Section 8 (Technical Hazards).

C2.5.2 MT, PT, or other AWS inspection methods are to be used when investigating the outer surface of components.

C2.6 Inspector qualifications. All individuals performing visual or other NDE operations must be knowledgeable concerning each of the principles and methods of inspection required on the weldment. The qualification and certification of these inspectors must be documented through the administration of written and hands-on practical examinations as performed by one of the following appropriate methods:

- AWS Senior Certified Welding Inspector (SCWI) or CWI program.
- American Society for Nondestructive Testing (ASNT) Qualification and Certification of NDT Personnel, as provided for in SNT-TC-1A Table 1A, 1B, 1C or 1D.
- ASNT Central Certification Program (ACCP) Level II certification, or better

C2.7 NDE acceptance criteria. The criteria for determining the acceptability of NDE discontinuities in welds and components must be in accordance with MIL-STD-2035 Class 3. The criteria for determining the acceptability of NDE discontinuities in brazed joints must be in accordance with NAVSEA 0900-LP-001-7000. The Contractor must repair all defects.

C2.8 Touch-up preservation. The Contractor must prepare and touch-up coat all new and disturbed surfaces to match existing adjacent surfaces, in accordance with Std Spec 6310, paragraph 3.1.13 (Touch-ups and minor coating repairs).

C3. NOTES

C3.1 Notices. Fifteen minutes prior to commencing pressurization for compartment air testing and every quarter hour thereafter until completely depressurized, the Coast Guard Inspector will announce on the ship's public address system that compartment air testing is in progress in the designated space and that personnel must stand clear.

APPENDIX D

BIMETALLIC BONDED JOINT WELDING REQUIREMENTS

D1. SCOPE

D1.1 Intent. This appendix provides the requirements for joining aluminum and steel plate or sheet using bimetallic bonded joints (consisting of aluminum alloy bonded to steel with or without an aluminum interlayer) on Coast Guard cutters and boats.

D2. REQUIREMENTS

D2.1 The Contractor must perform all welding on bimetallic bonded joints in accordance with the requirements of this standard specification and appropriate appendices. All welding procedure specifications using bimetallic bonded joints must be qualified through testing. Use of prequalified or standard welding procedure specifications for bimetallic joints is prohibited.

D2.2 Use of bimetallic bonded joints, other than a joint comprised of aluminum and carbon steel, must be approved for use by the KO on a case by case basis.

D2.3 Welding process. The Contractor must perform all aluminum bimetallic bonded joint welding using the direct current, reverse polarity GMAW process, or gas tungsten arc (GTAW) processes. Perform all steel to steel bimetallic bonded joint welding using the GMAW, GTAW, or Shielded Metal Arc Welding (SMAW) processes.

D2.3.1 Shielding gas. For welds to the aluminum side of the bimetallic bonded joint, use a shielding gas with a welding grade mixture of 100% argon, or 75% helium and 25% argon. 100% argon is preferred. For the steel welds to the steel side of the bimetallic bonded joint, use CO2 shielding gas (use argon or helium shielding gas with gas tungsten arc process).

D2.3.2 Electrode materials.

D2.3.2.1 Aluminum. For welding aluminum on the bimetallic bonded joint, use either AWS 5356 alloy or AWS 5556 alloy electrode material depending on the base metal. The filler metal must comply with AWS D1.2.

D2.3.2.2 Steel. For welding steel on the bimetallic bonded joint, the welding specification must comply with AWS D1.1.

D2.3.3 Joint preparation. Maintain minimum material separation at the joints to minimize distortion. Figure D-1 shows a typical bimetallic bonded joint material type.

D2.3.4 Minimum bend radius. The bimetallic bonded joint bars may be bent around a curved surface but any bending must be accomplished cold. The minimum bend radius in either the vertical or horizontal plane must not be less than 3T, where T is the bar thickness or width.

D2.3.5 Temperature control. Do not preheat the bimetallic bonded transition joint. Monitor interpass so that the temperature at the aluminum-steel bond remains below 600 degree F.

NOTE

At temperatures in excess of 600 degree F, brittle intermetallic compounds may form at the bond zone due to interdiffusion of aluminum and iron. In typical GMAW welding of a structural member of the design shown in Figure 1(a), the bond zone temperature will rarely exceed 450 degree F.

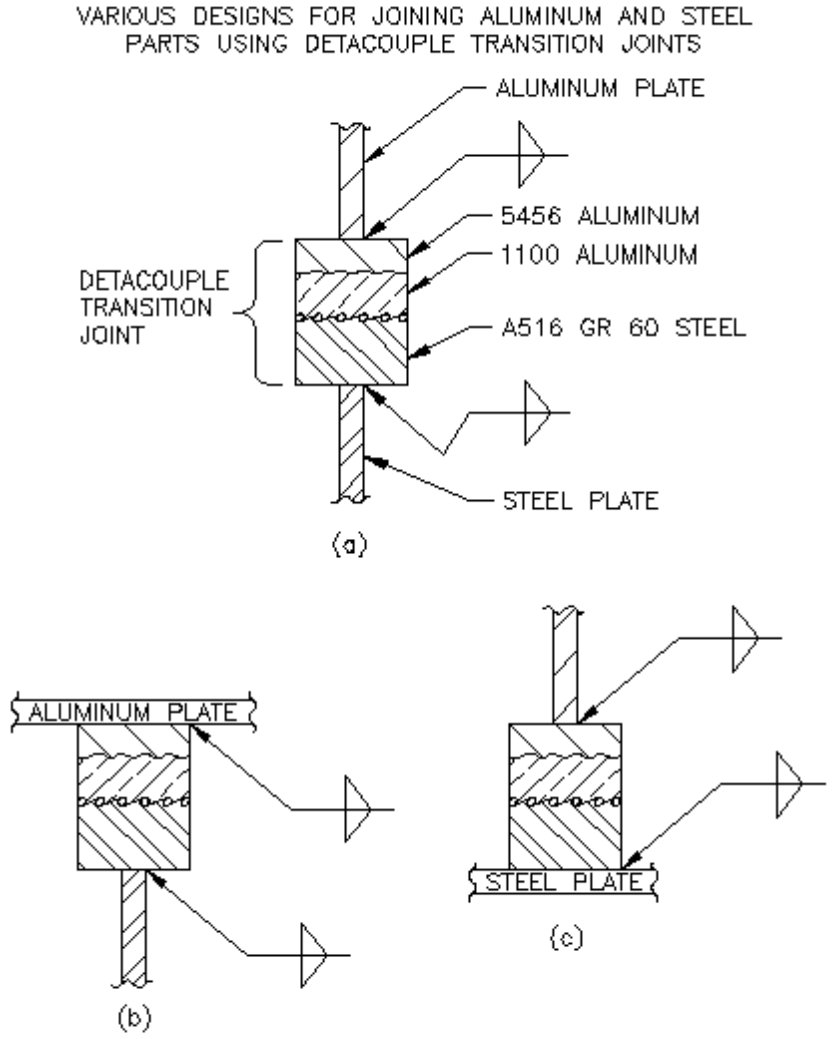


FIGURE 1

APPENDIX E

STRAY CURRENT PROTECTION

E1. SCOPE

E1.1 Intent. This appendix provides the requirements for preventing underwater body corrosion due to stray current flow from improperly connected electric arc welding equipment.

E2. BACKGROUND

E2.1 Underwater corrosion. Underwater hull and shaft corrosion is, in large part, directly attributable to improper hookup of welding leads while work is being performed on ships which are waterborne. Corrosion resulting from improper weld lead hookup is induced through electrolytic action by stray electrical currents.

E2.2 Current flow. Current flow is caused by the difference in electrical potential between any two localities. Even though the path through water offers greater resistance to current flow than adjoining electric ground cable, water still will carry a fraction of the current and create an undesirable condition.

E3. REQUIREMENTS

E3.1 Welding equipment. To prevent possible serious damage to electronic, electrical, mechanical, and ordnance equipment, as well as pitting of ship structure, while electric arc welding on ships, both waterborne and in dry or floating docks, observe the following requirements:

E3.1.1 Each ship must have a separate welding current power source.

E3.1.2 The return current cable of any welding generator must never be grounded to anything other than the ship the cable is servicing.

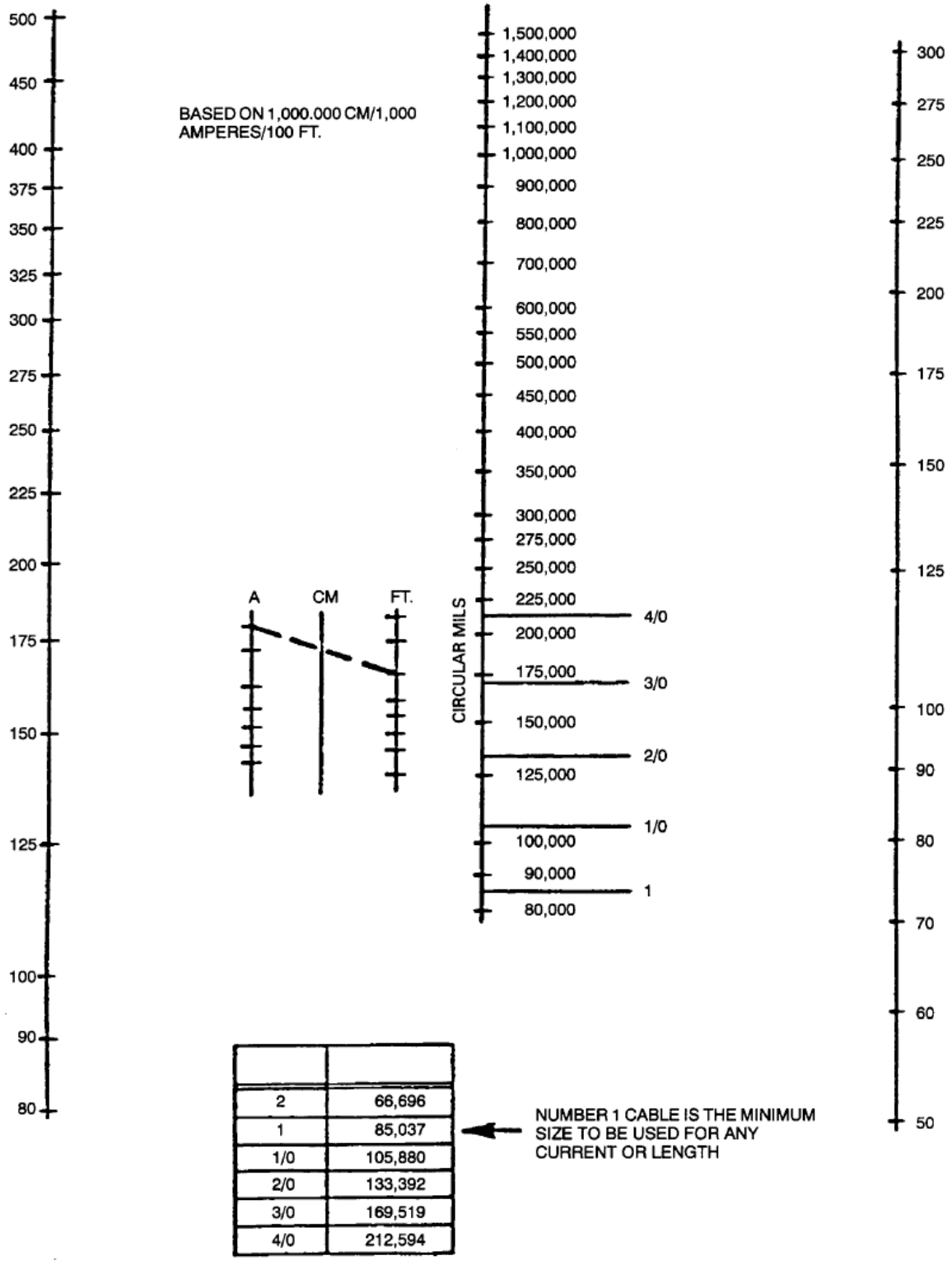
E3.1.3 The welding cable used in each welding circuit, both in the electrode and in the ground or return side of the circuit, must be completely insulated, and not permitted to drop overboard into the water.

E3.1.4 The frame or case of the welding machine, except engine-driven types, must be grounded, except portable and mobile engine-driven types complying with NFPA 70 need not be so. Frames must be grounded to the hull if shipboard and to earth ground if the welding machine is located ashore.

E3.2 Connections. Cables and lugs used for electric arc welding must meet the following requirements:

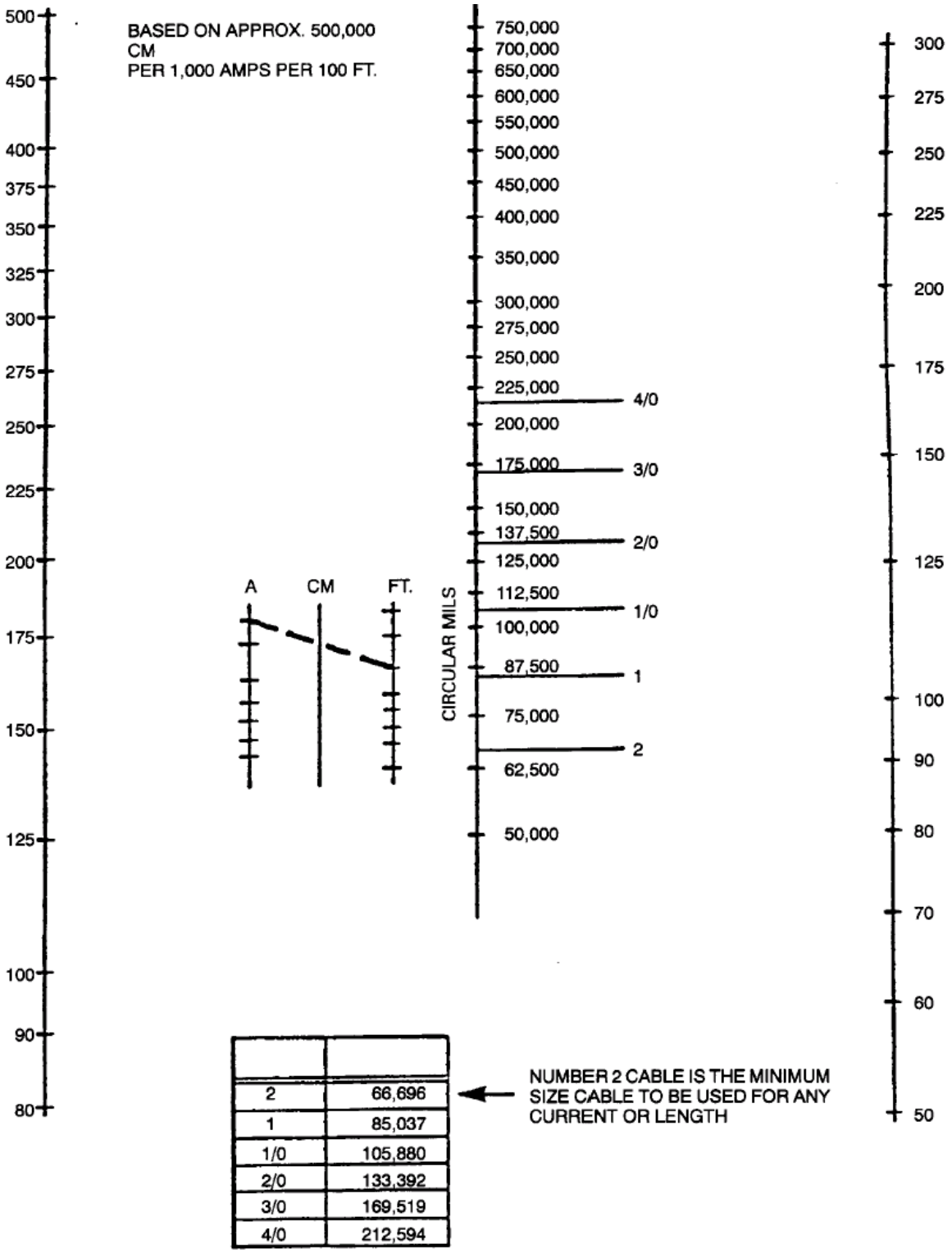
E3.2.1 Return conductor size. The cross-sectional areas of the return current cable should be one million circular mils minimum for each 1,000 A for each 100 feet. One or more cables, connected in parallel, may be used to meet the minimum cross-sectional area requirements. Such paralleled cables must connect to the same bus or waterway bar at each end. A nomograph showing required cable size for

return current leads is presented in Figure E-1.



2	66,696
1	85,037
1/0	105,880
2/0	133,392
3/0	169,519
4/0	212,594

FIGURE E-1. NOMOGRAPH FOR COPPER RETURN CURRENT CONDUCTOR SIZE



2	66,696
1	85,037
1/0	105,880
2/0	133,392
3/0	169,519
4/0	212,594

FIGURE E-2. NOMOGRAPH FOR COPPER ELECTRODE LEAD CONDUCTOR SIZE

E3.2.2 Electrode conductor size. Manufacturers' recommendations for electrode lead cable size must be used. Lead cable size is approximately 500,000 circular mils for each 1,000 A for each 100 feet. A nomograph showing copper electrode lead conductor size is presented in Figure E-2.

E3.2.3 Cable lugs. Return current cable lugs must be secured tightly to grounding plates. The lug contact area must be cleaned thoroughly to base metal. Ensure the adequacy of each return current cable connection between the ship's hull and power source by checking the resistance initially and after every setup change before welding. The maximum permissible resistance must be 125 microhms (μΩ) for each connection, or the voltage drop across the connection must be a maximum of 25 millivolts (mV) for a current of 200 A. Use Ohm's law (V = IR) to determine the allowable voltage drop for currents other than 200 A.

E3.2.4 Insulation resistance. The insulation resistance between the welding return current cable and the welding machine case must not be less than 0.1 megohm (MΩ) when the machine is not connected to the ship. Resistance less than 0.1 MΩ indicates improper insulation of the return current cable or a need to clean the welding machine. Perform insulation resistance checks during initial connection and after every setup change before welding.

E3.3 Welding unit arrangements. Combinations of electric arc welding unit arrangements with correct and incorrect return current connections are shown in Figure E-3, Figure E-4, Figure E-5, Figure E-6 and Figure E-7. These figures represent common arrangements and errors in making welding machine connections. Details for making provisions for welding return current connections on steel surface ships are shown in Figure E-8.

E3.4 Special precautions. Observe the special precautions below when welding on or near electronic, electrical, mechanical, navigational, or ordnance equipment:

E3.4.1 Magnetic compass. When welding in or near the pilothouse or other locations with a magnetic compass, maximize the separation between the binnacle and all arc welding leads. Where leads must approach within 10 feet of the binnacle, notify the COR so that Ship's Force may remove the compass prior to welding.

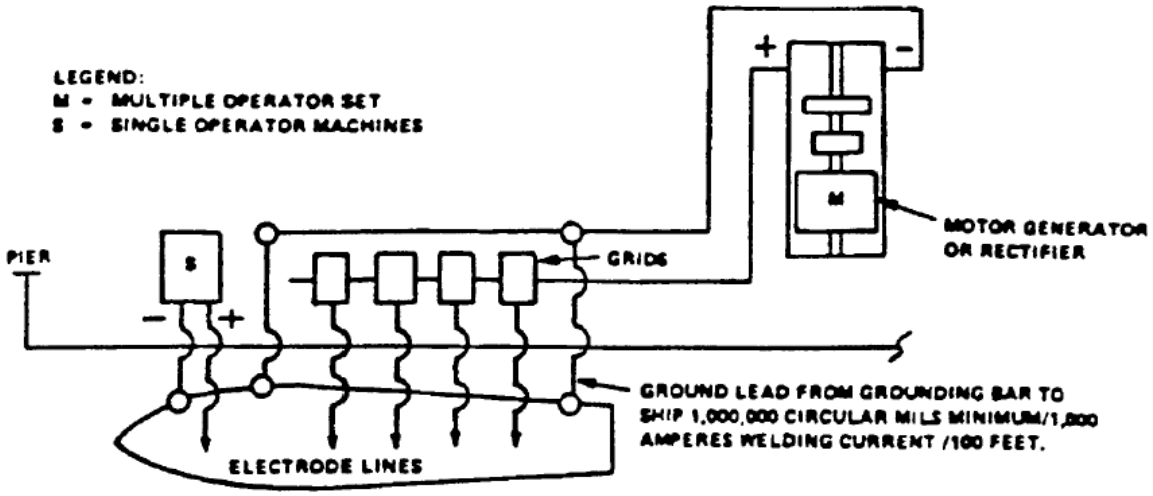
E3.4.2 Sensitive electronics. Precautionary measures outlined in manufacturers' equipment manuals and other documents should be observed when welding on or near sensitive electronic equipment. Control cables often must be disconnected and sensitive modules removed from platforms equipped with electronic engine control systems.

E3.4.3 Welding return current. The static grounding straps on electronics enclosures, electrical equipment, machinery, and ordnance equipment have not been designed, and must not be used, as welding current returns. Welding current must not be allowed to pass through bolted access covers or soft patches, gear meshes, bearings (ball, roller, or bushing type on components such as crane turrets, winches, capstans, windlasses, gun mounts, motors, and shafting), nor hinge pins (doors, hatches, and scuttles), to return to ground.

E3.4.4 Location of return current cables. When practicable, the welding return current cable connection must be no farther than 10 feet from the work. This ensures that welding current does not flow through bearings, threaded joints, and other areas where arcing could occur.

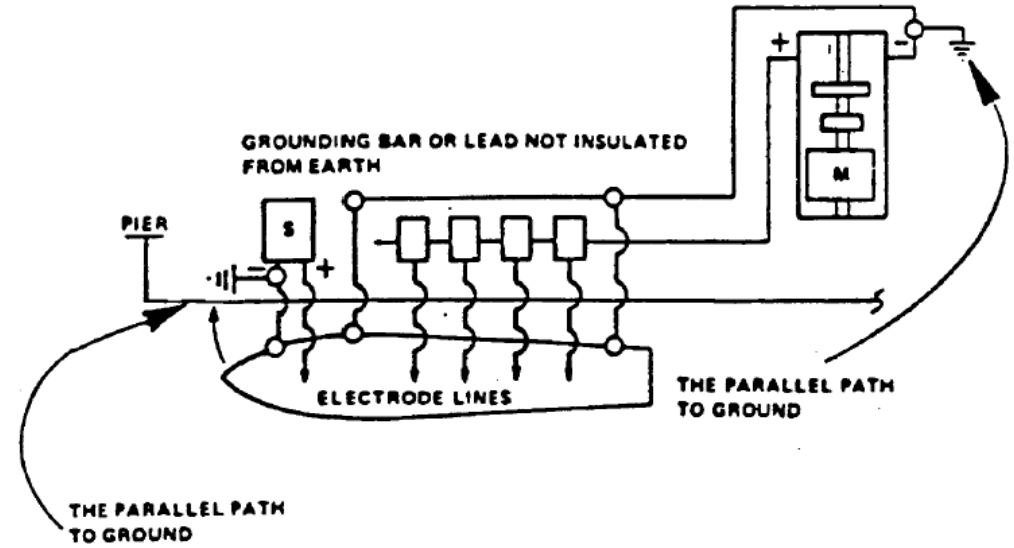
E3.4.4.1 Mechanical. When systems such as piping, pressure vessels, or machinery are being welded, a single return current cable connection should be located as close to the work as possible.

E3.4.4.2 Ordnance. When welding on piping that leads into loaded ordnance equipment areas, the return current cables must be split into two equal conductors so that one run is connected to the pipe on each side of the welding area, and located as close to the area as possible. If pipe hangers or branch pipes are located between the dual return current connections, provide additional split return current connections to such items.



NOTE: GROUNDING BAR OR LEAD SHALL BE INSULATED FROM EARTH AND OTHER STRUCTURES, BE OF SUFFICIENT CROSS-SECTIONAL AREA TO CARRY THE WELDING CURRENT, AND SHOULD REMAIN ABOVE WATER WITH TIDE CHANGES OR SHIP MOVEMENTS.

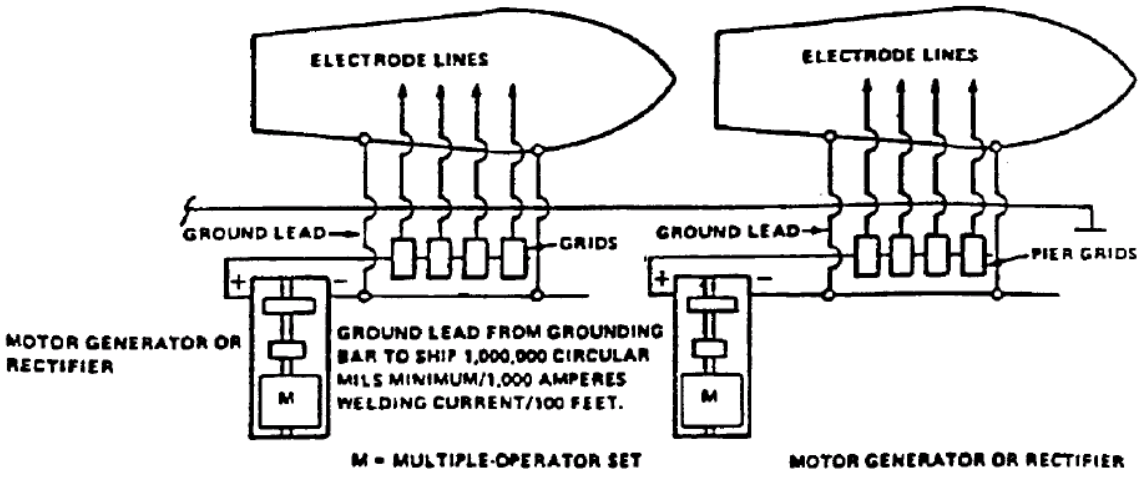
CORRECT



NOTE: WITH NEGATIVE SIDE OF GENERATOR OR RECTIFIER GROUNDED, PART OF THE WELDING CURRENT FLOWS FROM THE SHIPS HULL TO THE WATER AND EVENTUALLY REACHES THE NEGATIVE SIDE OF THE GENERATOR OR RECTIFIER.

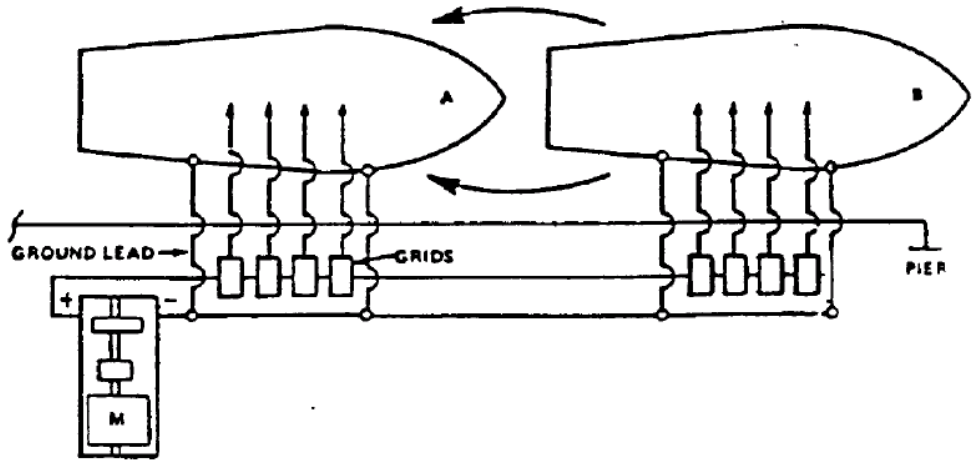
INCORRECT

FIGURE E-3. HOOKUP FOR SINGLE SHIP AT PIER



NOTE: WELDING ON TWO OR MORE SHIPS (IN CASE OF MULTIPLE-OPERATOR MACHINE) SHOULD NOT BE PERFORMED WITH THE SAME GENERATOR OR RECTIFIER.

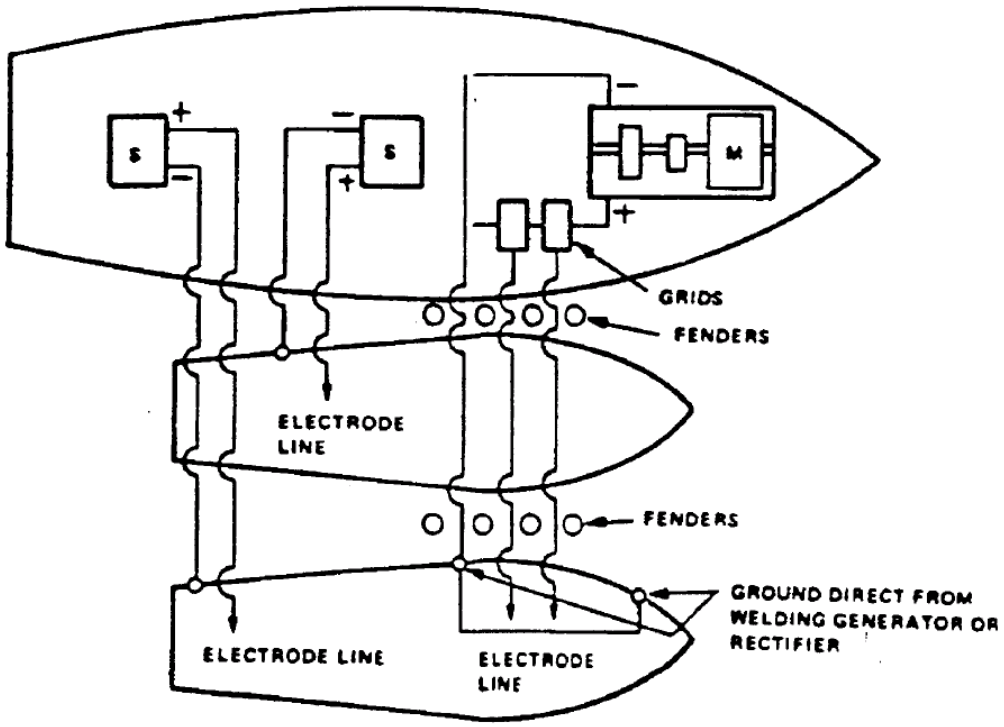
CORRECT



NOTE: WHEN TWO SHIPS ARE CONNECTED TO THE SAME GENERATOR OR RECTIFIER, THE RESISTANCE OF THE NEGATIVE RETURN BETWEEN THE SHIPS CANNOT BE MADE LOW IN COMPARISON WITH THE RESISTANCE THROUGH THE WATER. SOME OF THE CURRENT USED ON SHIP B FLOWS THROUGH THE WATER, CORRODING METAL OFF SHIP B AND POSSIBLY BLISTERING PAINT ON SHIP A.

INCORRECT

FIGURE E-4. HOOKUP FOR TWO SHIPS AT PIER



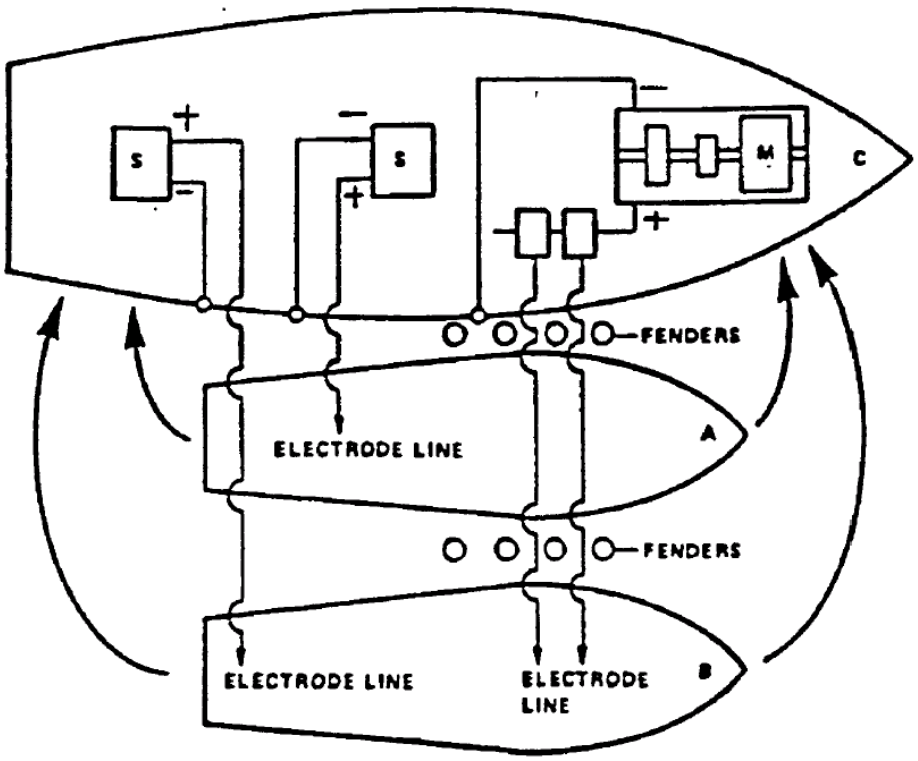
LEGEND. M = MULTIPLE-OPERATOR SET
S = SINGLE-OPERATOR SET

NOTES

1. FOR SINGLE OPERATOR MACHINES, ATTACH THE GROUND LEAD AS CLOSE AS PRACTICAL TO STRUCTURE OR COMPONENT TO BE WELDED.
2. WELDING ON TWO OR MORE SHIPS (IN CASE OF A MULTIPLE-OPERATOR MACHINE) SHOULD NOT BE PERFORMED WITH THE SAME GENERATOR OR RECTIFIER.

CORRECT

FIGURE E-5. HOOKUP FOR SHIPS AFLOAT (SHEET 1 OF 2)

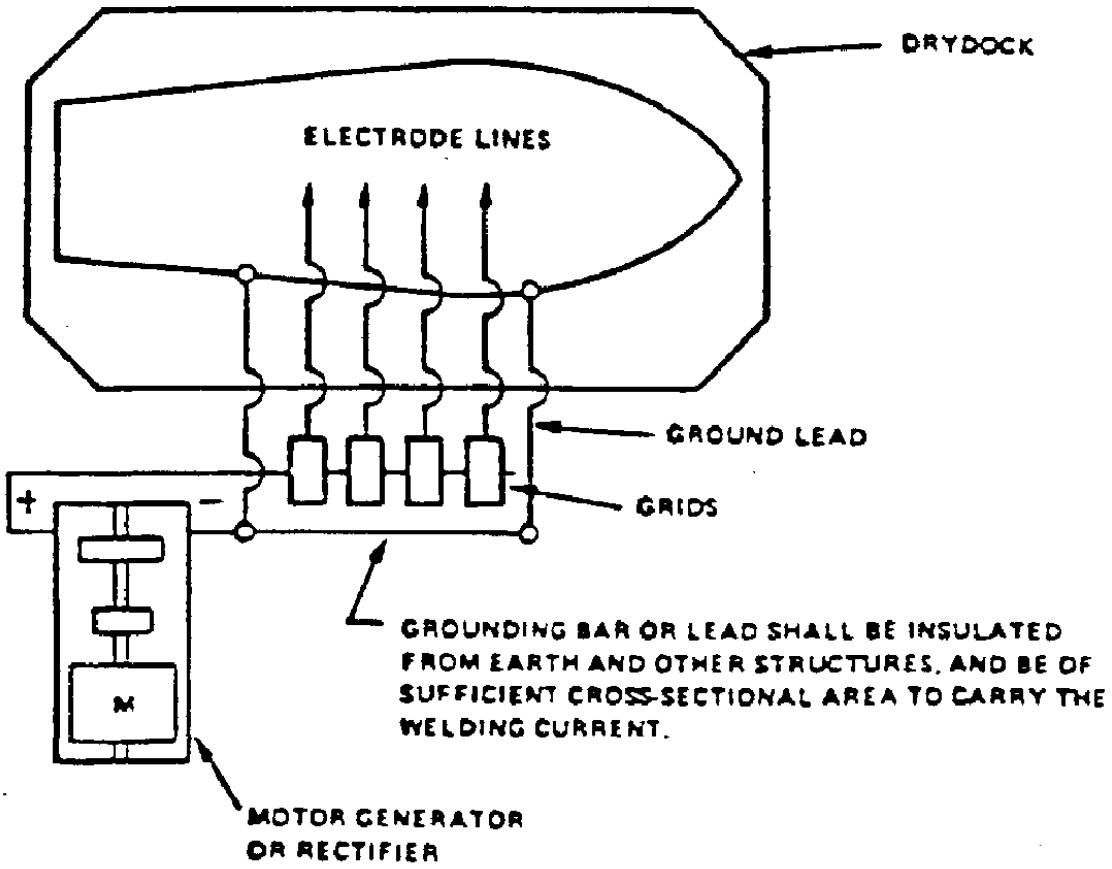


LEGEND: M = MULTIPLE-OPERATOR SET
S = SINGLE-OPERATOR SET

NOTE. WHEN THE GENERATOR OR RECTIFIER ON ONE SHIP GROUNDED TO THAT SHIP IS USED TO WELD ON ANOTHER SHIP WHICH IS WITHOUT A GROUND OR IS IMPROPERLY GROUNDED, ALL OR PART OF THE WELDING CURRENT RETURNS FROM SHIPS A AND B TO SHIP C THROUGH THE WATER.

INCORRECT

FIGURE E-5. HOOKUP FOR SHIPS AFLOAT (SHEET 2 OF 2)



LEGEND: M = MULTIPLE-OPERATOR SET

FIGURE E-6. HOOKUP FOR SHIP IN FLOATING DOCKS

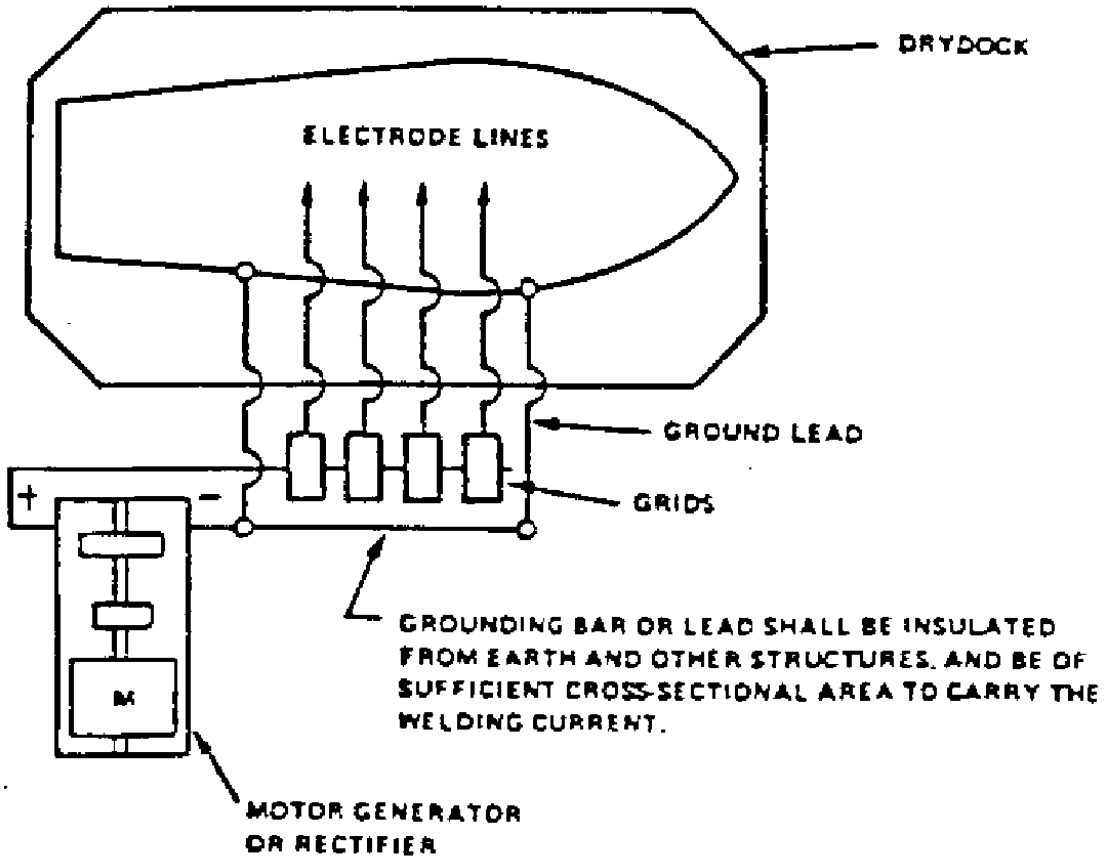
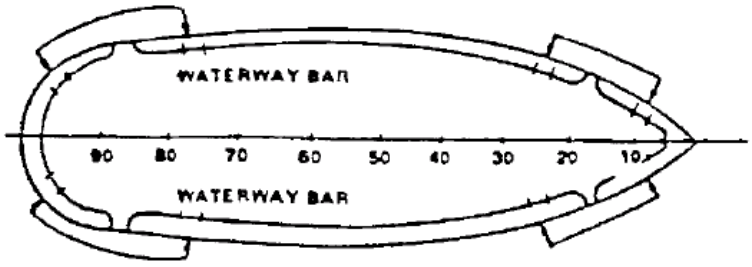


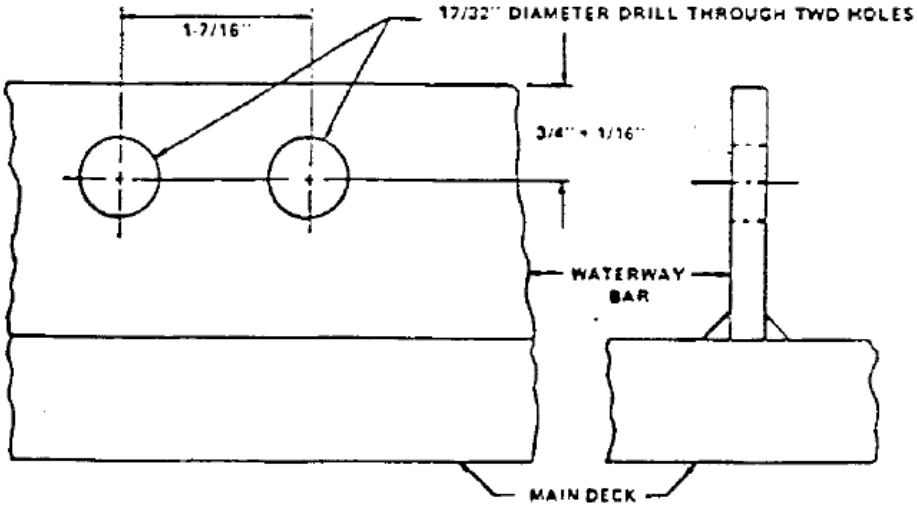
FIGURE E-7. HOOKUP FOR SHIPS IN DRY OR GRAVING DOCK



MAIN DECK STEEL HULL

NOTES:

1. LOCATE HOLES IN AREAS INDICATED BY ARROWS.
2. ON STEEL HULLS WITH NO WATERWAY BAR, DRILL HOLES IN DECK COAMINGS.
3. CLEAN LUG CONTACT AREA TO BARE METAL WHEN GROUNDING CONNECTIONS ARE MADE. (WHEN GROUNDS ARE BROKEN, THE AREA SHALL BE PAINTED TO MATCH THE SURROUNDING DECK.)
4. WITHIN 6 INCHES OF LUG CONTACT AREA, PAINT IN BLACK, 3/4-INCH-HIGH LETTERS: GROUNDING CONNECTION AREA.



TYPICAL HOLE SPACING GROUNDING LUG ATTACHMENT

NOTES:

1. HOLES ARE TO BE DRILLED AT LOCATIONS SHOWN ABOVE.
2. WHERE POSSIBLE, MODIFY AND UTILIZE EXISTING HOLES IN WATERWAY BARS.

FIGURE E-8. RETURN CURRENT CONNECTIONS ON STEEL SURFACE SHIPS