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NAVAL SHIPS' TECHNICAL MANUAL

CHAPTER 074 – VOLUME 1

WELDING AND ALLIED PROCESSES

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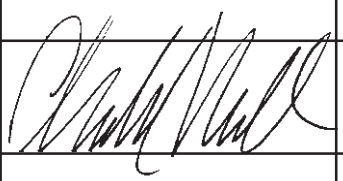
Technical	C. L. Null		Naval Sea Systems Command	03M2	7/31/98
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SECTION 1.
INTRODUCTION

074–1.1 GENERAL

074–1.1.1 SCOPE. This chapter furnishes both the minimum mandatory requirements (indicated by the word shall) and guidance information (indicated by the words should or may) necessary for welding, brazing, inspection, and safety when used for ship maintenance, repair, and alteration.

074–1.1.2 MANDATORY REFERENCING. Table 074–1–1 lists mandatory reference documents that form a part of this volume. Fabrication documents are used as basic mandatory references for all welding, fabrication, and inspection requirements and related material, and quality assurance requirements, unless specifically modified by the requirements of this volume.

074–1.1.3 NUCLEAR AND COMBAT WEAPONS SYSTEMS. This volume does not cover welding, brazing, or other work on nuclear or combat weapons systems. Unless otherwise specified, all the requirements contained in this volume apply to all activities performing repair or alterations on Navy ships and small boats. Other information, appropriate to nuclear systems, is contained in applicable technical manuals and shall be obtained from the cognizant authority before working on a nuclear system. Welding information for combat weapons and weapons systems is contained in individual technical manuals for components or systems. Application of these manuals shall be determined from the cognizant authority before working on weapon systems.

074–1.1.4 SHIP STRUCTURE AND SYSTEMS. To maintain the integrity of ship structure and systems when welding or brazing is performed, it is essential and mandatory to ensure complete compliance with the requirements specified in this volume, including those of the mandatory reference documents that form a part of this volume.

074–1.1.5 RESPONSIBILITY FOR COMPLIANCE. The Commanding Officer is responsible for ensuring compliance with requirements of this volume. Particular attention shall be given to using only trained and qualified personnel for welding, brazing, and inspection as defined in Section 2 and to personnel and equipment safety precautions given in Section 10 of this volume and in **NSTM Chapter 074, Volume 3, Gas Free Engineering.**

074–1.1.6 REQUIREMENTS. The requirements of some paragraphs in reference documents such as MIL–STD–248, **Welding and Brazing Procedure and Performance Qualification** and MIL–STD–278, **Fabrication, Welding, and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels in Ships of the U.S. Navy** are preceded by the words, **When specified in the contract or order** or similar words to this effect. These requirements are mandatory and shall be invoked and fully met without exception. Such requirements are not meant to be subject to discretion (including that of the Naval Sea Systems Command (NAVSEA)) as to applicability. Activities, including all levels of subcontractors, shall be specifically made aware of the mandatory nature of the aforementioned requirements.

074–1.2 WELD CATEGORIES

074–1.2.1 Welding on ships by crew members or activities other than shipyards shall be categorized as described in the following:

a. Category A. Category A welds are permanent repairs and alterations to submarine safety boundaries on submarine safety (SUBSAFE) certified submarines.

b. Category B. Category B welds are emergency temporary repairs to SUBSAFE certified submarines (see Section 3 concerning reporting of emergency temporary repairs).

c. Category C. Category C welds are:

1. Permanent repairs and alterations on the pressure hull envelope of submarines that are not certified as SUBSAFE

2. Permanent repairs and alterations on any submarine pressure hull supporting structure

3. Permanent repairs and alterations of the primary structures of surface ships, including ballistic plating and superstructure designed for blast loading

4. Permanent repairs and alterations of all P–1, P–LT, and P–3a piping systems; A–1, A–2, A–F, A–LT pressure vessels; and T–1 steam turbines

5. Permanent repairs and alterations of those portions of machinery or components essential to the mission of the ship.

d. Category D. Category D welds are temporary repairs and alterations on items listed under category C.

e. Category F. Category F welds are repairs performed on assemblies where the possibility of failure is remote, and failure would not result in danger to ship personnel or the ship.

f. Category E. Category E welds are permanent repairs and alterations on items not listed under category A or C, unless repairs and alterations are exempted by category F.

074–1.3 REFERENCE DOCUMENTS

074–1.3.1 GENERAL. Both mandatory reference and guidance documents are included in reference documents pertaining to welding and allied processes.

Table 074–1–1. MANDATORY REFERENCE DOCUMENTS

Identification	Title	General Applicability
MIL–STD–22	Welded Joint Designs	All weld joints
MIL–STD–101	Color Code for Pipelines and for Compressed Gas Cylinders	
MIL–STD–248	Welding and Brazing Procedure and Performance Qualifications	Procedure and personnel qualification requirements for welding and brazing
MIL–STD–271	Nondestructive Testing Requirements for Metals	Performance on all nondestructive testing when specified
MIL–STD–278	Welding and Casting Standard	All classes of piping and machinery in submarines and surface ships
MIL–STD–1687 (SH)	Thermal Spray Processes for Naval Ship Machinery Applications	Thermal spraying for machinery applications
MIL–STD–1688 (SH)	Fabrication, Welding, and Inspection of HY–80/100 Submarine Applications	HY–80/100 Submarine Applications
MIL–STD–1689 (SH) (See Notes 1 and 2.)	Fabrication, Welding, and Inspection of Ships Structure	For all materials used in combatant surface ships and submarines except HY–80/100 used in submarines in hull construction
MIL–STD–2191 (SH)	Repair Welding, Weld Cladding, Straightening and Cold Rolling of Main Propulsion Shafting	

Table 074–1–1. MANDATORY REFERENCE DOCUMENTS (Continued)

Identification	Title	General Applicability
DOD–STD–480	Configuration Control – Engineering Changes, Deviations and Waivers	
DOD–STD–2138	Metal Sprayed Coating Systems for Corrosion Protection Aboard Naval Ships	Thermal sprayed aluminum for corrosion control use
DOD–STD–2182	Engineering Chromium Plating (Electrodeposited) for Repair of Shafting (Metric)	
DOD–STD–2185	Requirements for Repair and Straightening of Bronze Naval Ship Propellers	
MIL–C–14550	Copper Plating (Electrodeposited)	
MIL–C–24576	Cloth, Silica Glass, Cloth, Glass, Silicone Rubber Coated	
MIL–G–45204	Gold Plating, Electrodeposited	
MIL–E–22200/1	Electrode, Welding, Mineral Covered, Iron Powder, Low Hydrogen Medium and High Tensile Steel As Welded or Stress Relieved Weld Application	
MIL–E–22200/2	Electrode, Welding Covered Austenitic Chromium–Nickel Steel	
MIL–E–22200/7	Electrode, Welding, Covered, Molybdenum Alloy Steel Application	
MIL–E–22200/8	Electrodes, Welding, Covered, Low–Hydrogen and Iron – Powder Low–Hydrogen Chromium Molybdenum Alloy Steel and Corrosion Resisting Steel	
MIL–P–15280	Plastic Material, Unicellular Sheets and Lub	
MIL–P–81728	Plating, Tin-Lead, Electrodeposited	
MIL–S–22698	Steel Plate, Shapes and Bars, Weldable Ordinary Strength and Higher Strength: Hull Structural	
MIL–T–10727	Tin Plating: Electrodeposited or Hot Dipped, for Ferrous and Nonferrous Metals	
FED Spec GGG–H–211	Helmet, Welders, Handshield, Welding, and Plates, Welding	
QQ–N–290	Nickel Plating (Electro-deposited)	
QQ–C–320	Chromium Plating (Electro-deposited)	
QQ–S–365	Silver Plating: Electrodeposited: General Requirements for	

Table 074–1–1. MANDATORY REFERENCE DOCUMENTS (Continued)

Identification	Title	General Applicability
NAVSEA SO300–BB–MAN–010	U.S. Navy Underwater Cutting and Welding Manual	
NAVSEA 0900–LP–001–7000	Fabrication and Inspection of Brazed Piping Systems	All piping systems brazed joints
NAVSEA 0900–LP–003–8000	Surface Inspection Acceptance Standards for Metals Includes MT, PT, and Visual Inspection	When specifically referenced
NAVSEA 0900–LP–003–9000	Radiography Standard for Production and Repair Welds	When specifically referenced
NAVSEA 0900–LP–006–3010	Ultrasonic Inspection Procedure and Acceptance Standard for Hull Structure Production and Repair Welds	
NAVSEA 0900–LP–006–3020	Supplement to NAVSEA 0900–LP–006–3010	
NAVSEA 0900–LP–038–6010	Deposition of Metals by Contact (Brush-on Method) Electroplating	
NAVSEA 0900–LP–060–4010 (See Note 3.)	Fabrication, Welding, and Inspection of Metal Boat and Craft Hulls	When specifically referenced
NAVSEA 0900–LP–082–3010	Ship Hull Structure Maintenance and Repair	
NAVSEA 0905–LP–501–7010	Trident Submarine Logistic Support Master Plan Introduction 1 July 74	
NAVSEA 0924–LP–062–0010 Rev A (or latest revision in effect)	Submarine Material Certification Requirements Manual for the Submarine Safety (SUBSAFE) Program	
NAVSEA 0929–LP–000–8010	Underwater Cutting and Welding Manual	
NAVSEA 0948–LP–045–7010	Material Identification and Control (MIC) for Piping Systems	When specifically referenced
NAVSEA 0951–LP–031–8010	Repair and Overhaul Main Boilers, 1200 PSI, Steam Propulsion Plant	
NAVSEA 0951–LP–038–6030	Repair and Overhaul Instructions, 1,200 PSI Pressure Fired Boiler and Supercharger	
NAVSEA 0994–LP–001–9010	U.S. Navy Diving Manual Volume 1 (Air Diving)	
NAVSEA S9086–BS–STM–000/CH–050	NSTM Chapter 050, Readiness and Care of Inactive Ships	
NAVSEA S9086–CH–STM–020/CH–074	NSTM Chapter 074, Volume 2, Nondestructive Testing of Metals, Qualification and Certification Requirements for Naval Personnel (Non-Nuclear)	
NAVSEA S9086–CH–STM–030/CH–074	NSTM Chapter 074, Volume 3, Gas Free Engineering	

Table 074–1–1. MANDATORY REFERENCE DOCUMENTS (Continued)

Identification	Title	General Applicability
NAVSEA S9086–C1–STM–000/CH–091	NSTM Chapter 091, Submarine Hull Inspection	
NAVSEA S9086–DA–STM–000/CH–100	NSTM Chapter 100, Hull Structures	
NAVSEA S9086–HB–STM–000/CH–233	NSTM Chapter 233, Diesel Engines	
NAVSEA S9086–S3–STM–010/CH–555	NSTM Chapter 555, Surface Ship Firefighting	
NAVSEA S9086–S3–STM–020/CH–555	NSTM Chapter 555, Submarine Firefighting	
NAVSEA 0901–LP–884–0004/CH–9880	NSTM Chapter 9880, Damage Control, Compartment Testing and Inspection	
American Bureau of Shipping (ABS) (See Note 1.)	Rules for Building and Classing Steel Vessels	For all materials used in noncombatant surface ships
ANSI B16.11	Forged Fittings, Socket–Welding and Threaded	
ASTM A106	Std Specification for Seamless Carbon Steel Pipe for High-Temperature Service	
ASTM A441	Std Specification for High Strength Low Alloy Structural Manganese Vanadium Steel	
ASTM B633	Electrodeposited Coating of Zinc on Iron and Steel	
AWS A3.0	American Welding Society Definitions; Terms and Definitions	All welding and cutting terminology
AWS A5.28	Specification for Low Alloy Steel Filler Metals	
AWS D3.6–93	American Welding Society Specification for Underwater Welding	Underwater welding
NAVEDTRA 43119–2C	Personnel Qualification Standard for Damage Control Qualifications, Section No. 2, General Damage Control	
OP NAV 5100.19	Navy Safety Precautions for Forces Afloat	
SSPC–SP5	Volume 2, White Metal Blast Cleaning	

Notes:

1. Where reference is made in this volume to MIL–STD–1689, **Fabrication, Welding, and Inspection of Ships Structure**, for surface ships, American Bureau of Shipping (ABS) rules may be used for applications involving noncombatant surface ships and ships originally built to ABS standards.
2. Where reference is made in this volume to MIL–STD–1689 for small boats and craft, NAVSEA 0900–LP–060–4010, **Fabrication, Welding, and Inspection of Metal Boat and Craft Hulls**, may be used.
3. Where NAVSEA 0900–LP–060–4010 is referenced in this volume, MIL–STD–1689 may be used.

074–1.3.2 MANDATORY REFERENCE DOCUMENTS. The latest editions of the mandatory reference documents are listed in Table 074–1–1. Requirements specified in changes or revisions to these documents, or to NAVSEA instructions of a date later than the issue date of this volume, supersede the requirements herein.

074–1.3.3 GUIDANCE DOCUMENTS. Documents which provide guidance information are listed in Table 074–1–2.

074–1.4 DEFINITIONS

074–1.5 Terminology concerning work being performed is included in the applicable fabrication document. Definitions of terms commonly used are as follows:

a. Approval or Approved. The item under consideration requires formal acceptance by NAVSEA or its authorized representative. The words approval or approved shall be used by NAVSEA's authorized representative to indicate acceptance, unless NAVSEA approval is specified. Authorized representatives of NAVSEA for approval purposes are:

1. Naval Shipyard Commanders
2. Supervisor of Shipbuilding (SUPSHIP)
3. Naval Ship Systems Engineering Station (NAVSSES)
4. Naval Ship Repair Facilities Commanders
5. Authorized agent as defined in the applicable fabrication document
6. Representatives specifically authorized by NAVSEA.

b. Certification. Certification indicates that the item under consideration has been tested by the manufacturer or that on receipt, inspection tests were conducted by an authorized government agency. Certification indicates that the item has been verified to be in conformance with the procurement specification requirements. Certification of conformance will be received in writing, properly signed by the manufacturer or other authorized individual.

c. Fabrication Document. The fabrication document is the document invoked by this volume for the contracts, purchase orders, and other requirements which govern work being accomplished. Examples include MIL–STD–1688 (SH), **Fabrication, Welding, and Inspection of HY–80/100 Submarine Applications,** MIL–STD–1689, **Fabrication, Welding, and Inspection of Ships Structure,** MIL–STD–278, **Welding and Casting Standard**, and so forth.

d. Higher Strength Steels. Higher strength steels are a class of steels in MIL–S–22698, **Steel Plate, Shapes and Bars, Weldable Ordinary Strength and Higher Strength: Structure**, which supersedes grade HT of MIL–S–16113C and MIL–S–20166B.

e. Ordinary Strength Steels. Ordinary strength steels are a class of steels in MIL–S–22698B, which supersedes grades A, B, and D of MIL–S–22698A and grade M of MIL–S–20166B.

f. Submarine Safety Boundaries. Submarine safety boundaries are defined in NAVSEA 0924–LP–062–0010, Rev A (or latest revision in effect), **Submarine Safety (SUBSAFE) Requirements** manual.

g. Welding Terminology. Terms related to welding shall be according to American Welding Society, Publication AWS A3.0, **American Welding Society Definitions; Terms and Definitions.**

Table 074–1–2. GUIDANCE DOCUMENTS

Identification	Title
ANSI/ASC Z49.1*	Safety in Welding and Cutting
AISI 8620	Carbon and Alloy Steels
AWS B4.0	Standard Methods for Mechanical Testing of Welds
NAVSEA 0900–LP–038–8010	Ship Metallic Material Comparison and Use Guide
NAVSEA 0389–LP–031–7000	Procedures for Maintenance and Repair of Naval Reactor Plants
NFPA 51B**	Standard for Fire Prevention in Use of Cutting and Welding Processes

Notes: * Available from American Welding Society (AWS), 550 LeJeune Road, Miami, FL 33126
** Available from National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

SECTION 2.
QUALIFICATION REQUIREMENTS

074–2.1 INTRODUCTION

074–2.1.1 Shipyards (naval and privately owned) and commercial contractors performing work according to this volume shall meet the qualification requirements of the applicable fabrication document. Other military activities shall meet the requirements of this section. All activities shall meet the qualification requirements of 074–6.9 for underwater welding and NDT.

074–2.2 WELDING, BRAZING, AND THERMAL SPRAYING PROCEDURE AND PERFORMANCE QUALIFICATIONS

074–2.2.1 INTRODUCTION. All welding shall be performed according to written procedures that have been prepared and qualified according to MIL–STD–248, **Welding and Brazing Procedure and Performance Qualification**. All brazing shall be performed according to written procedures that have been prepared and qualified according to MIL–STD–248 or Naval Sea Systems Command (NAVSEA) 0900–LP–001–7000, **Fabrication and Inspection of Brazed Piping Joints**, as referenced therein. All thermal spraying shall be performed according to written procedures prepared and qualified according to the requirements of MIL–STD–1687 (SH) **Thermal Spray Processes for Naval Ship Machinery Applications** or DOD–STD–2138, **Metal Sprayed Coating Systems for Corrosion Protection Aboard Naval Ships**, as applicable.

074–2.2.2 MILITARY ACTIVITIES OTHER THAN SHIPYARDS. Except for underwater welding, military activities other than shipyards may use welding or brazing procedures which have been qualified according to the requirements of the appropriate qualification document by a naval shipyard or ship repair facility. Procedures contained in NAVSEA 0389–LP–031–7000, **General Procedures for Maintenance and Repair of Naval Reactor Plants** may be used by forces afloat, Ship Repair Facilities (SRF's), and Intermediate Maintenance Activities (IMA's). Organizational and administrative changes may be made to adapt the welding or brazing procedure to the specific military activity. Changes to the technical content of any such procedure shall not be permitted unless approval is obtained from the activity that qualified the procedure.

074–2.2.3 APPROVAL AGENCIES. Agencies authorized to approve welding, brazing, or thermal spraying procedure qualifications are specified in MIL–STD–248, NAVSEA 0900–LP–001–7000, MIL–STD–1687, or DOD–STD–2138, as appropriate.

074–2.2.4 CIVILIAN PERFORMANCE QUALIFICATIONS. Civilian welder and brazer performance qualifications shall be according to MIL–STD–248 and NAVSEA 0900–LP–001–7000, as applicable for non-nuclear applications. Thermal spray operator performance qualifications shall be according to the requirements of MIL–STD–1687 or DOD–STD–2138, as applicable.

074–2.2.5 NONDESTRUCTIVE TESTING QUALIFICATIONS. Nondestructive testing personnel and procedure qualification requirements for military personnel shall be according to **NSTM Chapter 074, Volume 2, Nondestructive Testing of Metals, Qualification and Certification Requirements for Naval Personnel (Non-Nuclear)**. Nondestructive testing testing personnel and procedure qualification requirements for civilian facilities shall be according to MIL–STD–271, **Nondestructive Testing Requirements for Metals.** Additional NDT qualification requirements for underwater welding are specified in 074–6.9.

074–2.2.6 MILITARY PERFORMANCE (WELDER) QUALIFICATION. The qualification of naval welders shall be according to the performance qualification requirements of MIL–STD–248 and the following paragraphs.

074–2.2.6.1 Initial Qualification. Naval welders will normally receive their initial qualification at the welding school under MIL–STD–248. Each qualification shall require successful completion of applicable training projects and satisfactory performance qualification tests. However, achievement of a welding Navy Enlisted Classification

Code (NEC) is not a requirement for granting any specific qualification by the welding school. All specific qualifications received at the welding school, provided they are properly maintained (see paragraph 074–2.4.4) or requalified (see paragraph 074–2.4.5), are applicable to welding assignments at all naval activities. The welding school shall be either:

a. Welding School, Class C, Service School Command, Naval Training Center, San Diego, CA 92133.

b. Atlantic Fleet C School, HT Welding, Norfolk Naval Shipyard, Portsmouth, VA 23709.

Welders shall attend welding school except for aluminum welding and brazing when training is obtained otherwise.

074–2.2.6.2 Specific Qualification. Qualification for specific additional welding processes, filler metal groups, and welding positions may be obtained at a naval shipyard, SRF, or an IMA any time after the receipt of a welding NEC. Specific qualifications shall require the welder to be familiar with the specific type of welding and to weld satisfactory test assemblies according to MIL–STD–248.

074–2.2.6.3 Validation of Qualification. All military welder qualifications, requalifications, and maintenance of qualification shall be valid only if recorded in the individual's service record according to paragraphs 074–2.4 through 074–2.4.5.

074–2.2.6.4 Welding Navy Enlisted Classification Code Achievement. Personnel may achieve a welding NEC only by successfully completing the applicable course, projects, and qualification tests at a welding school. Training projects and qualification tests for NEC's other than Nuclear Welder NEC 4956 are listed in paragraph 074–2.2.7. Welding course number and related NECs are listed in Table 074–2–1.

074–2.2.7 NAVY ENLISTED CLASSIFICATION TEST REQUIREMENTS. The extent of welder or welding operator qualification resulting from tests shall be governed by MIL–STD–248 for all welders other than NEC 4956 (see Table 074–2–1).

Table 074–2–1. WELDING COURSE NUMBER, TITLE, AND NAVY ENLISTED CLASSIFICATION CODE

Course Number	Title	NEC
A–701–0025	Basic Welding	None
A–701–0026	General Maintenance Welder	4954
A–701–0027	Non-Nuclear Welder	4955
A–701–0028	Nuclear Welder*	4956

Note:
* Has previously achieved NEC 4955 and is qualified to perform gas tungsten arc welding (GTAW) on nuclear power plant components.

074–2.2.7.1 Completion of Tests. Any individual who has completed the school but is failing a part or all of the qualification tests should be encouraged to complete the tests for eventual achievement of an NEC code. Such test completion can be obtained by successful performance of an applicable test at naval shipyards, SRF, or aboard tenders or repair ships having radiographic facilities and a certified nondestructive test (NDT) examiner or inspector.

074–2.2.7.2 Welding Limitations. An individual successfully completing any valid performance qualification test may perform welding in the weld categories of 074–2.2.9.2 and 074–2.2.11.2, and within the limits of the qualification test; that is, process, materials, position, and so forth.

074–2.2.7.2.1 The NEC achievement requirements, required qualifications, and weld category limitations (see paragraph 074–1.2) for a welder other than NEC 4956 (see Table 074–2–1) are given in paragraphs 074–2.2.8 through 074–2.2.10.

074–2.2.8 COURSE A–701–0025, BASIC WELDING. This course consists of training in Shielded Metal Arc Welding (SMAW) of carbon steel and low-alloy steel plate and pipe. Training in Gas Metal Arc Welding (GMAW) of aluminum plate and SMAW of light gauge sheet steel is also included to provide supplementary skills for noncritical work. This course is a prerequisite for courses A–701–0026 and A–701–0027 (see Table 074–2–1).

074–2.2.9 COURSE A–701–0026, NEC 4954, GENERAL MAINTENANCE WELDER. This course consists of training in SMAW of carbon steel and low–alloy steel plate and pipe. Course phases include emergency weld repairs to boilers, instruction in application and measurement of acquired preheat for welding different grades of steel piping, training in brazing copper-nickel tubing, and visual and liquid–penetrant testing of welds. The training in nondestructive testing techniques in this course does not meet the NEC qualification requirements for a nondestructive testing operator or inspector.

074–2.2.9.1 Minimum Requirements. The minimum requirement to achieve an NEC 4954 (see Table 074–2–1) as follows:

a. The welder shall have successfully completed courses A–701–0025 and A–701–0026 (see Table 074–2–1) and used the SMAW process to produce two satisfactory pipe socket weld joint qualification test assemblies.

b. The welder must also demonstrate knowledge of emergency boiler repair methods and conduct and correctly interpret a liquid penetrant (PT) inspection of his or her qualification test welds.

c. Socket weld joint qualification test assemblies shall be welded with the MIL–7018 electrode in horizontal–fixed and vertical–fixed positions. The fitting shall be on top in the vertical-fixed position. Both tests shall be made with restricted access as illustrated in MIL–STD–248.

d. Socket joint qualification assemblies shall each be comprised of one socket type fitting and two sections of pipe with wall thickness of less than 3/16–inch. Diameter and wall thickness are to be based on the qualification limitations of MIL–STD–248 and what size is required to support a majority of production work. The fitting shall be a carbon steel socket type coupling according to American National Standards Institute (ANSI) B16.11, class 3000, or equivalent. Pipe shall be carbon steel according to American Society for Testing and Materials (ASTM) A106, grade B, or equivalent. Joint design shall be P–14 of MIL–STD–22, **Welded Joint Design.**

e. Socket weld test assemblies shall be visually inspected and PT inspected according to MIL–STD–271, and shall conform to the requirements of NAVSEA 0900–LP–003–8000, **Surface Inspection Acceptance Standards for Metal (Includes MT, PT, and Visual Inspection)**, class I. Each socket weld assembly shall be sectioned according to MIL–STD–248. At least one section shall be taken through a start or stop location. These specimens shall be examined to the requirements of MIL–STD–248.

f. Each welder and brazer shall be trained and tested on visual and workmanship requirements according to MIL–STD–248.

074–2.2.9.2 Weld Categories. Personnel who have achieved a NEC 4954 (see Table 074–2–1) rating may perform welding and brazing in categories D, E, and F (paragraphs 074–1.2.1.d through 074–1.2.1.e) within the performance qualification limitations of MIL–STD–248 and NAVSEA 0900–LP–001–7000, as applicable for the qualification tests passed. Welding of category C components as specified by paragraph 074–2.2.9.3, or category C aluminum components is also permitted.

074–2.2.9.3 Upon successful completion of socket weld qualification tests, NEC 4954 (see Table 074–2–1) welders may weld and, on an emergency basis, dye penetrant inspect socket design joints in category C piping of 2 inches iron pipe size (IPS) and less within the following limitations:

a. Except as provided in subparagraph b, consider all welds category D and require that an OPNAV 4790/2K Deferred Action be submitted for review and reinspection at the next availability. Meet all requirements of this document for category D welds. The welder shall not perform weld inspection at any activity where qualified nondestructive test inspectors are available. All welds inspected by the welder shall be reinspected by a qualified nondestructive test inspector, or removed.

b. A weld may be considered a permanent (category C) weld and the OPNAV 4790/2K Deferred Action mentioned in subparagraph a need not be submitted when all nondestructive test inspections are performed by qualified inspectors and all other requirements of this document for category C welds are met.

c. Preheat and interpass temperatures shall be according to MIL–STD–278, **Welding and Casting Standard** and the applicable welding procedure. The minimum preheat temperature for S–4 group materials shall be 250°F (121°C).

d. Accomplish welding on piping of material group S–1 of MIL–STD–248 with MIL–7018 electrodes in conformance with MIL–E–22200/1.

e. Accomplish welding on piping of material group S–3 with MIL–7010–A1 or MIL–7018–A1 electrodes according to MIL–E–22200/7. Accomplish welding on piping material group S–4 with MIL–8015–B2L, MIL–8016–B2L, or MIL–8018–B2L electrodes according to MIL–E–22200/8.

f. Accomplish welding on piping of material group S–5 with MIL–9015–B3L, MIL–9016–B3L, or MIL–9018–B3L electrodes according to MIL–E–22200/8.

g. Accomplish welding on joints incorporating material in two S–groups using the electrodes specified in subparagraphs d, e, or f for the higher number S–group. Do not perform welding on piping of any materials other than those listed in subparagraphs d, e, and f.

h. Unless otherwise specified by MIL–STD–278, stress relief is not required.

074–2.2.10 COURSE A–701–0027, NEC 4955, NON–NUCLEAR WELDER. Course consists of training in SMAW of ordinary strength steel and higher strength steel plate, and SMAW and gas tungsten arc welding (GTAW) butt–and–socket welding of carbon and alloy-steel pipe. The course will also familiarize individuals with visual inspection, workmanship and welding requirements of MIL–STD–1688 (SH) **Fabrication, Welding, and Inspection of HY–80/100 Submarine Applications**, MIL–STD–1689, (SH) **Fabrication, Welding, and Inspection of Ships Structure** and MIL–STD–278.

074–2.2.10.1 The minimum requirement to achieve an NEC 4955 (see Table 074–2–1) are as follows.

a. The welder shall have successfully completed courses A–701–0025 and A–701–0027 (see Table 074–2–1), used the SMAW process to produce two acceptable plate and pipe qualification test assemblies, and used the GTAW process to produce two satisfactory pipe qualification test assemblies.

b. SMAW plate qualification test assemblies shall be welded with the MIL–10018M or MIL–11018M electrode in the 3G and 4G positions as illustrated in MIL–STD–248. Assemblies shall be comprised of ASTM A36 carbon steel or equivalent. Plate thickness shall be 3/8–inch nominal minimum. Welding shall be done according to filler metal controls and welding requirements for greater than 1/2–inch HY–80 steel plate, as described in the applicable fabrication document.

c. SMAW pipe qualification test assemblies shall be welded with MIL–7018, MIL–8018–C3, or MIL–8018–B2L electrodes. Welding shall be conducted with restricted access, in the 2G and 5G pipe positions as illustrated in MIL–STD–248. Assemblies shall conform to test number 4 of MIL–STD–248, except that other applicable joint designs of MIL–STD–22 are not permitted and space restrictions of MIL–STD–248 are applicable. Pipe shall be carbon steel, 2–1/2 inch normal pipe size and of 3/8–inch normal wall thickness or greater, conforming to ASTM A106, **Std Specification for Seamless Carbon Steel Pipe for High-Temperature**

Service, grade B or equivalent, except that hydrostatic testing is not required. Welding shall be conducted using preheat and interpass temperature control requirements for group S–4 materials more than 1/2–inch thick according to MIL–STD–278.

d. GTAW pipe qualification test assemblies shall be welded with type MIL–70S–2, MIL–70S–3, MIL–70S–4 filler metal conforming to MIL–E–23765/1 or MIL–80S–1, MIL–80S–2 of MIL–E–23765/2, or ER 80S–B2 (or ER 80S–B2L) and ER 90S–B3 (or ER 90S–B3L) of AWS A 5.28, **Specification for Low Alloy Steel Filler Metals**. Welding shall be conducted with restricted access in the 2G and 5G pipe positions as illustrated in MIL–STD–248. Assemblies shall be identical to those required for SMAW pipe qualification referred to in subparagraph c except that joint design shall be either P–73 or P–74 (consumable insert) of MIL–STD–22. GTAW pipe qualification test assemblies shall be conducted using the preheat and interpass temperature control requirements for group S–4 materials over 1/2–inch thick, according to MIL–STD–278.

e. All qualification test assemblies completed in the A–701–0027 course (see Table 074–2–1) shall be evaluated by visual examination and radiographic inspection (RT). Acceptance standard for RT shall be NAVSEA 0900–LP–003–9000, **Radiography Standard for Production and Repair Welds**, class I, and for visual inspection, the acceptance standard shall be NAVSEA 0900–LP–003–8000 class I.

f. Each welder shall be trained and tested on visual and workmanship requirements according to MIL–STD–248.

074–2.2.11 EXTENT OF QUALIFICATION. Extent of qualification for welding SMAW plate and SMAW and GTAW pipe shall be as follows.

074–2.2.11.1 Acceptable completion of SMAW plate qualification tests shall qualify welding of plate and structural components in all categories of repair (see paragraphs 074–1.2.1.a through 074–1.2.1.e). Qualification limitations for joint designs, filler material, process, and so forth, shall be as specified by MIL–STD–248.

074–2.2.11.2 Acceptable completion of SMAW and GTAW pipe qualification test shall qualify welding of piping and machinery components in all categories of repair (see paragraphs 074–1.2.1.a through 074–1.2.1.e). Qualification limitations for joint designs, filler materials, process, and so forth, shall be as specified by MIL–STD–248.

074–2.3 UNDERWATER WELDING AND NDT QUALIFICATION

074–2.3.1 Qualification of underwater welding and NDT procedures and personnel shall be in accordance with 074–6.9 for all activities.

074–2.4 MILITARY RECORDS

074–2.4.1 QUALIFICATION TEST RECORDS. Qualification test records for personnel assigned shall be maintained as specified according to MIL–STD–248. The test record shall include information in subparagraphs a through g following. In order to ensure proper maintenance of welder and brazer qualifications, a log of qualification tests and annual vision tests shall be kept by each Commanding Officer for personnel assigned.

a. Welder or brazer identification (name, rate, social security number, or service number)

b. Test date

c. Qualification test number, process, position, base material type, filler metal type and size

d. Test results

e. Record of omission of space restriction when not used in pipe tests

f. Workmanship and visual inspection examination results according to MIL–STD–248

g. Certifying signature

074–2.4.2 VISION TEST RECORDS. The following vision test records shall be maintained.

a. Identification

b. Test date

c. Test description

d. Test results

e. Certifying signature

074–2.4.3 PERSONNEL SERVICE RECORD ENTRIES. entries into the individual's service record, NAVPERS 1070/613, are required for each successful vision test, performance qualification, and requalification test performed, and shall include information specified in paragraphs 074–2.4.1 and 074–2.4.2 as listed in the log.

074–2.4.4 QUALIFICATION MAINTENANCE. Proof of qualification maintenance shall consist of at least one process usage verification within each 3–month or calendar quarter period. For NECs, records shall be reviewed by personnel responsible for quality assurance provisions described in Section 3, and compared with the personnel file of the individual to determine the need for requalificaiton.

074–2.4.5 RENEWAL OF QUALIFICATIONS. Welders and brazers who lose qualification through lack of process use or record verification shall have requalification renewed according to MIL–STD–248 before performing production welding or brazing.

074–2.4.6 EQUIPMENT QUALIFICATION. Welding equipment (such as generators and rectifiers) capable of producing proper welding characteristics need not be qualified.

SECTION 3.
QUALITY ASSURANCE

074–3.1 INTRODUCTION

074–3.1.1 This section contains minimum requirements for quality assurance provisions for material and welding accomplished according to this chapter. For shipyards, Ship Repair Facilities (SRF's), and commercial contractors, the quality assurance requirements of mandatory reference documents shall be used instead of the quality assurance requirements specified in this section. For other military activities and forces afloat, the quality assurance provisions specified in this section apply. Mandatory reference documents do not apply unless specifically referenced.

074–3.2 MATERIALS REQUIREMENTS AND CERTIFICATION

074–3.2.1 Ordering and purchasing of materials shall be according to the latest military, federal, Joint Army–Navy (JAN), or industry specification (as applicable for intended service) indicated in mandatory reference documents, technical manuals, drawings, or other instructions. Material from the Navy Stock System, identified by proper stock number, shall be considered to conform to the latest specifications. The presence of a Material Identification and Control (MIC) number or Level 1 number on certified material supplied by the Navy Stock System satisfies the requirement for evidence of conformance.

NOTE

Material forming a part of the Submarine Safety (SUBSAFE) boundary or requiring level 1 certification according to NAVSEA 0905–LP–501–7010, **Trident Submarine Logistic Support Master Plan Introduction**, requires evidence of specification conformance.

074–3.2.2 The requirements of NAVSEA 0948–LP–045–7010, **Material Identification and Control (MIC) for Piping Systems**, shall be met.

074–3.3 WELDING MATERIAL CONTROL

074–3.3.1 Electrodes used for welding submarines and surface ships require special handling and maintenance procedures as specified in the applicable fabrication document. Identification of welding and brazing materials by type and grade shall be strictly controlled. Any welding or brazing materials that have lost their identification shall not be used.

074–3.4 INSPECTION AND RECORDS

074–3.4.1 CATEGORY A AND C WELDS. Inspection records of category A and C welds shall be as required in the applicable fabrication document. Records for category C underwater welds shall be in accordance with 074–6.9.

074–3.4.2 CATEGORY B WELDS. For submarines that have met SUBSAFE certification requirements, all repairs to SUBSAFE boundaries are considered temporary when requirements of the applicable fabrication documents are not met. A documentation and reporting procedure shall be used for category B welds.

074–3.4.3 EMERGENCY WELDS. Where emergency welds are to be made by activities unable to comply with all requirements for categories A or C welds, work shall be accomplished to the best of their ability to conform to applicable fabrication documents and, as a minimum, welds shall be accomplished within minimum requirements established in this chapter.

074–3.4.3.1 Activities accomplishing emergency work on equipment, components, and piping systems certified as SUBSAFE, or submarines safety boundaries, shall inform the Type Commander and Naval Sea Systems Command (NAVSEA) as soon as possible about the nature of emergency work, extent of noncompliance with requirements of applicable fabrication documents, and shall record such emergency work as an emergency temporary repair. Approval to deviate from the requirement of a fabrication document shall be obtained according to paragraph 074–4.2.2.

074–3.4.3.2 The Type Commander will evaluate noncompliance and determine whether interim operational restrictions are necessary to permit safe operations before ensuring full compliance with applicable fabrication documents. As soon as possible, emergency repairs shall be inspected by a shipyard or activity capable of complying with requirements of the applicable fabrication document. The fully qualified activity shall certify that work complies with the fabrication document or shall redo the work, as necessary, for compliance.

074–3.4.4 CATEGORY D WELDS. Records and reports for category D welds shall be in accordance with the applicable fabrication document. Records for category D underwater welds shall be in accordance with 074–6.9.

074–3.4.5 CATEGORY E AND F WELDS. No records are required for category F welds. Records for category E welds, associated with underwater welding, shall be in accordance with 074–6.9. No records are required for other category E welds.

SECTION 4.
WELDING AND BRAZING REQUIREMENTS

074–4.1 INTRODUCTION

074–4.1.1 This section contains welding and brazing requirements that apply to both surface ship and submarine repairs. Additional requirements that apply only to surface ships or submarines are contained in Section 5.

074–4.2 GENERAL REQUIREMENTS

074–4.2.1 For category A, C, and E welds, all requirements of the applicable fabrication document shall be met.

WARNING

Where an emergency condition endangers life or ship, the Commanding Officer shall determine and take necessary repair action. Repair action taken shall be reported to the Type Commander and Naval Sea System Command (NAVSEA).

074–4.2.2 For category B and D welds, requirements of the applicable fabrication document should be met. Where a particular requirement cannot be met, approval to deviate shall be obtained from the Type Commander and NAVSEA.

074–4.2.3 Category F welds such as identification plates, galley equipment, furniture, and fixtures should meet any relevant requirements of the applicable fabrication document.

074–4.2.4 Use of the shielded metal arc (SMA) welding process with alternating current (ac) is prohibited.

074–4.3 WELDING IN WAY OF WETTED SURFACES

074–4.3.1 Unless a NAVSEA approved procedure is used, no welding shall be done on material that requires preheating when water, oil, or similar materials are in contact with the surface opposite the side to be welded, and where there is less than 1/4 inch of base material between the weld area and the side in contact with the liquid. This restriction does not apply to materials which do not require preheating.

074–4.3.2 Surfaces to be welded shall be dry. It is recommended that a minimum preheat temperature of 60° F (15.6° C) be obtained, if possible. The precautions of this chapter, **NSTM 074 Volume 3, Gas Free Engineering**, shall apply.

074–4.4 TEMPERATURE–INDICATING CRAYONS

074–4.4.1 Temperature indicating crayons that contain weld-contaminating elements such as lead, sulphur, zinc, cadmium, or mercury shall not be used. Federal Stock Classification number for temperature indicating crayons is 6685.

074–4.5 BIMETALLIC BOND

074–4.5.1 Bimetallic bonded steel to aluminum transition joints are subject to degradation when overheated. Affected bond areas shall be monitored during welding to ensure that temperature does not exceed 400°F (204°C) or the maximum interpass temperature, whichever is less.

074–4.6 WELD DEPOSITS

074–4.6.1 Ferritic welds of any type shall not be deposited on welds made with austenitic or nonferrous electrodes.

CAUTION

Many ships are constructed using austenitic electrodes such as MIL–310–15 on high-tensile steel (HTS) and special treatment steel (STS) materials. When welding is to be performed on HTS or STS materials that have existing austenitic (stainless steel) weld deposits in way of the new welding, the new welding shall be done with austenitic electrodes according to the applicable fabrication document, or all of the austenictic material shall be completely removed and welding accomplished with ferritic electrodes according to the applicable fabrication document. Complete removal of austenitic material shall be verified by chemical etching according to good metallurgical practice before welding with ferritic electrodes. The austenitic material will appear lighter, while the ferritic material will appear darker.

074–4.7 OXYFUEL GAS CUTTING

074–4.7.1 The oxyfuel gas cutting of ferritic alloys shall be according to applicable fabrication documents. Resulting weld joint surfaces shall be cleaned and inspected to the requirements of applicable fabrication documents.

074–4.8 HOT OR COLD FORMING OF CASTINGS

074–4.8.1 Hot or cold forming of castings shall not be accomplished without NAVSEA approval.

074–4.9 PREPARATION OF FULL PENETRATION DOUBLE BEVEL WELD JOINT DESIGNS

074–4.9.1 Double bevel weld joint designs may be prepared by beveling one side of the joint before welding and by backgouging the root on the second side after sufficient weld metal has been deposited on the first side.

074–4.10 REDUCED SOCKET DEPTH

074–4.10.1 For repairs of joints P–14 and P–15 of MIL–STD–22, **Welding Joint Designs,** where the weldment and the pipe must be removed, the existing fitting with reduced socket depth may be reused under the following conditions:

a. The pipe end gap clearance shall be 1/32 to 1/16 inch maximum.

b. If the diametrical clearance between the pipe and the fitting is 0.025 inch and less, the L dimension may be reduced by 50 percent of the specified dimension.

c. If the diametrical clearance is greater than 0.025 inch, but is within 0.065 inch, the L dimension may be reduced by 25 percent of the specified dimension.

The provisions of reduced socket depth do not apply if the diametrical clearance exceeds 0.065 inch.

074–4.11 REDUCED COUNTERBORE DEPTH

074–4.11.1 For repair of joints P–73 to P–76 of MIL–STD–22, **Welding Joint Designs**, which have been cut and refit, the depth of counterbore shall be 1/8 inch minimum.

074–4.12 BRAZING

074–4.12.1 All structural brazing shall be according to requirements of the applicable fabrication document. All pipe brazing shall be according to requirements of NAVSEA 0900–LP–001–7000, **Fabrication and Inspection of Brazed Piping Systems.**

074–4.12.2 For the purpose of determining the permissible number of repair cycles, consider that all P–3a pipe joints (to be repaired) have been repaired once during initial construction unless evidence is available to the

contrary. P–3b pipe joints need not be considered as having been previously repaired unless evidence is available to indicate otherwise.

074–4.12.3 Minimum flux brazing technique may be used under the conditions specified in NAVSEA 0900–LP–001–7000 and shall conform to the requirements specified therein.

074–4.12.4 Any deviation in brazing from NAVSEA 0900–LP–001–7000 shall require prior approval.

074–4.13 ALLIED PROCESSES

074−4.13.1 RESISTANCE WELDING. Resistance welding shall be used only on category F welds.

074−4.13.2 METALLIZING. All metallizing applications shall be according to MIL–STD–1687, **Thermal Spray Processes for Naval Ship Machinery Applications**, or DOD–STD–2138, **Metal Sprayed Coating Systems for Corrosion Protection Aboard Naval Ships**, as applicable.

074−4.13.3 ELECTROPLATING. When electroplating is authorized for repair, it shall be performed by immersion technique or be contact (brush-on method) and shall conform to the applicable specifications listed in Table 074–4–1.

Table 074–4–1. ELECTROPLATING SPECIFICATIONS

Deposit	Specification
Chromium	QQ–C–320
Copper	MIL–C–14550
Gold	MIL–G–45204
Nickel	QQ–N–290
Silver	QQ–S–365
Tin	MIL–T–10727
Tin-Lead	MIL–P–81728
Zinc	ASTM B633

074−4.13.3.1 Selective Electroplating. Selective electroplating shall be accomplished according to NAVSEA 0900–LP–038–6010, **Deposition of Metals by Contact (Brush-On Method) Electroplating**.

074−4.13.3.2 Shaft Electroplating. Electroplating for repair of shafts not subject to seawater service shall be according to DOD–STD–2182.

SECTION 5.
STRAY CURRENT PROTECTION

074–5.1 UNDERWATER CORROSION

074–5.1.1 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.

074–5.1.2 Corrosion of a ship hull may result from other sources of direct currents. If a grounded neutral leg of a three–wire direct current system, used to supply power to the ship, is grounded permanently or accidentally on the ship, current flow will result.

074–5.2 CURRENT FLOW

074–5.2.1 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.

074–5.3 WELDING EQUIPMENT REQUIREMENTS

074–5.3.1 To prevent possible serious damage to electrical and ordnance equipment, and pitting of ship structure, the requirements for welding on ships, both waterborne and in dry or floating docks, shall be used. The requirements are:

a. Each ship shall have a separate welding current power source.

b. Return cable of any welding generator shall never be grounded to anything but the ship the cable is servicing.

c. Welding cable used in each welding circuit, either in the electrode or in the ground or return side of the circuit, shall be completely insulated, and not permitted to drop overboard into the water.

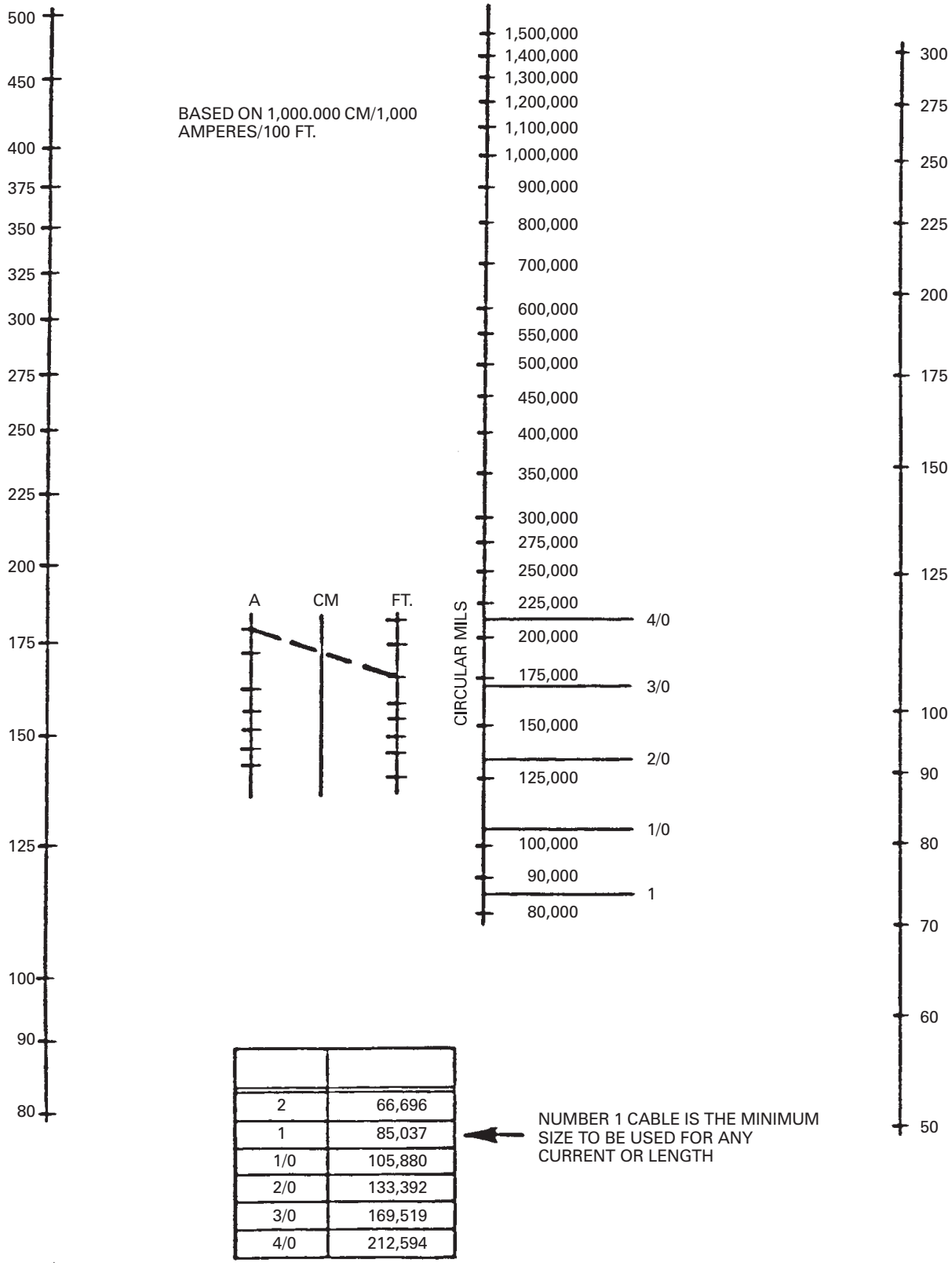
d. The frame or case of the welding machine, except engine–driven types, shall be grounded according to the methods prescribed in the National Electrical Code (primary side).

074–5.4 GROUNDING CONNECTIONS

074–5.4.1 CABLE LUGS. Grounding cable lugs shall be secured tightly to grounding plates. The lug contact area shall be cleaned thoroughly to base metal. Resistance of the connection shall be a maximum of 125 microhm for each connection; voltage drop across the connection shall be a maximum of 62.5 millivolts (mV) for a current of 500 amps (A) except as outlined in paragraph 074–5.4.1.1. Use Ohm's law (V = IR) to determine voltage drop for currents other than 500 A.

074–5.4.1.1 Electrical measurement at lug contact area need not be made onboard ships which are part of the forces afloat, provided welding is to be accomplished using a single–operator direct current (dc) machine using shipboard power. All other rules of grounding given in paragraphs 074–5.3 through 074–5.4.1 shall be strictly adhered to.

074–5.4.2 CABLE SIZE. Cross–sectional areas of return ground 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. A nomograph showing required cable size for ground return leads is presented in Figure 074–5–1.



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

NUMBER 1 CABLE IS THE MINIMUM SIZE TO BE USED FOR ANY CURRENT OR LENGTH

Figure 074–5–1. Nomograph for Copper Ground Wire Size

074–5.4.2.1 Manufacturers' recommendations for electrode lead cable size shall 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 cable size is presented in Figure 074–5–2.

074–5.4.3 RESISTANCE. Resistance between welding ground cable and the welding machine case should not be less than 0.1 megohms when the machine is not connected to the ship. Resistance less than 0.1 megohms will indicate improper insulation of ground cable, or a need to clean the welding machine.

074–5.5 WELDING UNIT ARRANGEMENTS

074–5.5.1 Combinations of welding unit arrangements with correct and incorrect grounding connections are shown in Figure 074–5–3, Figure 074–5–4, Figure 074–5–5, Figure 074–5–6 and Figure 074–5–7. These figures represent common arrangements and errors in making welding machine connections.

074–5.5.2 Details for making provisions for welding grounding connections on steel surface ships and submarines are shown in Figure 074–5–8 and Figure 074–5–9.

074–5.5.3 These minor modifications for welding grounding connections can be accomplished when authorized by the Type Commanders. Because electrical currents have the tendency of running to structural points, two grounding cables should be used. The grounding cables should be located as close to the bow and stern as practical.

074–5.5.4 For ocean minesweepers (MSO's) and other ships constructed of nonmagnetic materials, ground return cable shall be connected directly to the component being welded. Ground return cables shall be located as close to the weld zone as possible.

074–5.6 SPECIAL PRECAUTIONS

074–5.6.1 GENERAL. For welding on or near electrical equipment, machinery, or ordnance equipment, special precautions shall be observed. Precautions listed in paragraphs 074–5.6.2 through 074–5.6.5 shall be followed for welding equipment electrical connections when welding on or near electrical or loaded ordnance equipment.

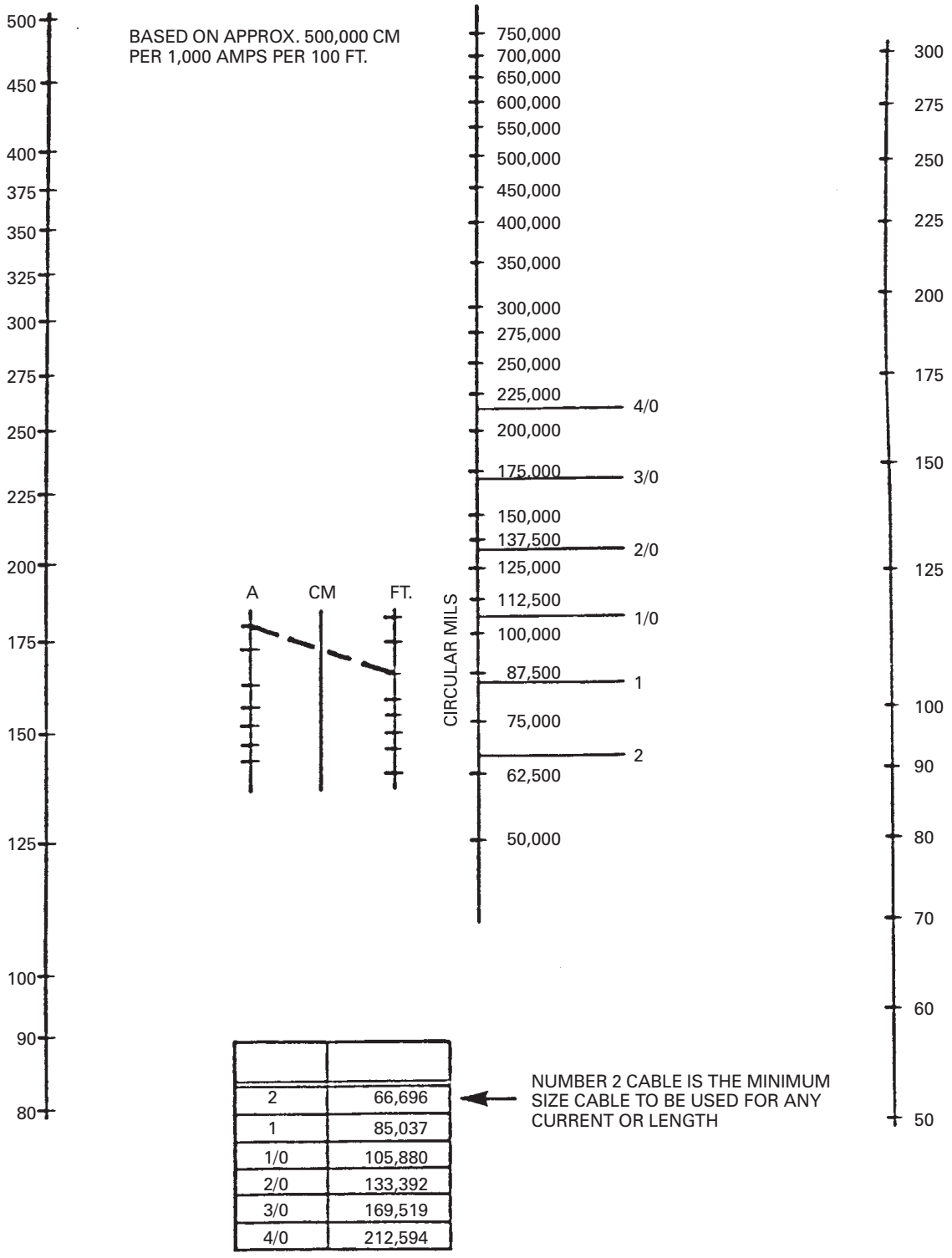
074–5.6.2 WELDING CURRENT. The static grounding straps on electrical equipment, machinery, and ordnance equipment have not been designed, and shall not be used, as welding ground returns. Welding current shall not be allowed to pass through bearings (ball, roller, or bushing type) to return to grounds such as gun mounts, motors, and lathes.

074–5.6.3 SPLITTING GROUND RETURN CABLES. When welding on piping that leads into loaded ordnance equipment areas is welded, ground return cables should be split into two equal ground return cables, 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 ground connections, provide additional split ground connections to such items. A maximum distance of 10 feet should be maintained between connectors and work. See ANSI/ASC Z49.1, **Safety in Welding and Cutting**, for additional restrictions.

074–5.6.4 RESISTANCE CHECKS. Ensure adequacy of ground return cable connections between ship hulls and power source by checking resistance of the connection, which shall be a maximum of 125 microhms for each connection, or the voltage drop across the connection should be a maximum of 25 millivolts (mV) for a current of 200 A.

074–5.6.4.1 Ensure that ground return cables are adequate for amperage and distance involved (see Figure 074–5–1).

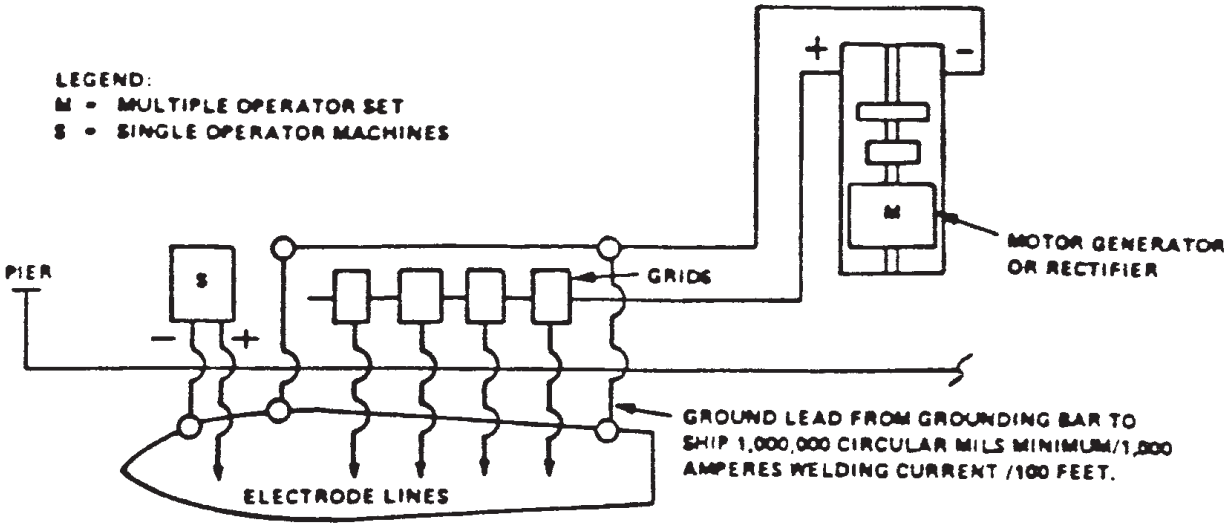
074–5.6.4.2 Precautionary measures outlined in manufacturers' equipment manuals and other documents should be observed when welding on or near electrical equipment. These measures should be observed because the induced magnetic field produced by welding may damage electrical equipment.



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

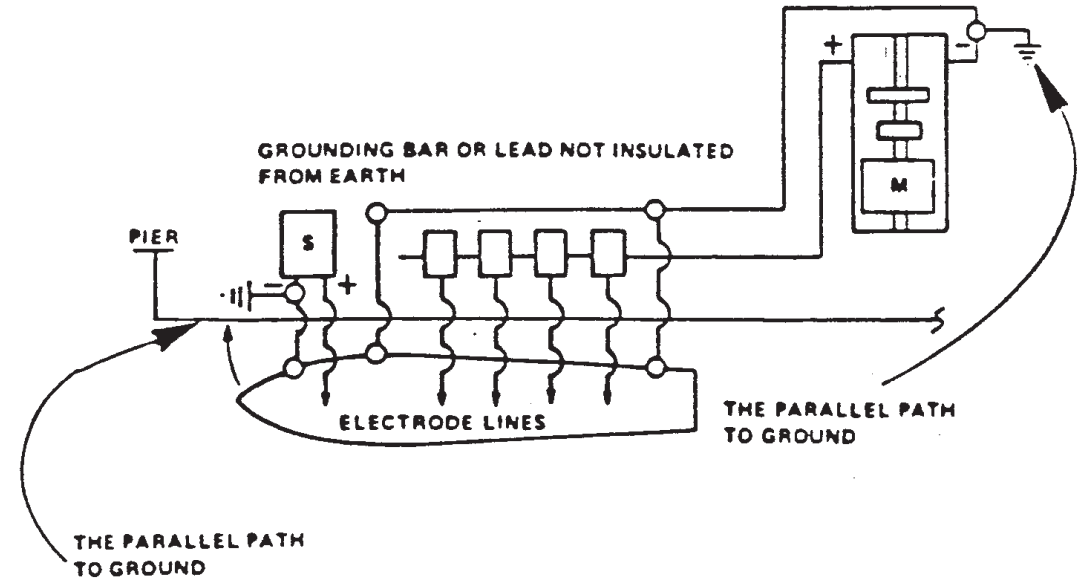
NUMBER 2 CABLE IS THE MINIMUM SIZE CABLE TO BE USED FOR ANY CURRENT OR LENGTH

Figure 074–5–2. Nomograph for Copper Electrode Lead Cable Size



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.

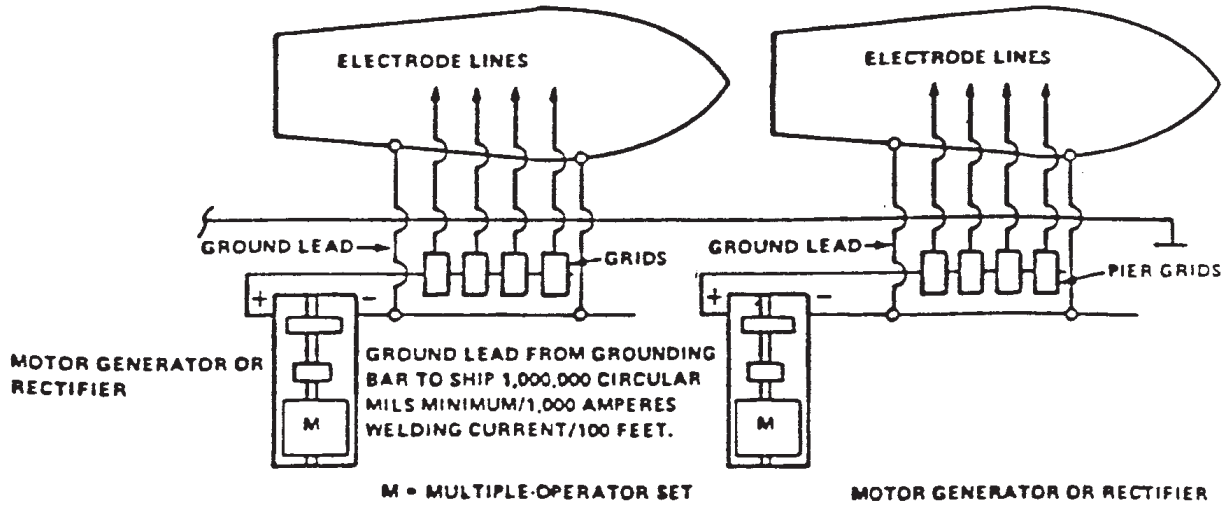
CORRECT



NOTE: WITH NEGATIVE SIDE OF GENERATOR OR RECTIFIEB 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.

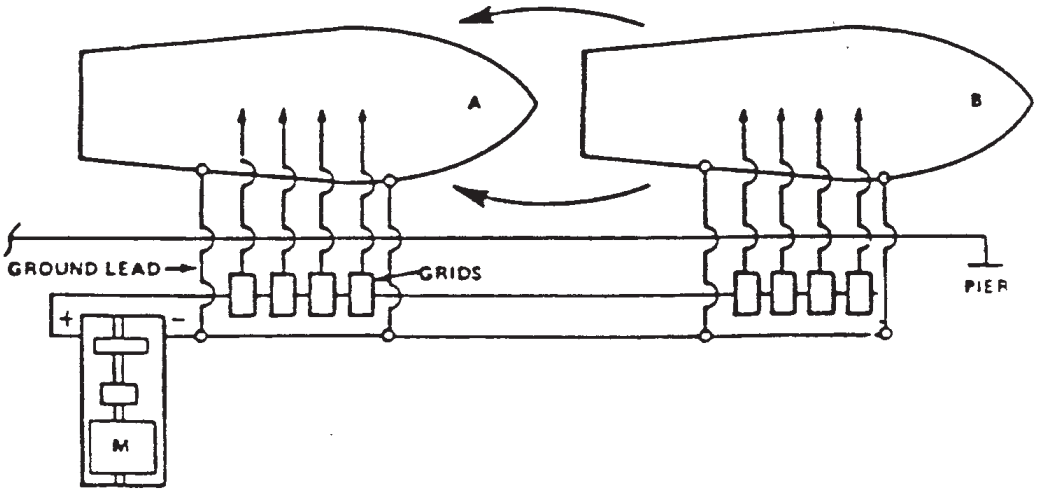
INCORRECT

Figure 074–5–3. 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.

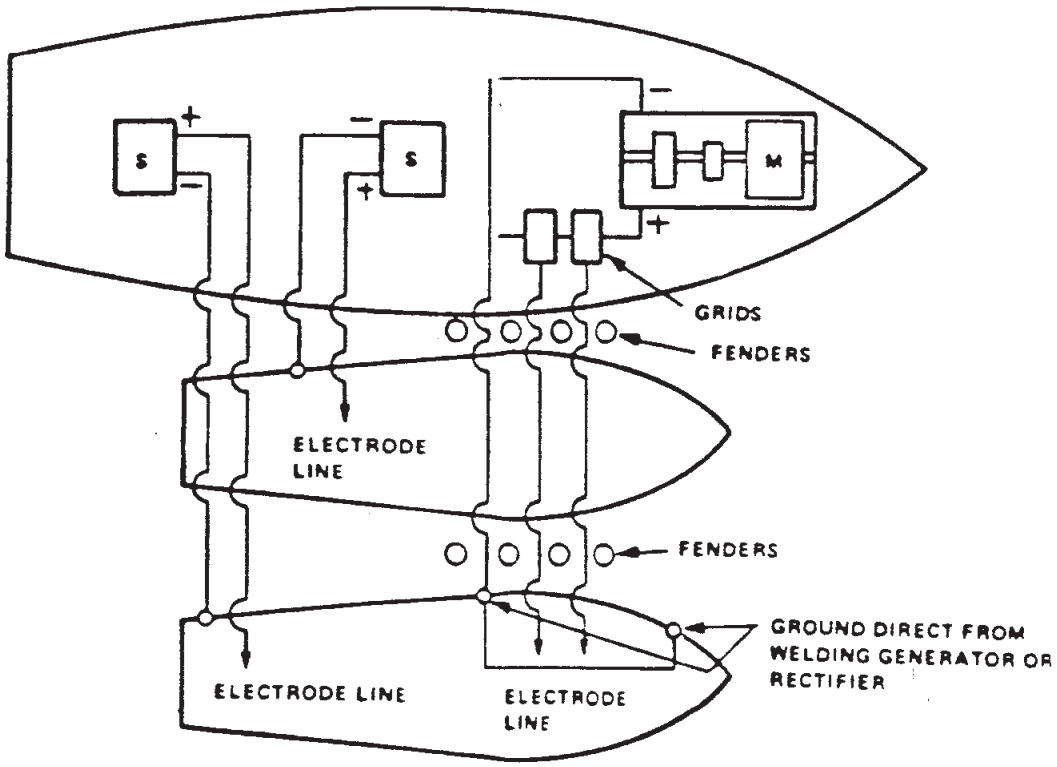
CORRECT



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 074–5–4. Hookup for Two Ships at Pier



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

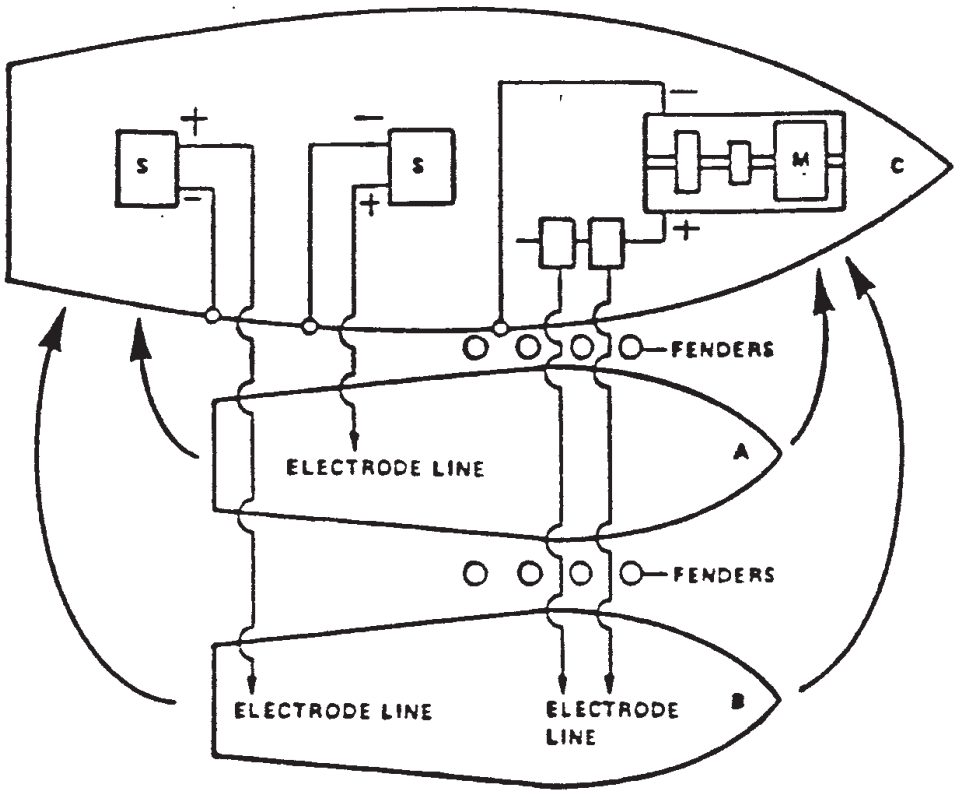
NOTES

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 074–5–5. Hookup for Ships Afloat (Sheet 1 of 2)

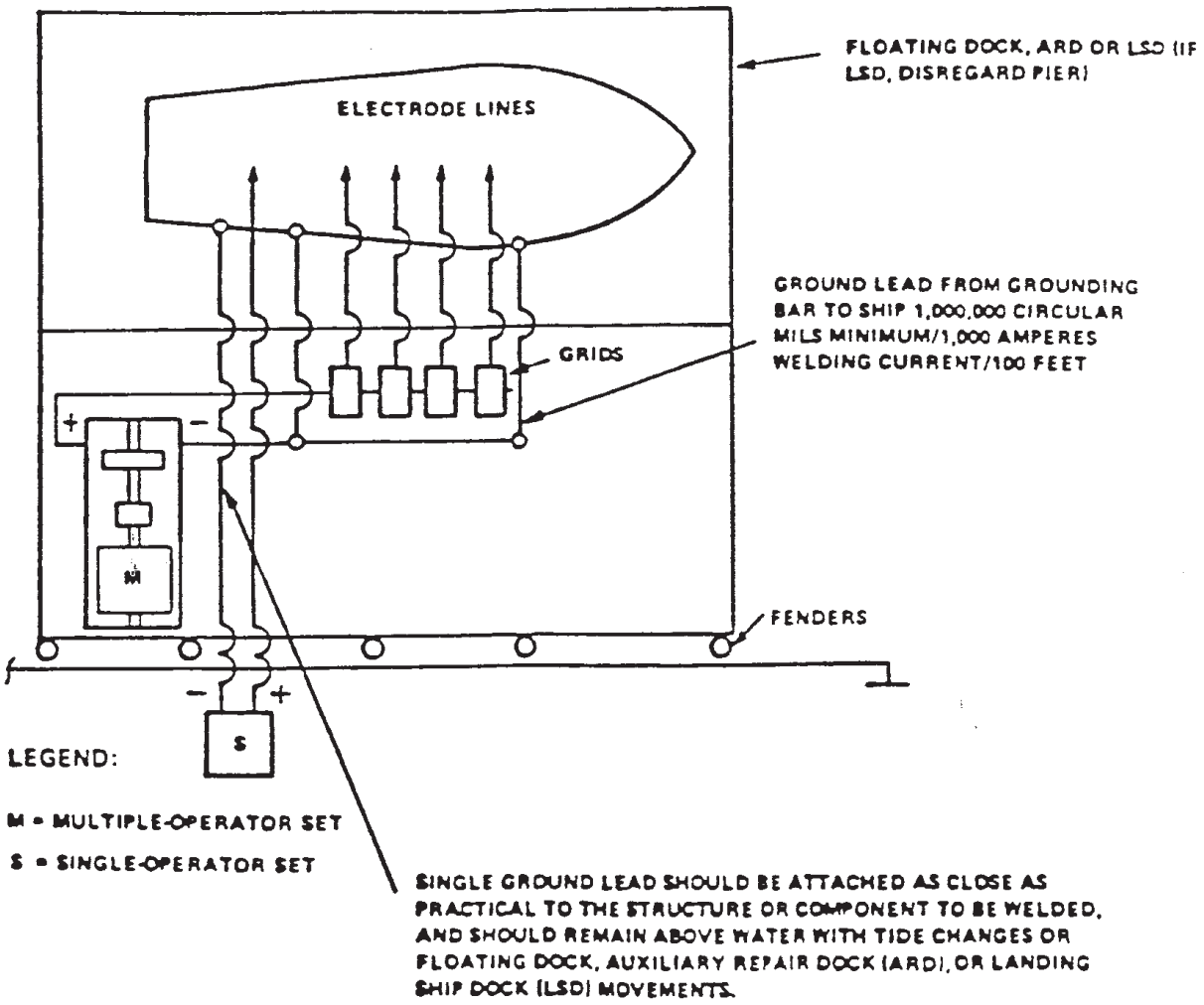


LEGEND: M = MULTIPLE-OPERATOR SET
S = SINGLE-OPERATOR SET

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.

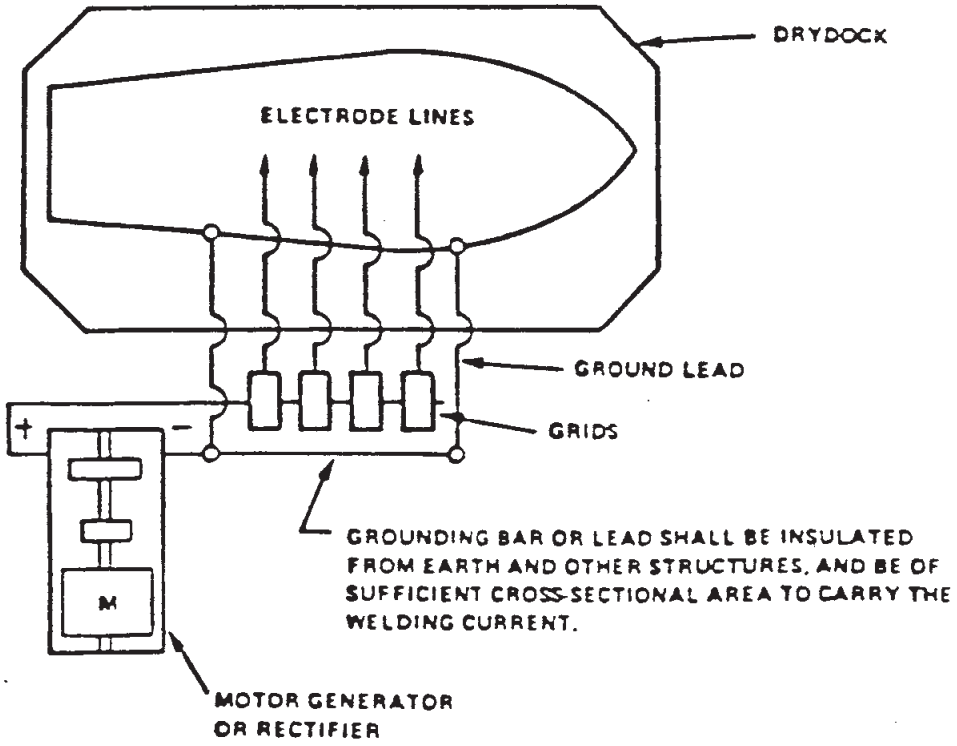
INCORRECT

Figure 074–5–5. Hookup for Ships Afloat (Sheet 2 of 2)



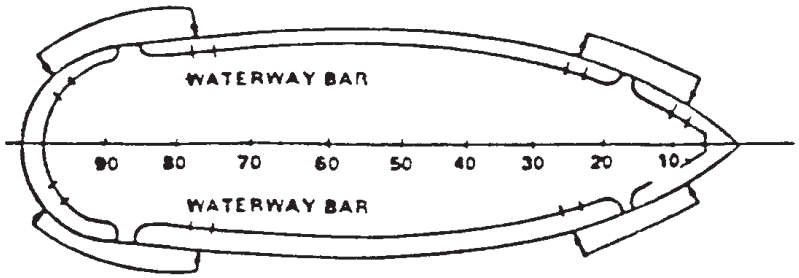
NOTE: GROUNDING BAR OR LEAD SHALL BE INSULATED FROM EARTH AND OTHER STRUCTURES, AND BE OF SUFFICIENT CROSS-SECTIONAL AREA TO CARRY THE WELDING CURRENT

Figure 074–5–6. Hookup for Ship in Floating Docks or HRD or LSD



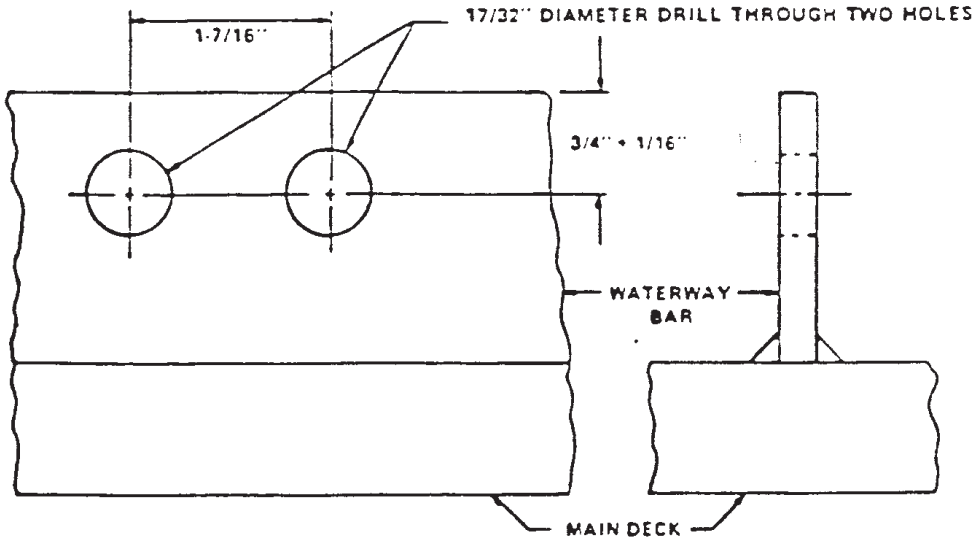
LEGEND: M = MULTIPLE-OPERATOR SET

Figure 074–5–7. Hookup for Ships in Dry or Graving Dock



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.

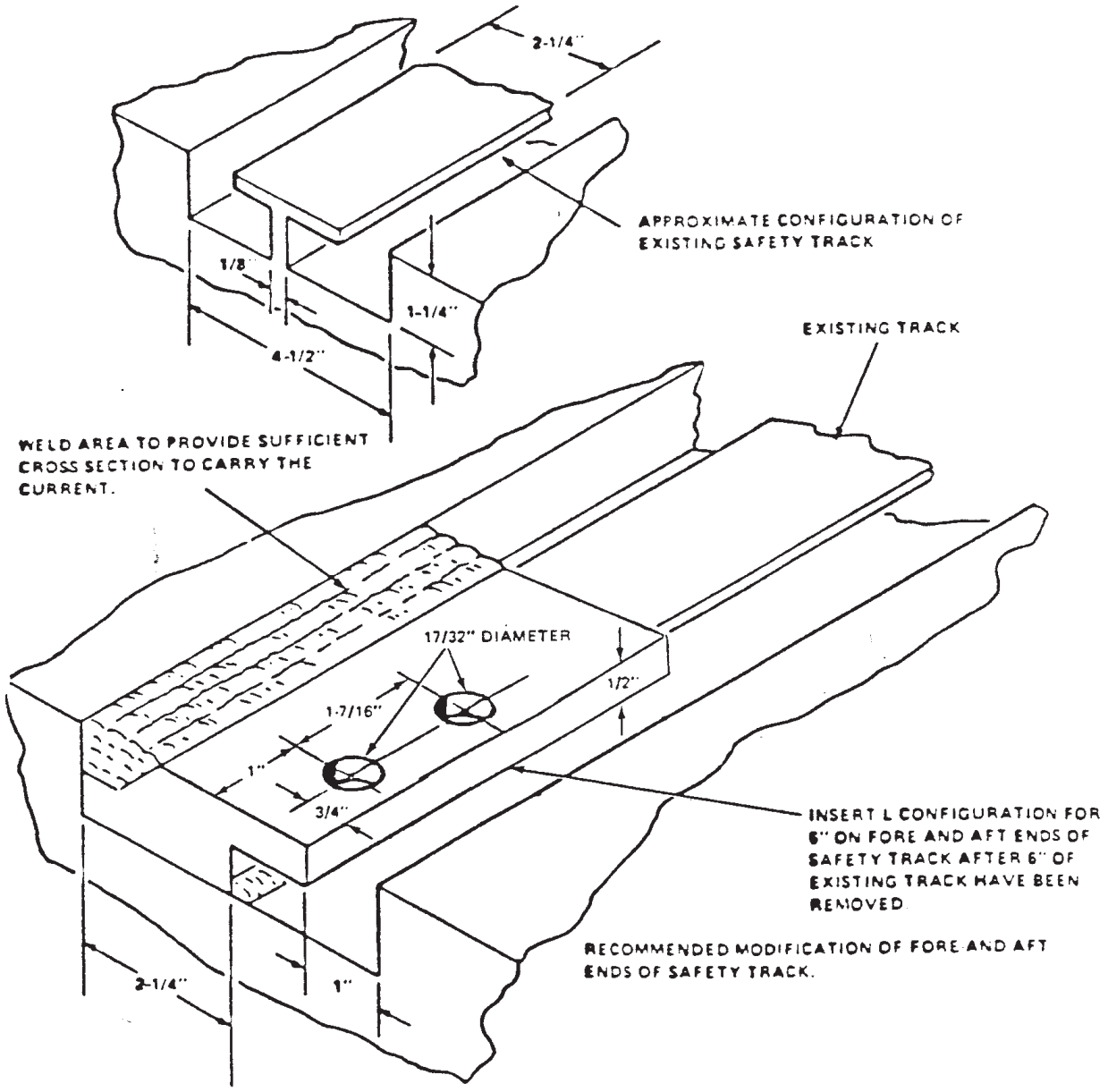


TYPICAL HOLE SPACING GROUNDING LUG ATTACHMENT

NOTES:

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

Figure 074–5–8. Grounding Corrections on Steel Surface Ships



NOTE LUG CONTACT AREA SHALL BE CLEANED TO BARE METAL WHEN GROUNDING CONNECTIONS ARE MADE. WHEN GROUNDING CONNECTIONS ARE BROKEN, THE AREA SHALL BE PAINTED TO MATCH THE EXISTING AREA.

Figure 074–5–9. Grounding Connections on Submarines

074–5.6.5 LOCATION OF GROUND RETURN CABLES. When systems such as piping, pressure vessels, or machinery are being welded, the ground return cable connection should be located as close to the work as possible. This ensures that welding current does not flow through bearings, threaded joints, and other areas where arcing could occur. Ground return cable connection should be no farther than 10 feet from work.

SECTION 6.
SURFACE SHIP HULL STRUCTURE

074–6.1 HULL MATERIAL REPLACEMENT

074–6.1.1 GENERAL. Unless otherwise specified, ship hull material which has been removed from a structure shall be replaced with material of identical type and thickness.

074–6.1.2 HY–80 AND HY–100 STEEL. HY–100 steel shall be used as a replacement for special treatment steel (STS) in surface ship structures when present stocks of STS are expended. HY–80 or HY–100 steel may be used as a replacement for HY–80 where ballistic protection is required.

074–6.1.3 ALUMINUM ALLOY 6061–T6. Repairs of existing deckhouse structures of aluminum alloy 6061–T6 shall be performed with welding procedures specially qualified on 6061–T6 using either type 4043 or type 5xxx filter materials. Repairs shall meet all requirements of the applicable fabrication document. Weld repair of other components of 6061–T6 alloy aluminum shall not be performed unless specifically approved by the Naval Sea Systems Command (NAVSEA).

074–6.2 STEEL SONAR DOMES

074–6.2.1 Preheat and interpass temperature controls shall be based on skin thickness and backing bar thickness at point of repair.

074–6.3 REPAIR OF MECHANICAL FASTENERS

074–6.3.1 Corroded mechanical fasteners and the surrounding area shall be chipped and ground out to sound metal (all visual evidence of rust and oxides removed) to a smooth contour for welding accessibility. The removal depth shall be limited so the welding will not fuse the two plates together. (There should be a minimum of 1/8 inch of remaining plating.)

074–6.3.2 For mechanical aluminum–to–steel joints, repair shall be according to NAVSEA 0900–LP–082–3010, **Ship Hull Structure Maintenance and Repair.** Mechanical fasteners and ground areas shall be built up flush with the surrounding plate area and then the mechanical fastener area shall be built up a minimum of 1/8–inch thickness which extends 1/4 inch beyond the area of countersink. Where replacement of mechanical fasteners is necessary, the work shall be accomplished according to the applicable fabrication document.

CAUTION

The procedure for repair of leaking mechanically fastened seams, described in paragraph 074–6.3.3, shall be used for emergency repair only. This method shall not be used for the shear, stinger, or bilge stakes within the midship 3/5 length.

074–6.3.3 Leaking mechanically fastened seams may be repaired by seal welding along the seam and around the heads of fasteners. Welding shall be by the Shielded Metal Arc Welding (SMAW) process, using the stringer bead technique. Half of the first pass and half of each subsequent pass in which pinholes are visible shall be removed by grinding. A minimum of two layers of weld shall be deposited. Seal welding should be performed along the entire length of the seam within a compartment or tank.

074–6.4 DUCTILE METAL OVERLAY TO ARREST CRACKS IN SHIP PLATES

074–6.4.1 The metal overlay procedure for arresting cracks shall be used in emergency conditions for ordinary strength steel, higher strength steel, or STS steels only. Ductile metal overlay is a temporary device, and it is emphasized that ductile metal overlay is not to influence any other repair or overhaul procedure.

074–6.4.2 A hole shall be drilled through plating at the end of the crack. It is important that the crack does not extend beyond the drilled portion. No welding is done on the crack nor within 1/2 inch of the hole. Dimensions shall be approximately as shown in Figure 074–6–1. The electrode shall be type MIL–309–15/16 or 310–15/16 of specification MIL–E–22200/2, **Electrode, Welding Covered Austenitic Chromium–Nickel Steel, for Corrosive and High Temperature Services**. Care should be taken to fill craters and minimize arc strikes to prevent stress concentration.

074–6.4.3 After this temporary overlay has been accomplished, actual repair of cracks may be accomplished according to the requirements of the applicable fabrication document.

074–6.5 WELDING CORRODED PLATE SURFACES AND WELDS

074–6.5.1 GENERAL. All corroded surfaces shall be ground smooth to sound metal and shall have a surface satisfactory for repair welding.

074–6.5.2 ABRASIVE BLASTING. As an alternative to grinding, abrasive blasting to a white metal finish (in accordance with SSPC–SP5, volume 2, **White Metal Blast Cleaning)** may be employed for surface preparation before welding, provided the following requirements are met and verified.

a. In addition to the base metal cleaning requirements of the applicable fabrication document, all surfaces to be welded shall be wire brushed or otherwise cleaned free of the blasting medium. These surfaces shall also be free from rust (except that a light surface flash is considered permissible provided it does not affect welding), paint, embedded blasting material, oil from air compressors, and any contaminant which might adversely affect welding.

b. Pits, crevices, and surface irregularities shall be contoured by grinding to the extent required to ensure complete removal of any remaining corrosion products and complete weld fusion of their bottoms.

c. Before welding, all surfaces shall be completely inspected in a manner which ensures that the acceptability of surface preparation does not change from the time of inspection to the time of welding.

d. Welders shall be specifically trained as to the acceptability of prepared surfaces for welding; they shall be responsible for welding acceptably prepared surfaces only.

e. Surface preparation shall be accomplished according to a written procedure which is approved by the authorized representative. The procedure shall also include accept and reject criteria, responsibilities, and disposition of nonconformance.

f. Regular independent audits shall be conducted both before and during welding to assure the adequacy of surface preparation.

074–6.5.3 CORRODED PLATE. Generally corroded areas on plates which have suffered thickness reduction in excess of 45 percent of original thickness shall not be repaired by surfacing. Both sides of the plating shall always be examined for thickness reduction. Corroded areas shall be surfaced in those cases where plating thickness is less than the minimum specified for corroded plating according to **NSTM Chapter 100, Hull Structures**.

074–6.5.4 ISOLATED PITS. For purposes of this discussion, a corroded area is considered to be a pit if it is 2 inches or less in diameter before preparation for welding. (Larger areas are considered to be general corrosion.) To be considered isolated, pits must be separated (by sound metal) a minimum distance equal to two times the larger pit diameter. They may be part of a generally corroded area. Isolated pits shall be repair welded where remaining plate thickness under the pit is 1/4 inch or greater. They may be drilled through and plug–welded according to requirements for repair of holes (see paragraph 074–7.6). When surfacing is required, it shall be to the original thickness. High-tensile steel (HTS) material over 3/4–inch thick shall be Brinell hardness tested and material with a Brinell hardness number over 192 shall be preheated to 150°F (65.6°C) before welding.

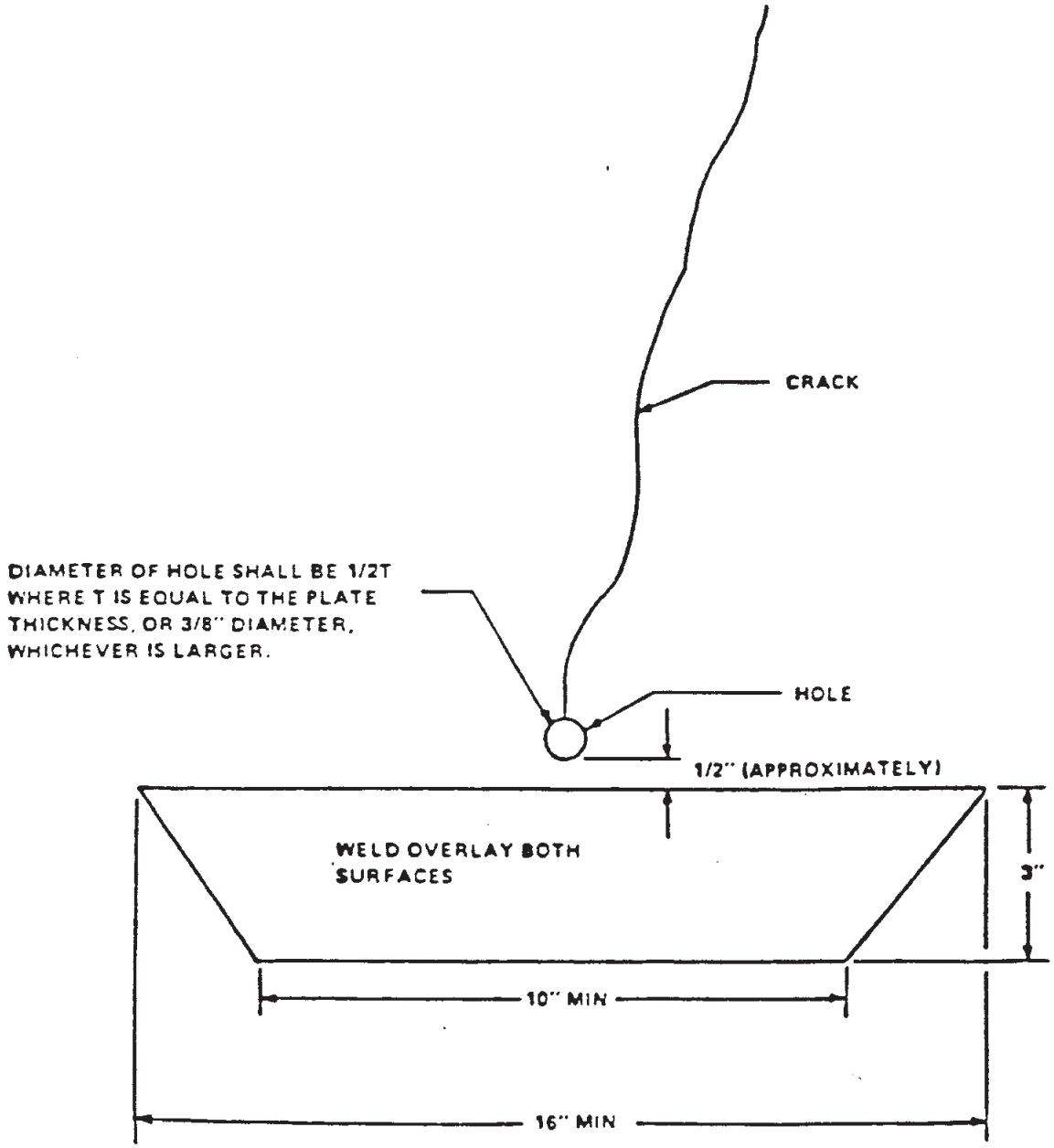


Figure 074–6–1. Ductile Metal Overlay To Arrest Cracks in Surface Ship Hull Structure

074–6.5.5 CORRODED WELDS. After welds are ground smooth, the welds shall be weld repaired if the weld is below a noncorroded plate surface by an amount which exceeds the allowable undercut of the applicable document or the welds are below a corroded plate surface in a generally corroded area. All welding shall be according to the applicable fabrication document.

074–6.6 ALUMINUM DECKHOUSE REPAIR

074–6.6.1 Aluminum deckhouse cracking and corrosion shall be repaired according to **NSTM Chapter 100**, **Hull Structures**. All welding shall be according to the applicable fabrication document.

074–6.7 CLOSURE PATCHES FOR TEMPORARY OPENINGS AND ACCESSES

074–6.7.1 GENERAL. In addition to the requirements of the applicable fabrication document, information detailed in paragraphs 074–6.7.2 through 074–6.7.6 shall apply for closure patches.

074–6.7.2 NEW ACCESS HOLES. If possible, cuts should be made in existing welds to avoid needless multiplicity of welds. When a boundary lands on an existing hull longitudinal or transverse butt weld, the corners shall intersect the butt weld at a 90–degree angle as shown in Figure 074–6–2. Butt weld cutback dimensions are illustrated in Figure 074–6–3 and Figure 074–6–4.

074–6.7.3 CLOSURE PATCHES ON PREVIOUSLY MADE JOINTS. For all welded construction where more than two multiple cuts and replacements have been made in primary hull structure, and where requirements of this volume have been violated more than once, remove patch area as shown in Figure 074–6–5 and discard. Prepare, fit, and weld in place replacement patch of the same material using new plating as required by paragraphs 074–6.1 through 074–6.6

074–6.7.4 WELDING REQUIREMENTS FOR PATCHES AND CLOSURE PLATES. Welding requirements shall be according to the applicable fabrication document.

074–6.7.5 PROXIMITY REQUIREMENTS. When cuts cross or come within 6 inches of mechanically fastened seams, the fasteners shall be removed and replaced 6 inches from the weld edge, or the mechanically fastened seam and fasteners shall be tested for tightness and tightness verified.

074–6.7.6 CLOSURE PATCHES ON MECHANICALLY FASTENED JOINTS. Plate replacement shall be according to Figure 074–6–6.

074–6.8 MECHANICAL FASTENER REQUIREMENTS

074–6.8.1 All mechanical fastening shall be according to the applicable fabrication document.

074–6.9 UNDERWATER WELDING

074–6.9.1 SCOPE. The requirements specified herein govern underwater welding and inspection for ship repair. Detailed requirements pertaining to diving operations, gas freeing, and maintenance of ship's watertight integrity during diving operations are not contained herein.

074–6.9.1.1 Requirements for military personnel conducting diving operations are contained in **U.S. Navy Diving Manual, Volume I** and OSHA regulations 29 CFR Ch XVII 1910.401 through 1910.441. Commercial activities shall adhere to the above mentioned OSHA regulations and Coast Guard Regulation 46 CFR 197.

074–6.9.1.2 Gas–free requirements for conduct of underwater welding are contained in **NSTM Chapter 074 Volume III** and shall be met by all activities.

074–6.9.1.3 Operations that affect watertight integrity shall have prior review by the cognizant Planning and Estimating (P&E) code of the government agency responsible for administering the repair to ensure adequacy and proper coordination with the ship's commanding officer.

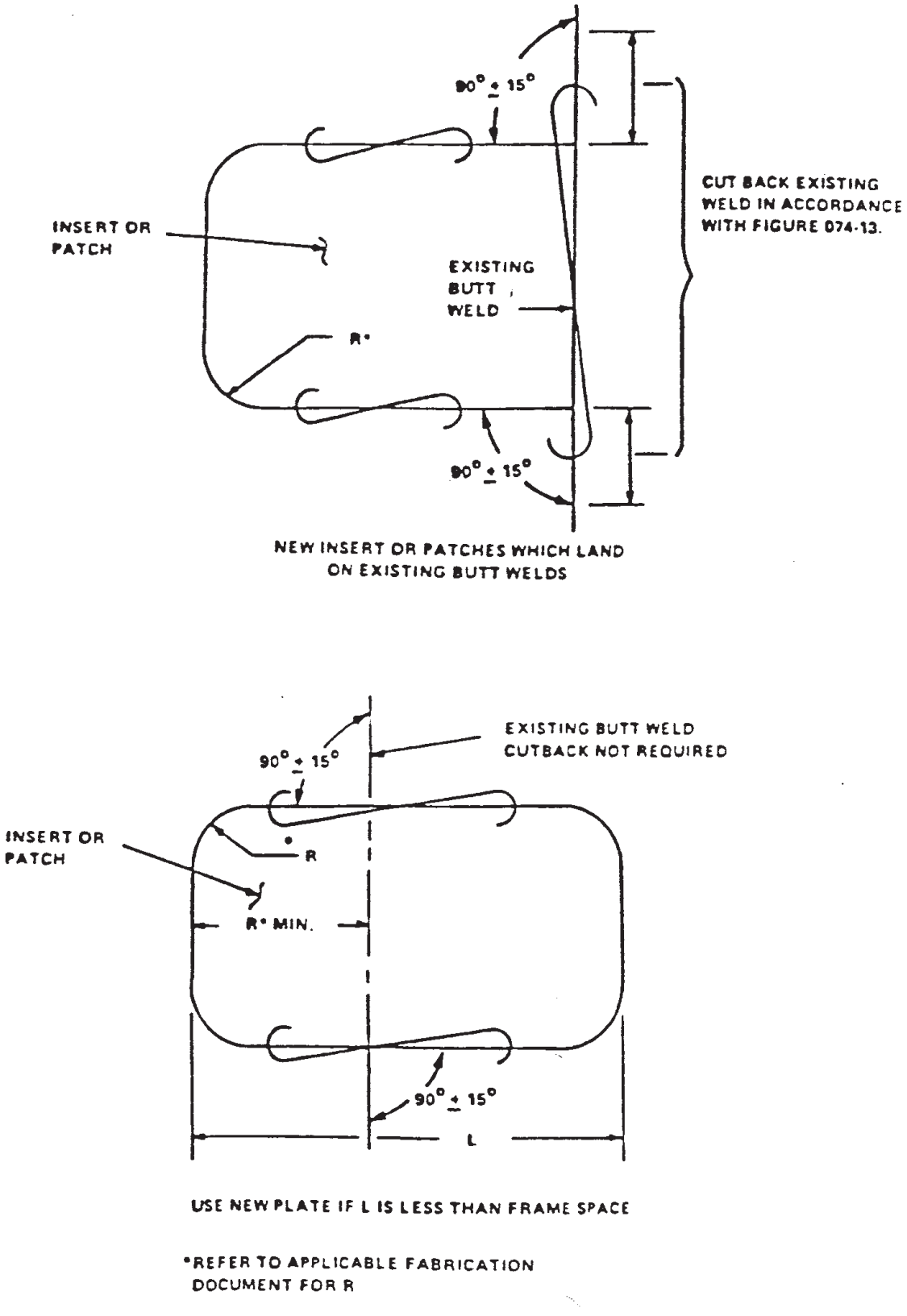


Figure 074–6–2. New Inserts on Patches Crossing Existing Butt Welds

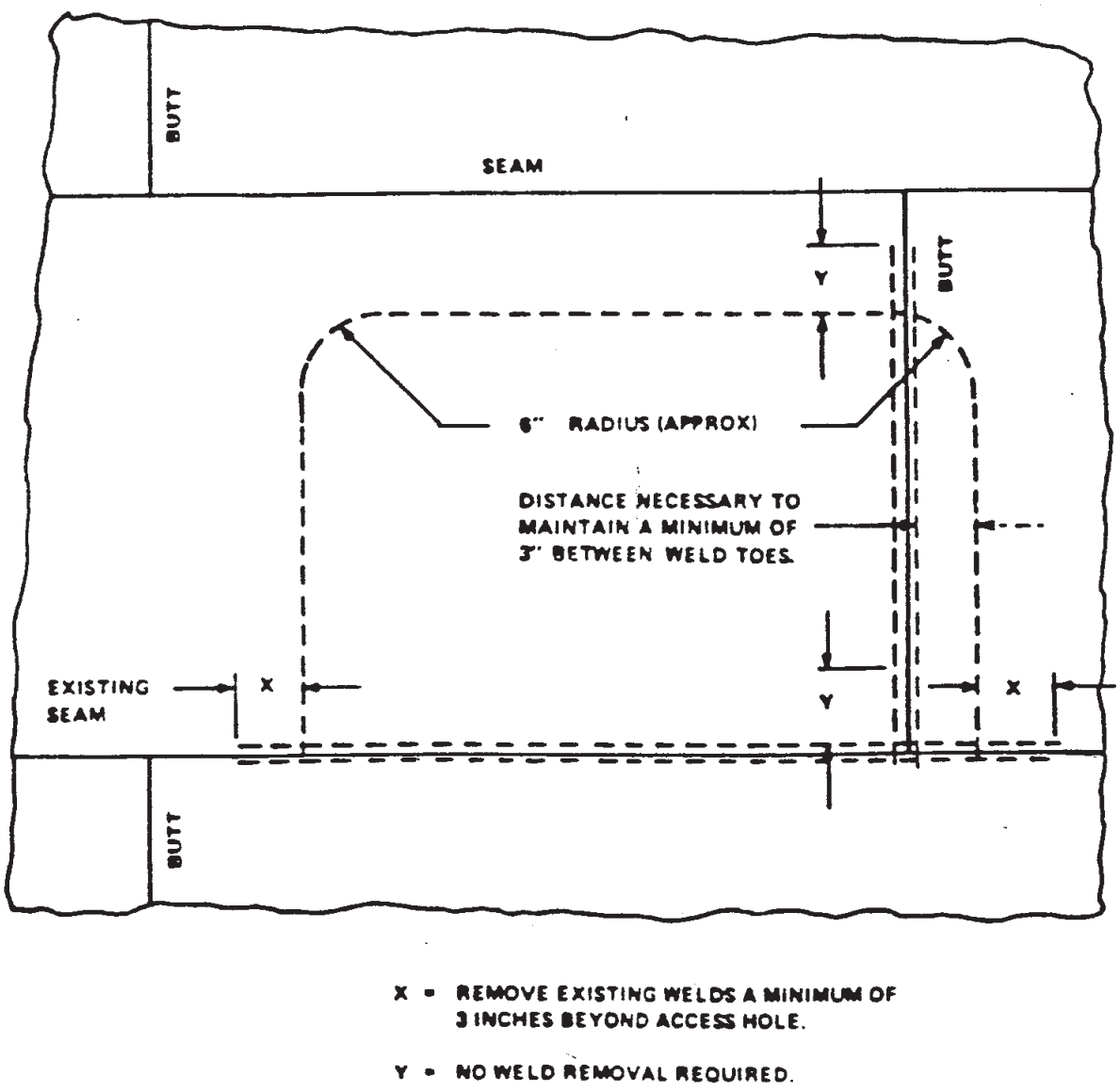
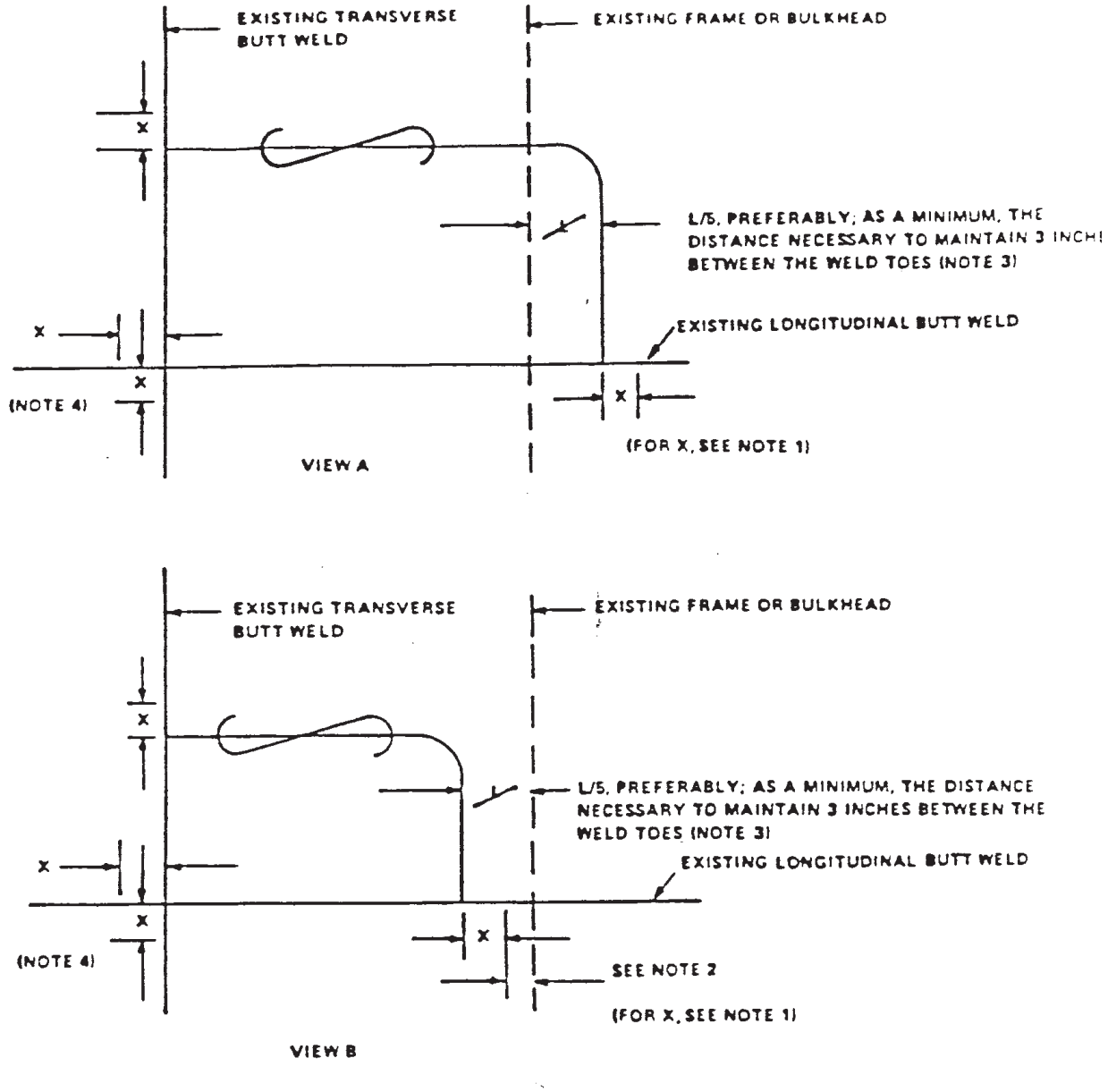


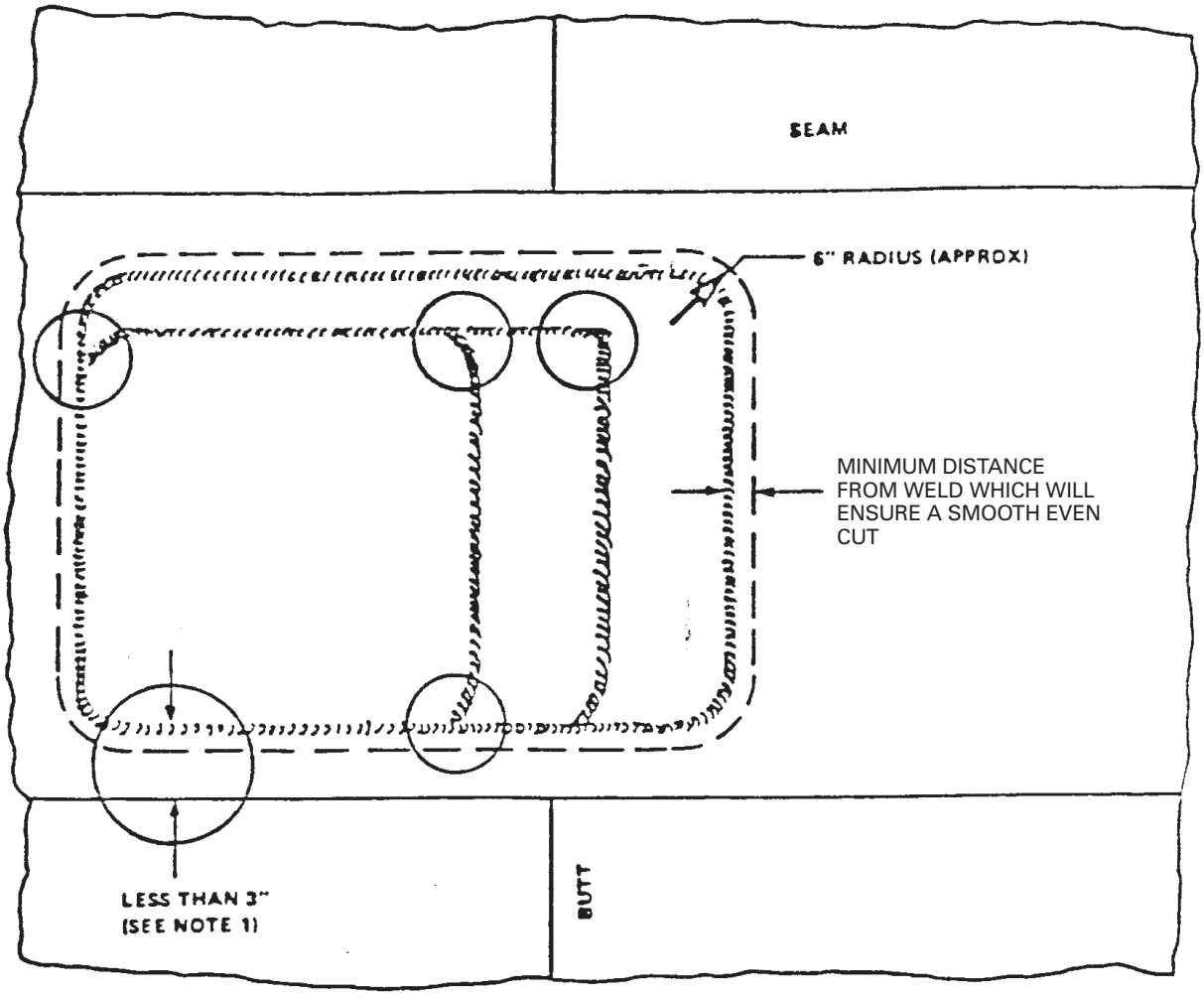
Figure 074–6–3. Example of Access Hole Intersecting Existing Welds



NOTES:

1. X EQUALS CUTBACK OF 3-INCH MINIMUM.
2. THE 3-INCH REMOVAL OF LONGITUDINAL BUTT WELDS MAY BE REDUCED WHEN THE CUTBACK WILL RESULT IN CROSSING A FRAME OR OTHER STRUCTURAL MEMBER, OR WILL RESULT IN LESS THAN 2 INCHES OF WELD BETWEEN THE CUTBACK AND THE STRUCTURAL MEMBER. IN NO CASE, HOWEVER, SHALL THE CUTBACK BE LESS THAN 2 INCHES UNLESS OTHERWISE APPROVED.
3. L EQUALS THE DISTANCE BETWEEN FRAMES.
4. CUT MAY BE MADE ON ONE (CHOICE OPTIONAL) EXISTING BUTT OR SEAM WELD.

Figure 074–6–4. Example of Boundary Location for Welded Patch Installation



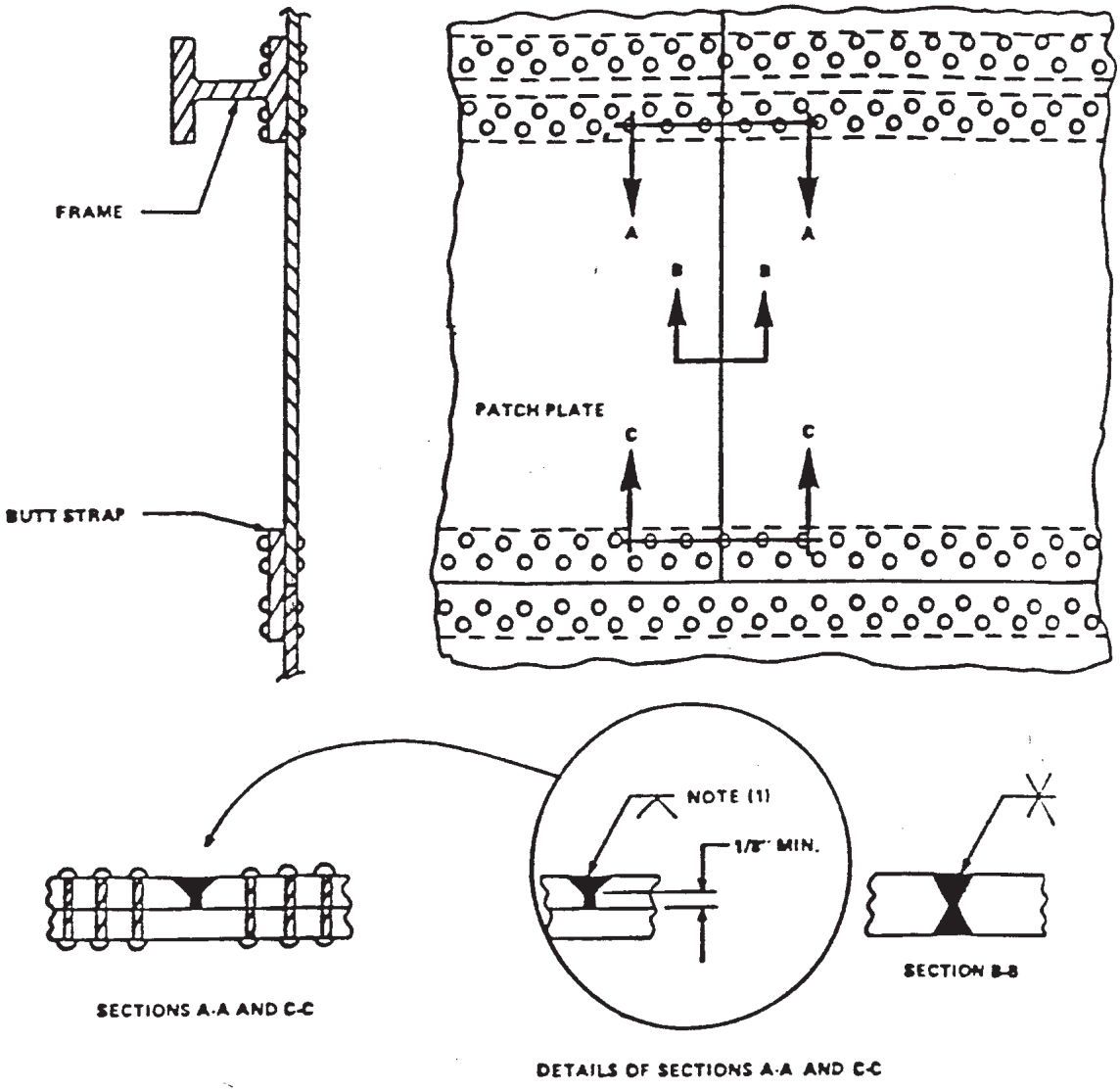
NOTES:

1. WHERE PATCH REPLACEMENT IS REQUIRED, AND ONE OF THE VIOLATIONS IS THE TOE-TO-TOE VIOLATION, THE NEW CUT SHALL EXTEND TO THE CONTIGUOUS BUTT OR SEAM INVOLVED.

2. CIRCLED AREAS ARE EXAMPLES OF SOME TYPICAL VIOLATIONS AS IDENTIFIED IN THE GOVERNING DOCUMENTS AND PARAGRAPHS 074−6.7.3 THROUGH 074−6.7.5 AND PARAGRAPH 074−6.9.

3. REMOVE PATCH AREA BY CUTTING ALONG EXISTING WELD IF NO VIOLATIONS EXIST. OTHERWISE, MAKE CUT OUTSIDE THE EXISTING WELD AS REQUIRED BY PARAGRAPH 074−6.7.3

Figure 074–6–5. Example of Patch Removal Where More Than Two Existing Multiple Cuts Are Involved



NOTES:

1. DO NOT ALLOW WELD METAL TO FUSE THROUGH AT THE ROOT AND WELD THE TWO PLATES TOGETHER.
2. A BACK-UP OF GLASS TAPE (MIL-C-20079) MAY BE USED TO PREVENT FUSION TO THE FRAMING OR TO THE MECHANICALLY FASTENED BUTT STRAP.
3. IN THE EVENT THAT THE BUTT WELD INTERSECTS A MECHANICAL FASTENER HOLE, REMOVE THE FASTENER, WELD THE BUTT, INSPECT AS REQUIRED, REDRILL THE HOLE, AND REPLACE THE FASTENER.

Figure 074–6–6. Patch Plate Replacement

074–6.9.2 DEFINITION. The definitions of MIL–STD–1689 and AWS D3.6 shall apply. Additional terms are defined below. Where conflict in definitions exists, the following order of precedence in requirements shall be observed:

1. As specified herein
2. MIL–STD–1689
3. AWS D3.6

074–6.9.2.1 Customer. This term as used in AWS D3.6 shall be understood to be NAVSEA.

074–6.9.2.2 Dry Chamber Welding. A hyperbaric underwater welding method, in which the weldment is in a dry environment provided by a chamber fitted over the joint to be welded. Water is displaced from the chamber by air at ambient pressure. Chamber size is as required herein.

074–6.9.2.3 Underwater Welding. Underwater welding means both wet welding and dry chamber welding.

074–6.9.3 GENERAL. Application of underwater welding shall be limited to ship deactivation, as governed by **NSTM Chapter 050, Readiness and Care of Inactive Ship**s, and repair of surface ships as specified in this section. All welding and inspection shall conform to MIL–STD–1689 except as modified herein. All requirements of drawings, technical manuals, and specifications which apply to the component items being repaired shall be adhered to.

074–6.9.3.1 Dry chamber welding shall be limited to ordinary strength steel, higher strength steel, and equivalent carbon steels specified in MIL–STD–1689 having a thickness of 2 inches and less. Welding of other base metals shall require NAVSEA approval.

074–6.9.3.2 Wet welding shall be limited to the eight category E welds listed below. Other applications shall require prior NAVSEA approval on a case–by–case basis.

a. Fairwater repair and replacement

b. Sonar dome fairing plate, fairing angle and closure plate repairs

c. Rope guard repair

d. Splitter (strainer) bar repairs

e. Bilge keel repairs

f. Ship deactivation as per **NSTM Chapter 050**

g. Repair of air channels on struts (welds to the struts are excluded)

h. Cover plate repair and replacement on rubber non–structural members and members that are not structural members

NOTE

Internal voids that have been exposed to sea water as a result of the repair process shall be preserved against corrosion using MIL–C–16173 Grade 3 preservative. All wet weld repairs and adjacent base metal shall be painted using an approved underwater anticorrosion coating. Unless otherwise approved, all dry chamber weld repairs and adjacent base metals shall be painted with appropriate coatings in accordance with **NSTM Chapter 631**.

074–6.9.3.3 Any of the above welds which attach directly to the ship's hull plating shall require a NAVSEA approved deviation. The following limitations shall also apply to all wet welding.

a. Only ordinary strength and higher strength steels of MIL–S–22698, or equivalent steels in accordance with MIL–STD–1689 shall be welded.

b. Ferritic wet welding electrodes shall be limited to welding on steel having a carbon equivalent of 0.40 or less. (See 074–6.9.3.4 for carbon equivalent calculations).

c. Austenitic stainless steel wet welding electrodes shall be used for welding steel with a carbon equivalent greater than 0.40.

d. Austenitic stainless steel wet welding electrodes shall be limited to fillet welds with a maximum weld throat dimension of 3/8 inch.

074–6.9.3.4 For wet welding, carbon equivalent shall be determined by the long formula of AWS D3.6. Chemistry of the base metals(s) being welded shall be determined by chemicals analysis performed in accordance with the ASTM standard test methods invoked by the applicable base metal specification for at least the elements contained in the carbon equivalent formula. Removal of material for analysis shall be performed so as not to damage or necessitate additional wet weld repair of the applicable component(s). Chippings or fillings taken by drilling no more than 1/8–inch deep (followed by contouring of the removal site) at the weld joint edge are suggested methods. The details of material removal shall have NAVSEA approval from the authorized representative prior to actual removal.

074–6.9.3.5 Underwater welding shall only be accomplished by the manual shielded metal arc welding process, unless otherwise approved by NAVSEA.

074–6.9.3.6 Underwater welding shall not be performed at depths greater than 50 feet unless specifically approved by NAVSEA.

074–6.9.3.7 Where AWS D3.6 is referenced in this section, ANSI/AWS D3.6–93 shall only apply.

074–6.9.3.8 Calibrated gauges shall be used for measuring voltage and amperage during all qualification and production welding. The gauges shall be the digital type when mounted on or in portable equipment or facilities. Calibration of gauges shall conform to MIL–STD–45662. Calibration interval shall not exceed 6 months.

074–6.9.3.9 For military activities, underwater welding shall only be carried out by IMAs, or shipyards.

074–6.9.4 SAFETY REQUIREMENTS. In addition to Section 10, the following requirements shall be adhered to: For Navy activities, all underwater cutting shall be performed in accordance with **US Navy Underwater Cutting and Welding,** Manual S0300–BB–MAN–010.

074–6.9.4.1 General. Alternating current shall not be employed for wet or dry underwater welding.

074–6.9.4.2 Dry Chamber Support Requirements. All dry chamber and dry chamber type welding operations (i.e., sea chest) require a ventilation system (Figure 074–6–7) that will maintain adequate visibility by removing welding fumes and explosive gases and meet the basic ventilation objectives of **NSTM Chapter 074 Volume 3**, Section 21. The chamber shall be purged with a continuous flow of diver–breathable air. All valves in the ventilation system shall be of the type that the welder–diver can easily and rapidly operate in case of flooding or excessive gas build–up. Wood chambers shall be constructed using fire–retardant wood.

074–6.9.4.3 Explosive and Hazardous Materials. In addition to the explosive mixtures of hydrogen and oxygen that are disassociated from the water by wet welding or arc cutting processes, the welder–diver must be aware of all possible sources of explosive gases and hazardous materials (i.e., oxygen and corrosion preventative compounds). Prior to the start of any underwater welding or cutting, as–built drawings and physical configuration

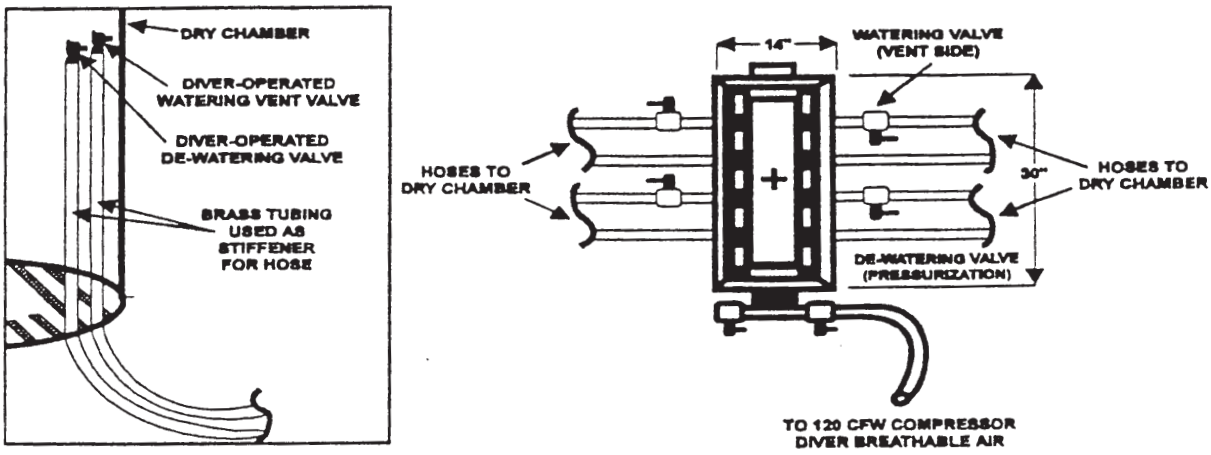


Figure 074–6–7. Dry Chamber Ventilation System

shall be studied to determine all areas and voids that could contain or entrap explosive gases. Procedures shall be developed in accordance with **NSTM Chapter 074, Volume 3**, Sections 21 and 24 for venting and inerting voids and gas entrapment areas. Areas that can trap and contain explosive gases shall be properly ventilated. Where effectiveness of the ventilation cannot be evaluated, monitoring of the explosive gases shall be accomplished by topside personnel in accordance with **NSTM Chapter 074, Volume 3**, paragraph 20.9.

074–6.9.4.4 Power Cables and Connectors. All welding leads including in–line connections that are exposed to water or a wet environment shall be fully insulated and watertight.

074–6.9.4.5 Electrode Holders. Only electrode holders that are specifically designed for wet welding shall be used during the wet welding process.

074–6.9.4.6 Diving Helmets. (Navy activities only) Diving helmets for underwater welding and cutting shall conform to the requirements in the **U.S. Navy Diving Manual Volume 1**.

074–6.9.4.7 Diver Dress. (Navy activities only) Diver dress for underwater welding and cutting shall conform to the requirements in the **U.S. Navy Diving Manual Volume 1**.

074–6.9.4.8 Safety Switches. (Navy activities only) Only safety switches listed in NAVSEA INSTRUCTION 10560.2B (ANU) shall be used. The Knife Switch shall be fitted with a non–conducting slotted cover to prevent accidental contact with the electrical circuit. Switches shall be located within arm's reach of the diver–tender communication operator. Switches shall be mounted in the vertical position in a manner that requires the handle to be raised upward to make electrical contact.

074–6.9.4.8.1 All welding circuits shall be deenergized except when welding is actually taking place. Grounding shall be in accordance with Section 5. Both welding leads shall be unplugged from the welding machine when not in use or at the end of the work shift. Any additional measures shall be taken as necessary to prevent any damage to ship's hull or equipment.

074–6.9.5 UNDERWATER WELDING PROCEDURE AND PERFORMANCE QUALIFICATION. Prior to production welding, all procedures and personnel shall be qualified in accordance with the requirements specified

herein. Requirements are specified for both dry chamber welding and wet welding. Video equipment as per 074–6.9.14 shall be provided during all procedure and performance qualification welding unless test tanks with viewing ports which permit observation of welding are used. Grinding during qualification shall be limited to contouring of starts and stops and removal of defects visually observed by the welder. Grinding of entire passes is permitted for slag removal only.

074–6.9.5.1 Dry Chamber Welding Procedure Qualification. Preparation and qualification of welding procedures shall conform to MIL–STD–1689 and MIL–STD–248 except as specified below. Procedure qualification is required for all welding. Submittal of welding procedures and qualification test data shall be made to NAVSEA. The procedure for transporting and handling electrodes shall be included in the submittal. NAVSEA shall be notified in writing at least three weeks prior to start of any qualification welding so that the welding may be witnessed at NAVSEA's option.

074–6.9.5.1.1 Qualification welding shall be performed in a dry chamber submerged in a test tank or in open water. The chamber shall be open to the water. Pressure inside the dry chamber shall be equivalent to a water depth of from 23 feet to 50 feet. This shall qualify the procedure for a water depth range of 0 feet to 50 feet and shall also qualify the procedure for a water depth range of 0 feet to 50 feet and shall also qualify for surface welding.

074–6.9.5.1.2 Qualification for S–1 base metals of MIL–STD–248 shall be performed on MIL–S–22698 high strength steel base material using MIL–E–22200/10 type MIL–7018–M electrodes. Minimum base metal thickness shall be 3/4–inch. Electrodes shall be exposed in the dry chamber for at least 50 percent of the maximum exposure time prior to use.

074–6.9.5.1.3 Welding positions shall be both 3G and 4G plate positions. This shall qualify all welding positions.

074–6.9.5.1.4 The procedure for transport and handling of filler materials during production welding shall be employed during qualification welding.

074–6.9.5.1.5 Joint design shall be a B1V.1 of MIL–STD–22, except B2V.3 may be used for plates exceeding one–inch in thickness.

074–6.9.5.1.6 In addition to the requirements of MIL–STD–248 the following tests shall be performed for each plate:

a. Two .505 all weld metal tensile tests per AWS B4.0. Results shall confirm to MIL–E–22200/10 for yield and ultimate strength and percent elongation.

b. Four 5/8–inch dynamic tear tests per AWS B4.0. Two specimens at –20°F (75 ft–lbs minimum average) and two specimens at 30°F (200 ft–lbs minimum average).

c. One weld metal chemistry analysis from the center of the weld near the top surface. Testing shall be per MIL–E–22200/10. Nitrogen and Oxygen content shall also be measured, using standard ASTM test methods, and reported for information along with accuracy tolerances.

074–6.9.5.1.7 The following additional changes shall require partial requalification of the welding procedure. (Full qualification testing is only required for the 3G position; inspection and testing of the 4G position shall be limited to NDT as per MIL–STD–248):

a. A change from an internally pressurized electrode transport container to a non–pressurized container.

b. A change in welding polarity.

c. A change in electrode manufacturer.

d. A change from a constant current to a constant voltage power source and vice versa.

e. An increase in pressure differential, between front side and the back side of a joint made against a backing, exceeding 5 psi per 1/8” of backing thickness beyond that qualified. Requalification welding is required in the 4G position only, and inspection and testing shall be limited to NDT per MIL–STD–248.

074–6.9.5.1.8 Each of the items in 074–6.9.5.1.7, along with the qualification depth and depth range qualified, shall be specified in both the welding qualification test report and the welding procedure.

074–6.9.5.2 Dry Chamber Welding Performance Qualification. Qualification shall conform to MIL–STD–1689 and MIL–STD–248 except as specified below:

a. As a prerequisite, military welders shall hold an NEC 4954 or NEC 4955 welding rating (see Section 2) for type of welding (category E or C, as applicable) to be performed.

b. The requirements of 074–6.9.5.1.1 shall apply.

c. The welder–diver shall not be provided with less staging support during production welding than as provided during welding of the qualification coupons.

d. Maintenance of qualification shall conform to 074–6.9.5.5.

074–6.9.5.3 Wet Welding Procedure Qualification. Each activity performing wet welding shall prepare written welding procedures and perform the required welds and testing, as specified herein, to qualify these wet welding procedures. NAVSEA shall be notified in writing at least three weeks prior to qualification welding so that welding may be witnessed at NAVSEA’s option. Each activity shall be responsible for qualifying each wet welding procedure they intend to use for production welding. Assemblies may be repair welded only under the following conditions:

a. The weld defects repaired are not indicative or an inadequate weld procedure, and are representative of defects that would be rejected by nondestructive tests required for production work.

b. The repair welding is representative of repair that would be performed on production work.

c. No cracks, other than crater–cracks, may be repair welded.

d. Only one cycle of repair welding is permitted.

e. Test results, including a description of the nondestructive test results which failed to meet the requirements and repair work performed to correct the condition, shall be submitted with the procedure qualification test report.

074–6.9.5.3.1 After qualification testing, each activity shall prepare a qualification test report. The report shall contain the results of all nondestructive and destructive tests and shall indicate the specific acceptance criteria met. The test report shall also specify the base metal type, grade, thickness, and chemical composition, as well as actual values employed for all essential and nonessential variables outlined in AWS D3.6 and 074–6.9.5.3.8. Bend radius and specimen thickness shall be included. The responsible official of the activity shall certify on the test report that the tests and the test results meet the requirements specified herein. This report shall be submitted to NAVSEA.

074–6.9.5.3.2 Prior to the initial production application of any wet welding procedure, the activity shall obtain written NAVSEA approval of the procedure qualification data. The welding procedure shall be submitted along with the qualification test data for NAVSEA review. Any changes in non–essential variables made to a qualified procedure shall be submitted to NAVSEA with the changes specifically identified for information.

074–6.9.5.3.3 Wet welding procedures shall be prepared and qualified in accordance with AWS D3.6 Sections 5 and 8, for Class B welds and the additional requirements specified herein. The procedure shall cover all the welding variables shown in Table 2 of AWS D3.6. Filler metal (manufacturer and manufacturer's designation) to be used shall require NAVSEA approval prior to qualification welding.

074–6.9.5.3.4 Austenitic stainless steel electrodes are limited to fillet welds (see 074–6.9.3.2) and shall be qualified as such. For ferritic electrodes, qualification shall be accomplished by a groove weld test using 3/4 inch and 1/8 inch plate butt weld test assemblies; the qualification will cover production fillet and groove welds in plate and tubulars, as well as base metal repair. Qualification welding shall take place in the flat, horizontal, vertical and overhead positions. Weld joint design shall be a single Vee groove against a permanent backing as per MIL–STD–22. Backing bar thickness shall be 1/8–inch thick when using 1/8–inch base metal. The qualified thickness range shall be 1/8–inch through 1–1/8 inch.

074–6.9.5.3.5 Qualification welds shall be tested and evaluated in accordance with Table 9 of AWS D3.6 and as specified herein.

074–6.9.5.3.6 Wet welding procedures shall address the repair of defects in both base metal and weld metal. The method to be used for excavation, minimum included angle, minimum excavation, minimum included angle, minimum excavation root radius, and inspection method for verification of defect removal shall be addressed.

074–6.9.5.3.7 The allowance of AWS D3.6 Section 5 to heat all–weld–metal tensile specimens for hydrogen release is unacceptable. The use of post weld heat treatment, for any purpose, is prohibited, unless that same treatment will be applied to production welds and is specified in the welding procedure.

074–6.9.5.3.8 With respect to AWS D3.6, Section 5, the following modifications apply to changes in essential variables which require wet welding procedure requalification.

a. As opposed to Items A.1(b) and A.1(f) of Table 2, the following applies: a multiple pass groove weld qualifies both single pass and multiple pass fillet welds, but not vice versa. A multiple pass fillet weld qualifies a single pass fillet weld, but not vice versa.

b. The chemistry limitations of AWS D3.6 paragraph 5.6.1.5 shall not apply to the welds of 074–6.9.3.2. However, where such chemistry limitations are known to be exceeded in the steel to be welded in production, such information shall be reported to NAVSEA.

c. Item A.2(c) of Table 2, this does not apply to S–1 base metals of MIL–STD–248.

d. In lieu of the requirements of Item A.6(b) of Table 2, the following shall apply:

a. A change from a constant current to a constant voltage power supply and vice versa;

1. A change to a resistive power supply from any other type of power supply.

e. In lieu of the requirements of Item A.7(d) of Table 2, the following shall apply: For groove welds made from one side against a permanent backing, the change from a multiple pass root to a single pass root shall be considered an essential variable. In the case only the root layer plus one cover layer may be deposited on an 8–inch long groove weld test assembly for the qualification welding. Testing may be limited to VT, MT and 4 macro specimens (see 074–6.9.5.5.2 for macro location).

f. In lieu of the requirements of Item A.8(d) of Table 2, the following shall apply: An increase in pressure differential, between the front side and the back side of a joint made against a backing, exceeding 5 psi per 1/8–inch of backing thickness beyond that qualified. Requalification welding is required in the 4G position, and inspection and testing shall be limited to visual inspection and four macro specimens.

074–6.9.5.3.9 Nondestructive inspection shall be as specified herein. Prior to destructive testing, all welds shall be nondestructively inspected for 100 percent of their length except for 1–inch on each end of plate welds which may be disregarded.

a. All nondestructive testing shall be performed in accordance with the requirements of MIL–STD–271.

b. All welds shall meet Class 2 visual acceptance standards of MIL–STD–2035 except that maximum butt weld reenforcement may be 3/16 inch. Fillet weld profile shall meet AWS D3.6. Weld bead reentrant angle, at the weld toe shall be 90° or greater.

c. Ferritic welds shall be magnetic particle inspected to the Class 2 acceptance standards of MIL–STD–2035.

d. Austenitic welds shall be liquid penetrant inspected to the Class 2 acceptance standards of MIL–STD–2035 for linear indications only. Rounded indications need not be evaluated.

e. All groove butt welds shall be radiographically inspected to Class 3 acceptance criteria of MIL–STD–2033 except that porosity less than 1/16–inch diameter can be ignored. However, if the weld meets a more stringent acceptance standard of MIL–STD–2035, the highest standard met shall be reported for information.

074–6.9.5.3.10 Welds shall be destructively tested in accordance with requirements of Section 8 of AWS D3.6 except as follows:

a. The Allowance of Table 9, Note a, does not apply the vertical and overhead positions; it does apply for the flat and horizontal position.

b. Destructive testing for 1/8–inch butt weld plates is required only for the vertical and overhead positions. Destructive testing shall consist of only two reduced section tensile tests, two root bend tests, and two face bend tests.

c. For each position 3/4–inch vertical and overhead position butt welds shall also require the testing of two 0.505 inch diameter all–weld–metal tensile specimens and five weld metal Charpy impact specimens. The Charpy impact impact specimens shall be tested at a temperature of 28°F.

d. Macroscopic examination shall include the weld and 3/16 inch of base metal on either side of the weld. Macroscopic examination acceptance criteria shall be as follows:

1. There shall be no cracks when examined at 7X minimum magnification except as permitted in 3. below.

2. Slag and porosity shall not exceed five percent of the weld surface area. The maximum dimension of any discontinuity shall not exceed 3/32 inch.

3. Linear discontinuities of 1/16 inch and less are acceptable when associated with the root of partial penetration and backing bar welds.

e. Bend testing radius shall be four times the thickness of the bend specimen.

f. The results of all–weld–metal tensile testing should meet the following criteria:

1. Ultimate tensile strength shall be 70 KSI minimum.

2. Yield strength shall be 60 KSI minimum.

3. Elongations shall be six percent minimum.

Where the above criteria are not met, an evaluation will be made by NAVSEA to determine the acceptability of the qualification test data.

g. Where weld metal Charpy impact testing is required, the highest and lowest values shall be disregarded. The remaining three values shall be averaged and should result in an average energy of 25 foot–pounds. All values

shall be reported. Where the 25 foot–pound minimum energy is not met, an evaluation will be made by NAVSEA to determine the acceptability of the qualification test data. The percent shear of the impact specimens shall be reported for information.

h. Fillet break test assemblies shall be bent with the weld root in tension. The weld shall be considered acceptable if the test assembly members bend flat against themselves without weld fracturing. If fracture occurs, the following requirements must be met for acceptance: (1) There must be complete weld penetration to the root (but not necessarily beyond) for at least 90 percent of the joint length; (2) There shall be no cracks; (3) There shall be no slag inclusions in the weld. Slag outside the weld area, between the test assembly faying surfaces, will not be cause for rejection; (4) Porosity 1/16–inch in diameter and greater shall be limited to four per linear inch and shall not exceed 10 in number in any 8–inches of weld. Maximum porosity size shall be limited to 1/8–inch in diameter; (5) There shall be no lack of fusion between weld passes or between the weld and the base metal.

074–6.9.5.4 Wet Welding Performance Qualification. Except as specified herein, welder performance qualification shall be in accordance with Sections 5 and 8 of AWS D3.6 for Class B welds.

074–6.9.5.4.1 In lieu of the requirements of paragraph 5.15 of AWS D3.6, the following shall apply:

a. Prior to qualification testing, military personnel shall have either, (1) an NEC 4954 rating (or have passed the NEC 4954 curriculum), or (2) two years work experience as a welder qualified to an industry or government standard and familiarity with Section 10 of this volume and volume 3 of this chapter, **Gas Free Engineering**, and demonstration of individual competence in safe practices.

b. All welders employed in performing wet welding in accordance with the requirements of this section shall be qualified prior to production welding as required herein. Each activity engaged in wet welding under this section shall conduct the required qualification testing.

c. Each welder shall be required to pass an annual vision test. Vision tests shall be conducted using standard test methods for determining visual acuity. The standard of acceptance for vision tests shall be natural or corrected near distance acuity such that the individual is capable of reading J1 letters on the standard Jaeger type chart for near vision. Other equivalent visual tests, such as the Snellen chart, may be substituted for the Jaeger chart. When corrective aids are used for the vision test, equivalent aids shall be employed in production work.

d. Each welder shall know the workmanship and visual inspection requirements of MIL–STD–1689. To ensure this knowledge, each welder shall complete an appropriate training program which has been approved by a MIL–STD–271 certified Level III nondestructive test examiner. This program shall include:

1. A written procedure covering all aspects of training and associated responsibility. A copy of the procedure shall be provided to NAVSEA for approval.

2. Training in workmanship and detailed visual inspection requirements of MIL–STD–1689.

3. Examinations covering detail workmanship and visual inspection requirements to be passed by each person with a grade of no less than 75 percent.

4. Approval of items 1, 2, and 3 above the Level III examiner.

5. Maintenance of examination records for each welder which shall include: name, fabrication and acceptance standards covered, date of test, and certifying signature of test administrator.

6. Re–testing of each welder every three years.

7. Auditing of the entire program by the Level III examiner to assure adequacy. Audits shall be conducted at least once in every two years.

074–6.9.5.4.2 The following exceptions to AWS D3.6 shall apply:

a. Welds shall be non–destructively inspected in accordance with 074–6.9.5.3.9.

b. In lieu of AWS D3.6 paragraph 5.16 (6), first sentence, the following shall apply:

1. Pipe diameter beyond the limits of Table 6, or

2. Base metal thickness beyond the limits of Table 2.

c. Bend test radius shall be four times the thickness of the bend specimen.

d. With respect to Table 5, the following changes apply:

1. The 3G plate position does not qualify the horizontal (2G) position; 3G, 4G, and 2G position welds are required to obtain all–position qualification. The 3F plate position does not qualify the horizontal (2F) position. 3F, 4F and 2F position welds are required for all–position qualification.

2. The 5F pipe position does not qualify the overhead (4F) position. 5F and 4F position welds are required for all–position qualification.

e. With respect to Note (a) of Table 10, macros may not be substituted for radiographic inspection. Where ultrasonic inspection is substituted for radiographic inspection, the ultrasonic inspection shall be performed to the requirements of the MIL–STD–271 and acceptance standards shall be Class III of MIL–STD–2035.

f. Fillet break testing shall meet the requirements of 074–6.9.5.3.10.

074–6.9.5.4.3 Each activity shall maintain the records of welder qualification. The records shall contain at least the following information:

a. Welder name and identification number.

b. Date of the test.

c. Weld joint design, depth, visibility, water temperature, diving suit protection, direction of vertical travel, description of staging support, welding procedure number, process, position, base metal (specification, alloy or type, thickness and pipe diameter), and filler metal type and size.

d. Results of qualification tests (include bend radius and specimen thickness).

e. Signature by activities' responsible official certifying that all requirements of this section have been met.

074–6.9.5.4.4 Transfer of performance qualification from one activity to another is not permitted without specific approval by NAVSEA.

074–6.9.5.5 Maintenance of Dry Chamber and Wet Welding Performance Qualification. Performance qualification maintenance shall be as specified herein. The requirements of AWS D3.6 paragraph 5.21, and MIL–STD–248 shall not apply.

074–6.9.5.5.1 A welder–diver's qualification to specific underwater welding procedures shall remain in effect as long as he performs satisfactory production welding using each of those procedures at least once every three months. As an alternative, the welder–diver's qualification to a specific underwater welding procedure may be maintained by using that procedure to weld an eight–inch long, three pass, fillet weld test assembly at least once every three months. For maintenance of dry chamber welding qualification, this welding may be done on the surface. The test assembly shall receive visual inspection of the completed weld.

074–6.9.5.5.2 Where a welder–diver fails to maintain his welding qualification as specified in 074–6.9.5.5.1 above, and six months have not elapsed since either his original qualification or his last qualification maintenance welding, the welder will be allowed to reinstate his qualification by performing the following tests:

1. To retain a fillet weld qualification, the welder–diver shall weld an eight–inch long, three pass, fillet weld test assembly. The test assembly shall receive visual inspection of the completed weld.

2. To retain both a fillet weld and a groove weld qualification, the welder–diver shall weld an eight–inch long groove butt weld test assembly. The completed test assembly shall receive visual and radiographic inspection. Macrosection examination may be used in lieu of radiographic inspection. Four macrosections will be required; the macrosections shall be removed 1–1/2 inches from each end of the test assembly and at least 2 inches apart in the center section.

074–6.9.5.5.3 If a welder–diver fails to maintain his welding qualification as specified in 074–6.9.5.5.1 or if six months or more have elapsed since his original qualification or qualification maintenance welding he must requalify to the requirements of 074–6.9.5.5.4 or 074–6.9.5.4 as applicable.

074–6.9.5.5.4 Where test assemblies are used in the maintenance of performance qualification, the following shall apply:

a. Mild steel base metal may be used with a minimum base metal thickness of 3/8 inch.

b. All welding shall be performed in the overhead position.

c. Welding shall be accomplished within the allowable depth range of the original performance qualification. In all cases, except as allowed for dry chamber welding in 074–6.9.5.5.1, the welding shall be done in a test tank or in open water at a depth of no less than 5 feet.

d. Non–destructive and destructive testing and acceptance standards shall be as specified in 074–6.9.5.4 for performance qualification.

074–6.9.5.5.5 Each activity shall maintain records demonstrating how performance qualification has been maintained for each welder. Records shall cover the current and preceding 3–month periods.

074–6.9.6 UNDERWATER WET NDT PROCEDURE AND PERSONNEL QUALIFICATION. Qualification of underwater wet NDT procedures and personnel shall be in accordance with MIL–STD–1689, Section 4 and the requirements specified in the **Underwater Ship Husbandry Manual** SO600–AA–PRO–070 **Chapter 7 Non–Destructive Testing.**

074–6.9.7 UNDERWATER DRY CHAMBER NDT PROCEDURE AND PERSONNEL QUALIFICATION. Qualification of underwater dry chamber NDT procedures and personnel shall be in accordance with MIL–STD–271 for all activities.

074–6.9.8 RECORDS. Records shall be in accordance with MIL–STD–1689, Section 5 and as specified herein. In contrast to the record requirements of Section 3 of this volume, records shall be maintained for production underwater welding associated with all weld categories.

074–6.9.8.1 Welding Qualification. Welding qualification records shall be as specified in this section.

074–6.9.8.1.1 A record of MT and VT inspections for each production weld inspected shall be prepared in accordance with MIL–STD–1689 and the following:

a. The date of inspection shall be included.

b. The signature of the level II inspector for the weld involved shall be included.

c. For inspections performed in the water, distance of visibility at time of inspection shall be recorded.

d. Fully legible photographs of representative areas of the weld fit–up, and the completed weld and surrounding 3–inches of base metal before and after painting, shall be included.

e. When a video recording is required in accordance with 074–6.9.14, the recording shall be made part of the inspection records.

074–6.9.8.1.2 For dry chamber welds, a record shall state that the weld area was maintained dry during all welding or, if not, that all weld metal deposited in the area was removed, the resultant excavation was inspected as required herein, and the source of the moisture problem was eliminated prior to resumption of welding. The record shall identify the repaired weld, the ship involved, the date of weld, each welder–diver involved by signature with badge number and the activity's responsible representative by signature.

074–6.9.8.1.3 Each activity shall prepare and maintain written records for each joint welded. Traceability shall exist between these records and the applicable weld joint and from the weld joint to the record.

074–6.9.8.1.4 Records shall be maintained on a form, developed prior to commencement of underwater welding operations, by the activity performing the work. The form shall contain at least the following information:

a. Weld joint identification.

b. Joint design (see MIL–STD–22).

c. Base metal type. For wet welds, the results of chemical analysis and calculated carbon equivalent shall be shown.

d. Filler metal type, including the manufacturer and the manufacturer's designation.

e. Fit–up verification.

f. Welding procedure identification.

g. Any required preheat and interpass temperatures.

h. Welder identification with badge number.

i. Visual and other nondestructive testing performed and inspection results. Identify final, root pass, and backgouge inspections separately. The applicable inspection procedure identification number shall be shown.

j. Number of weld repair cycles.

k. Inspection personnel identification with badge number.

l. Disposition of welds.

m. Water depth of welding.

074–6.9.8.1.5 Each item on the record form shall be filled in and signed for each weld joint before proceeding with the next item on the form. With the exception of weld root passes which may be performed by qualified diving personnel, items e, n, o, and g shall be signed or stamped by the activity's inspector. All other items shall be signed and dated by qualified production or inspection personnel. When a specific item on the record form is non–applicable, the letters "N.A." shall be entered. Final acceptance of a weldment shall require all items of the record form be completed as specified above.

074–6.9.8.2 Maintenance of Records. Unless otherwise specified, all required records shall be maintained by the activity and available to NAVSEA or its authorized representative throughout the life of the contract and for 3 years after delivery. At the expiration of the record retention period, NAVSEA or its authorized representative shall be given a written notification. Disposition of records shall be as agreed upon by NAVSEA and the contractor.

074–6.9.9 INSPECTION REQUIREMENTS. In addition to the requirements of MIL–STD–1689, the following inspections shall be conducted.

074–6.9.9.1 All welds performed in a dry chamber shall be MT or PT inspected, as applicable, to the acceptance criteria of MIL–STD–1689, Section 8 for MT or PT. This includes the backgouged root surface of full penetration groove welds. 5X visual inspection may be substituted for MT or PT inspection of backgouged root surfaces.

074–6.9.9.2 On full penetration dry chamber butt welds that are 1/4–inch thick and over in primary structure, 100 percent radiographic inspection shall be performed. If accessibility precludes RT, ultrasonic inspection may be substituted. Acceptance criteria shall be class III of MIL–STD–2035. There RT or UT cannot be performed, MT or each weld layer may be accomplished when approved; acceptance criteria of 074–6.9.18 shall apply.

074–6.9.9.3 MT inspection shall be performed on the final surface of all wet welds made with ferritic electrodes. Acceptance criteria shall be per Section 8 of MIL–STD–1689.

074–6.9.9.4 All underwater welds (including root layer and final welds) shall be VT inspected to the criteria of Section 8 of MIL–STD–1689.

074–6.9.9.5 All inspections shall conform to MIL–STD–271 and MIL–STD–1689, Section 7.

074–6.9.9.6 Welder–divers shall not inspect their own welds except for root pass and backgouge inspections when all other requirements of this section are met.

074–6.9.10 MATERIALS. All dry chamber welding of S–1 base metals (see MIL–STD–248) shall be performed with MIL–7018M electrodes of MIL–E–22200/10. Otherwise MIL–STD–1689 requirements shall apply.

074–6.9.10.1 Wet Welding Filler Materials. All wet welding electrodes shall be receipt inspected by the activity. Handling and storage of filler materials shall be as required to ensure that, when used in accordance with the activity's welding procedure, welds conforming to the requirements of this document will be obtained. Special attention shall be given to the waterproof coating integrity of the wet welding electrodes. Electrodes which exhibit breaks or flaking in the waterproof coating shall not be used.

074–6.9.10.1.1 Filler material shall be the same (manufacturer and manufacturer's designation) as that employed for procedure qualification.

074–6.9.10.1.2 Limitations on the use of welding filler materials shall be per 074–6.9.3.2.

074–6.9.11 WELDING AND WORKMANSHIP REQUIREMENTS. Welding and workmanship requirements shall conform to MIL–STD–1689 with the following modifications.

074–6.9.11.1 Preheat of S–1 base metal (see MIL–STD–248) for all dry chamber welding shall be 125°F minimum.

074–6.9.12 CONFIRMATION WELD TEST. Prior to production underwater welding, a confirmation weld test in accordance with the following requirements shall be satisfactorily completed.

074–6.9.12.1 General. Confirmation welds shall be made by each welder–diver who is to perform production welding. The confirmation weld shall be satisfactorily completed at the job site at the depth at which production welding will take place. At least one set of confirmation welds shall be completed for each welding system to be

used during production. The confirmation welding is intended to verify the capability of each welder–diver; it is also intended to confirm the operability of each welding system (power supply and welding leads) to be used in production. These requirements shall apply for each welding procedure to be used on a particular job.

NOTE

It is not the intent that each welder–diver perform confirmation welding using each and every welding system. It is intended that each welder–diver produce at least one set of confirmation welds, and that each welding system is used at least once by one of the welder–divers.

074–6.9.12.1.1 S–1 base metal (see MIL–STE–248) of 3/8–inch minimum thickness shall be used. For wet welds, base metal carbon equivalent should be approximately the same or higher (but with procedure requirements) than the highest carbon equivalent material to be welded in production, if such material is readily available.

074–6.9.12.1.2 One confirmation weld shall be completed in the vertical position and one in the overhead position. The test weld shall be a fillet break weld conforming to dimensions shown in AWS D3.6, Section 5. A root pass (with a start and stop at approximately mid–weld length) and a minimum of two cover passes shall be made. Grinding of weld passes should be limited.

074–6.9.12.2 Examination Requirements. Each confirmation weld shall undergo visual inspection and fillet break testing (macro etch testing, as described in AWS D3.6, is not required). The test plate may be cut into smaller sections by any convenient means (e.g., oxygenacetylene) to facilitate breaking. However, cutting shall not interfere with evaluation of the root pass start and stop. Acceptance criteria shall be as specified herein for performance qualification.

074–6.9.12.2.1 Should the welder–diver fail the initial confirmation weld test, he will be required to take two additional tests in that position. Should he fail either of the two additional tests, he shall not be allowed to perform production welding until he has requalified as required for the production welding to be performed.

074–6.9.12.2.2 Where a welding power supply change–out is required during production welding, or where visibility (for wet welding) is decreased significantly from that which existed during confirmation welding, the welding system operability (or wet welding visibility) shall be confirmed by making a 6–inch long single pass fillet weld in any position. The fillet weld shall be visually examined and shall conform to the requirements of Section 8 of MIL–STD–1689.

074–6.9.13 ELECTRODE TRANSPORT. Transporting of electrodes from the surface to the work site shall be controlled in accordance with a written procedure. The procedure shall also address the maximum permissible exposure time allowed for electrodes.

074–6.9.13.1 For dry chamber welding, electrodes shall not be exposed in the chamber for more than 90 minutes. Transport should be accomplished in a container which is pressurized above the pressure in the chamber. Electrodes should be sealed in an airtight plastic gab inside the container. Pressurizing gas shall be an inert gas or diver breathing quality air.

074–6.9.14 VIDEO EQUIPMENT. Underwater video equipment shall be set up on site to allow observation of any ongoing aspect of an underwater welding repair. Video camera design shall be such that the camera may be mounted as well as hand–held. The system resolution shall allow clear observation of all activities, including weld joint fitup and weldment visual inspection. The video equipment shall be set up at the beginning of the job to avoid delays during any subsequent video monitoring operations.

a. The extent of video monitoring shall be as required by the NAVSEA authorized representative. As a minimum, joint fit–up, completed root pass, preheat set–up and control (when preheat is required), 10 percent of all NDT activities, all completed weld joints, and all final coated surfaces should be observed.

b. Video recording shall be at the discretion of the NAVSEA authorized representative.

074–6.9.15 QUALITY ASSURANCE SYSTEM. In addition to other requirements for a quality assurance system, the following shall apply to commercial activities.

074–6.9.15.1 The contractor shall provide and maintain a quality assurance system which will assure that all supplies and services submitted to the government for acceptance conform to contract requirements whether manufactured or processed by the contractor, or procured form sub–contractors or vendors. The contractor shall perform, or have performed, the inspections and tests required to substantiate product conformance to drawing specifications and contract requirements; and shall also perform, or have performed, all inspections and tests otherwise required by the contract. The contractor's quality assurance system shall be documented and shall be available for review by the government representative prior to the initiation of production and throughout the life of the contract. Written procedures shall be prepared to assign responsibility and provide accountability for performing work and inspections. The government at its option may furnish written notice of the acceptability or non–acceptability of the quality assurance system. The contractor shall notify the government representative in writing of any change to his system. The quality assurance system shall be subject to disapproval if changes thereto would result in nonconforming product.

074–6.9.16 NAVSEA CERTIFICATION. Prior to performing underwater welding, each activity shall obtain NAVSEA certification of its capability to perform work in accordance with this document. Separate certification will be required for wet welding and dry habitat welding. Once certification is obtained, any significant change in the activity's capabilities, organization, or management structure shall require notification of NAVSEA. NAVSEA at its option may require review for recertification.

074–6.9.17 DRY CHAMBER WELDING. The following additional requirements apply to dry chamber welding. The dry chamber interior must be kept dry by purging with diver breathable air while providing enough working space for welding, grinding, and inspection. A minimum of 36 inches of dry surface should be maintained form the lower boundary of the weld area to the water line. The dry chamber shall be large enough to meet the following requirements:

a. At least the welder–diver's upper torso shall be in the dry within the dry chamber.

b. Welding, handling of materials and related work shall not result in moisture contamination.

c. Storage areas shall be such that welding electrodes, and other applicable consumables and materials, are maintained dry.

d. The dry chamber shall accommodate, as a minimum, one welder–diver on a platform in full diving dress.

074–6.9.17.1 Adequate staging, either inside or outside the chamber, shall be provided for support of the welder–diver.

074–6.9.17.2 The dry chamber shall have sufficient strength and rigidity to withstand handling, wave impact, and hydrostatic pressure differentials.

074–6.9.17.3 Attachment of the dry chamber to the hull shall be such that adequate watertight integrity is maintained. Unless otherwise approved, wet welded padeyes shall not be used for handling or attachment of the dry chamber to the ship's hull.

074–6.9.17.4 Oxygen–fuel gas processes and arc air burning and gouging processes are prohibited in the dry chamber.

074–6.9.17.5 For the first three production applications of the procedure, a weld place shall be completed as follows:

a. Welding position shall be vertical.

b. Base material shall be MIL–S–22698 Grade DH36. Two weld plates shall be 3/4 inch minimum thickness and 1–weld plate shall be 2" thickness, or the maximum thickness qualified whichever is less.

c. Weld joint design shall be B1V.1 except that a B2V.3 shall be used for the thicker plate.

d. Welding shall be spread out over the period of production welding. The weld plate shall be completed along side the production weld with the same filler material and following the production procedure.

e. The weld shall be VT, MT, and RT inspected to the requirements of MIL–STD–248.

f. Upon satisfactory completion of nondestructive testing as specified above, NAVSEA Underwater Ship Husbandry Division shall be contacted. NAVSEA will provide shipping information for the weldments and will coordinate subsequent destructive testing. A record of water depth, chamber temperature and water temperature, along with a copy of the electrode test certificate for the lot and heat of the electrodes used for the welding, shall be sent to NAVSEA.

g. NAVSEA will perform the following destructive testing:

1. One all–weld–metal tensile specimen shall be removed and tested out of the 3/4 inch thick plate. Two all–weld–metal tensile specimens shall be removed and tested out of the thicker plate, one from each side of the weld.

2. Four dynamic tear test specimens shall be removed and tested from each plate, two at –20F (one from each side of the weld for the thick plate) and two at 30F (one from each side of the weld for the thick plate).

3. Removal and testing of test specimens shall conform to 074–6.9.5.1.6 for qualification welding.

h. After evaluation of the destructive test results from the third plate, NAVSEA will advise the underwater welding activity as to the need for further plate welding and testing.

074–6.9.18 THIRD PARTY MONITORING AND CERTIFICATION. An independent third party activity shall be obtained to issue a certification report for welding procedure qualification and production welding. The third party shall perform the surveillance of work and materials as is necessary to certify that all work performed was in full compliance with the requirements of this chapter and its reference documents. Third party inspection shall in no way substitute for those inspections required of the performing activity. Nor shall third party inspection reduce the quality assurance or other contract requirements or responsibilities of the performing activity.

074–6.9.18.1 Third Party Qualifications. Third party activities shall require NAVSEA approval. NAVSEA will maintain a list of third party activities. The minimum technical requirements for third party activities shall be as follows:

a. Monitoring personnel shall have all the following minimum qualifications or shall conform to NO TAG below:

1. Four year engineering degree from an accredited college.

2. Minimum of five years' experience in welding and NDT of U.S. Navy ships. This shall include demonstrated experience in applying MIL–STD–1689, MIL–STD–271, MIL–STD–248 and **NSTM Chapter 074 Volume 1.**

3. Minimum of five years' experience directing or supervising underwater welding projects, or performing underwater welding. This shall include demonstrated experience in applying AWS D3.6 requirements.

4. Current Level II MIL–STD–271 qualification in visual inspection and at least one other NDT method.

5. Minimum of five years' experience in quality assurance related work associated with welding and NDT requirements.

b. When under the direct supervision of an individual meeting the requirements of 1 above, monitoring personnel may meet the following minimum requirements.

1. A high school diploma.

2. A minimum of five years' experience directing or supervising underwater welding projects, or performing underwater welding. This shall include demonstrated experience in applying AWS D3.6 requirements.

3. A minimum of three years' experience in welding and NDT of U.S. Navy ships. This shall include demonstrated experience in applying MIL–STD–1689, MIL–STD–271, MIL–STD–248 and **NSTM Chapter 074 Volume 1**.

4. Current MIL–STD–271 Level II qualification in visual inspection and at least one other NDT method.

5. Minimum of three years' experience in quality assurance related work associated with welding and NDT requirements.

074–6.9.18.2 Third Party Surveillance Requirements. Surveillance of procedure qualification work shall include welding and visual inspection of test plates and review of the destructive and nondestructive test reports.

074–6.9.18.2.1 Surveillance of production work shall encompass, but not be limited to, the following:

a. Verification that welding and NDT procedures are currently qualified for actual welding performed.

b. Verification of the requirements specified in 074–6.9.8.1.4, with specific emphasis on fit–up and intermediate and and final weld inspections.

c. Verification of confirmation welding.

d. Verification of base metals and filler metals, performing activity certification, quality assurance plan application, adequacy of underwater video coverage, equipment adequacy for the intended application, conformance to the workmanship requirements of MIL–STD–1689, weld category (see 074–1.7), and performance of the welding required by 074–6.9.17.5**.**

e. Where deemed necessary by the government representative or the third party activity, surveillance will include independent diver (in–water) inspection of critical aspects of work including completed welds.

074–6.9.18.3 Third Party Reporting. The third party shall routinely update the Government's appointed representative and promptly notify him in writing of any detected noncompliance.

074–6.9.18.3.1 For production and procedure qualification, the third party activity's written report shall include a summary of surveillance conducted, findings, and dated certification by the on–site person and the company's responsible official of compliance of work to the requirements of this volume. For commercially performed work, the report shall be provided to the responsible Navy contracting activity. For Navy performing activities, the report shall be provided to the activity's most senior representative responsible for production, or as otherwise directed by the activity.

074–6.10 RANDOM OR PARTIAL INSPECTIONS

074–6.10.1 Where random or partial inspections are specified for the structural categories of radiographic or ultrasonic inspection in the fabrication document, each activity shall prepare an inspection plan according to the

fabrication document. This plan may address overhaul and repair work performed in general terms rather than each class of ship. The plan shall be approved by the authorized NAVSEA representative.

SECTION 7.
SUBMARINE HULL STRUCTURE

074–7.1 PATCHES, ACCESS HOLE CLOSURES AND PENETRATIONS

074–7.1.1 All activities shall be equipped and prepared to carry out full requirements outlined in paragraphs 074–7.1 through 074–7.8 and paragraph 074–9.2 before cutting and welding patches, closure plate openings, and penetrations in pressure hull structure. The activity performing these functions is responsible to ensure that all work undertaken is performed strictly according to applicable fabrication documents. Further guidance is contained in **NSTM Chapter 100, Hull Structures**.

074–7.1.2 Naval Sea Systems Command (NAVSEA) approval is required for all cutting and welding required for reinstallation of pressure hull structure except for the following items.

a. Openings that are designed as closure plates, where such openings are included on approved drawings.

b. Closure plate cuts not shown on approved drawings, but which are located between adjacent frames and designed according to the applicable fabrication document, which are cut through plating only, and which do not extend more than 5 feet in hull circumferential girth.

c. Closure plate openings approved by NAVSEA for which documented approval records exist. The recutting of these openings need only be reported to NAVSEA with identification of previous record of approval. Those closure plates which open into the reactor compartment may be recut only when these openings are shown on approved class drawings.

d. Plating renewals, which do not disturb framing, 5 feet or less in hull circumferential girth and extending across no more than two frames.

e. Openings 5 feet or less in hull circumferential girth in cylindrical sections of special treatment steel (STS) conning towers which do not extend across more than two frames.

f. Installation of fittings and appurtenances, including the location of pressure hull penetrations (see paragraph 074–7.7.4), and inserts or patches for sizes are covered in Table 074–7–1. NAVSEA approval is required if penetrations cannot be located to conform to requirements of paragraph 074–7.7.4.

074–7.2 PROCEDURE FOR MAKING PARTIAL CIRCULARITY CHECK

074–7.2.1 Whenever pressure hull frames are cut, procedures outlined in paragraphs 074–7.2.2 through 074–7.2.10 or other approved procedures shall be used to establish partial hull circularity.

074–7.2.2 As stated in **NSTM Chapter 091**, **Submarine Hull Inspection**, existing circularity of each frame being cut shall be established before cutting hull structure. Determining circularity is done so that results of a check made after the repair can be compared with original geometry.

074–7.2.3 When a partial circularity check is made, the check shall be made as close to frames to be cut as is practicable, but not more than 6 inches away. The transverse arc length of the circularity measurement shall be twice the transverse arc length of the proposed cut, but shall not exceed 30 degrees beyond the edge of the proposed cut. An example of standard partial circularity check for patch plate replacement is shown in Figure 074–7–1.

074–7.2.4 Where tank tops intersect pressure hull, the circularity measurement shall not extend beyond the point at which the tank top intersects the hull. An example of a partial circularity check where the tank top intersects the hull is illustrated in Figure 074–7–2.

Table 074–7–1. MEASUREMENTS REQUIRED FOR REMOVAL AND REPLACEMENT OF SUBMARINE HULL PLATING AND FRAMING

The following measurements will be taken when:*		**Existing hull plating with attached framing is removed and reinstalled**		**Frame or part of frame is renewed, fabricated or removed from existing/new plating and reinstalled.**		**Frame remains in place and existing plating is removed and replaced.**	
Measurement**	**References**	**Before Cut**	**Post-Installation**	Before Cut	**Post-Installation**	**Before Cut**	**Post-Installation**
Frame Spacing	MIL–STD–1688	X	X(1)		X	X	X
Frame Depth	MIL–STD–1688	X		X	X	X	X
Web Thickness	Ship's Drawing	X		X	X	X	
Flange Thickness	Ship's Drawing	X		X	X	X	
Shell Thickness	Ship's Drawing	X		X	X	X	X(3)
Flange Width	MIL–STD–1688	X		X	X	X	
Web Tilt	MIL–STD–1688	X	X	X	X	X	X
Flange Tilt	MIL–STD–1688	X		X	X	X	
Flange Unbalance (2)	MIL–STD–1688	X		X	X	X	
Frame Flange Curvature	MIL–STD–1688	X		X	X	X	
Frame Circularity	Ship Specification S9086–CH–STM–010/CH074, V1, para 074–7.2	X	X	X	X	X	X
Fame Alignment	MIL–STD–1688		X		X		
Plate Alignment	MIL–STD–1688		X		X		X

* Measurements are required where marked by an X.
** Reference MIL–STD–1688 for definitions and allowable frame dimensions and frame alignment tolerances.
(1) Only for frame spacing in bays which contain the forward and aft butts of the plate or patch.
(2) This measurement is required only for fabricated frames.
(3) This measurement is required only when existing plating is replace.

074–7.2.5 The first step in determining circularity of a frame to be cut is to establish the elevation of points A and B of Figure 074–7–1 and Figure 074–7–2 relative to similar points at adjacent undisturbed frames forward and aft of proposed cut. Elevation can be established by the use of optics or by erection of a range wire similar to the example shown in Figure 074–7–3. The elevations (h dimensions) should be recorded for future reference.

074–7.2.6 Next, the existing radial geometry between points A and B of Figure 074–7–1 and Figure 074–7–2 should be established. This can be done by using a template similar to the one shown in Figure 074–7–4. The template can be made of steel, aluminum, or plywood. The template should have a scribed radius which is a known amount greater than design radius of hull to be measured. The template should contain radial scribed lines at 5 degree intervals.

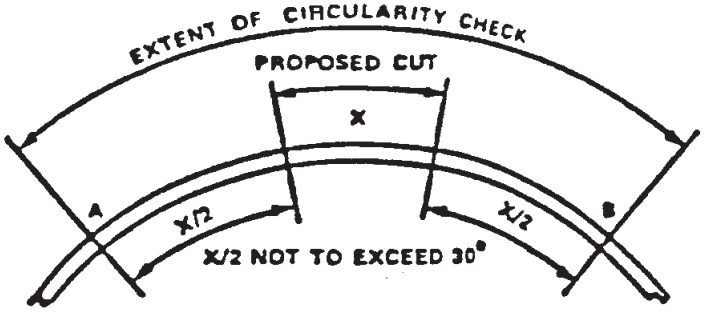


Figure 074–7–1. Standard Partial Circularity Check

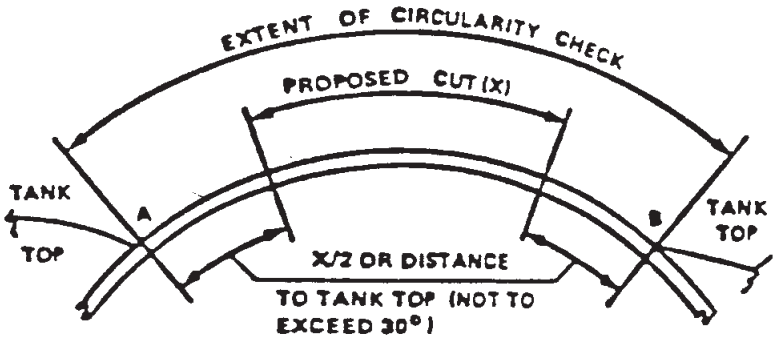


Figure 074–7–2. Partial Circularity Check Where Tank Top Intersects Hull

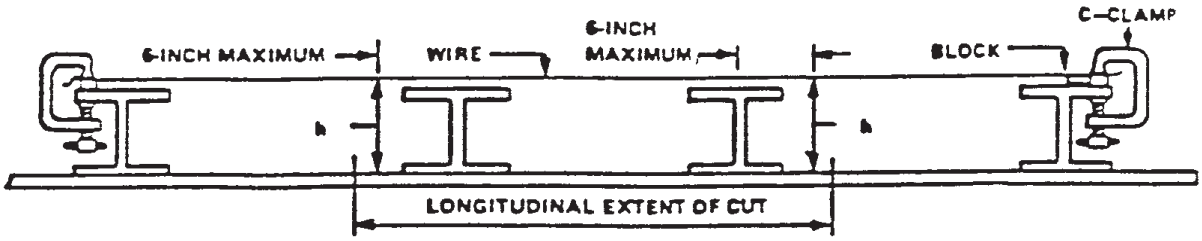


Figure 074–7–3. Use of Range Wire To Establish Elevation

074–7.2.7 Position the template over area to be measured. The template shall stand normal to the submarine main axis and the points of contact between template and hull shall be those points whose elevations were previously measured and recorded. After the template has been positioned properly, a series of measurements shall be taken at the 5 degree intervals indicated on the template. Measurements shall be taken from the hull surface to the scribed line on the template. All these readings shall be recorded for future reference.

074–7.2.8 After the patch has been cut out and rewelded into place, and all adjacent major welding has been completed and allowed to cool to ambient temperature, the procedure shall continue:

1. The range wire, referred to in paragraph 074–7.2.5, shall again be erected and the h distances shown in Figure 074–7–3 shall again be measured and recorded.

2. The template shall be positioned over area previously measured and a new set of radial measurements shall be taken at 5 degree intervals and recorded.

074–7.2.9 An acceptable method of recording all measurements is illustrated in Figure 074–7–5. Measurements to be recorded are:

a. Actual measurements of end point elevations and contour taken before cutting should be recorded on line A.

b. Points of contact between template and hull shall be considered to be zero points. Therefore, all readings greater than the distance from the zero point to the scribed line on the template will reveal a dip in the hull and should be considered negative readings. All readings less than the distance from the zero point to the scribed line reveal a bump in the hull and should be considered positive readings. Contour measurements relative to zero end points before cutting should be recorded on line B.

c. Actual measurements of end point elevations and contour taken after rewelding should be recorded on line C.

d. Contour measurements relative to zero end points after rewelding should be recorded on line D.

e. Inspection of existing tabulated information will reveal whether or not there has been any movement of end point elevations. If h dimensions obtained after rewelding deviate from original h dimensions, corrections equal to the deviation shall be added to if h increases, or subtracted from if h decreases, the contour measurements recorded on line D. These new corrected contour measurements shall be recorded on line E.

074–7.2.10 When information has been recorded (see Figure 074–7–5), three comparisons shall be made to determine whether or not a full circularity check is required.

a. If any of the contour measurements shown on either line B or D has a magnitude greater than one–half the thickness of the pressure hull plating or 1/2 inch, whichever is less, this shall be a cause for requiring a full circularity check.

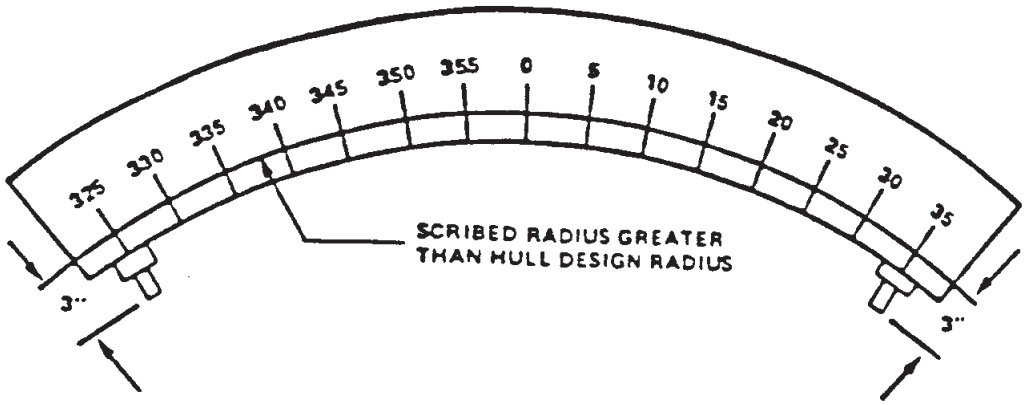
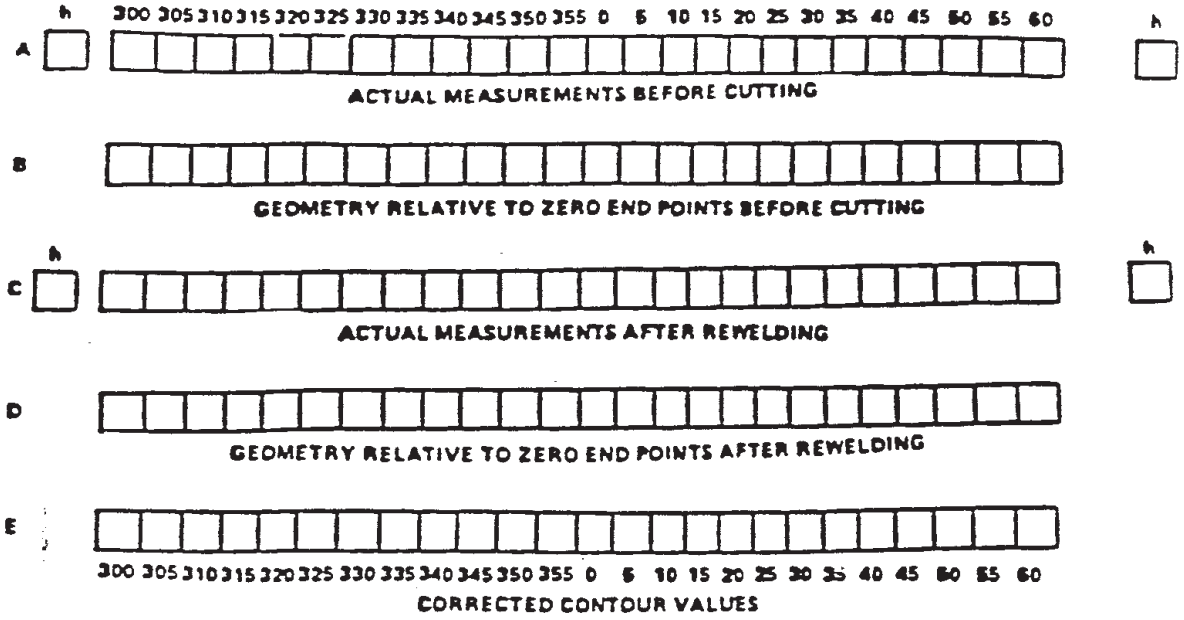


Figure 074–7–4. Example of Template Used To Establish Radial Geometry



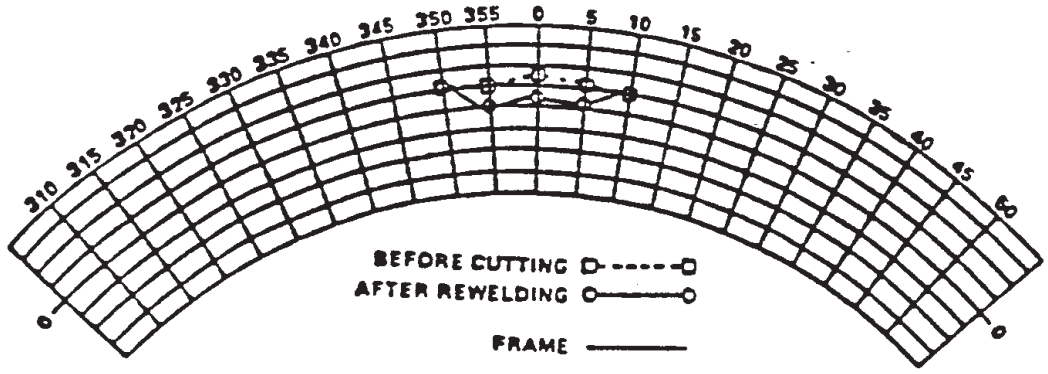


Figure 074–7–5. Method of Recording All End Point Elevation and Contour Measurements Before Cutting and After Rewelding Hull

b. If the difference between the b dimensions taken before cutting and after welding is greater than 1/8 inch, this shall be cause for requiring a full circularity check.

c. If the difference between contour measurements on line B and those on either line D or E is greater than 1/8 inch, this shall be cause for requiring a full circularity check.

074–7.3 HULL PATCH DIMENSIONAL AND ALIGNMENT REQUIREMENTS

074–7.3.1 A completed hull patch shall have frame and plate conditions checked according to Table 074–7–1. These conditions shall meet the dimensional requirements as specified in MIL–STD–1688, **Fabrication, Welding, and Inspection of HY–80/100 Submarine Applications or** MIL–STD–1689, **Fabrication, Welding, and Inspection of Ships Structure**, as applicable.

074–7.3.2 The requirement of the preceding paragraph assumes that hull arrival condition is satisfactory. The overhaul or repair activity cannot be held responsible for the existing hull condition. Condition of hull on arrival shall be determined by taking measurements, according to Table 074–7–1, in the area to be cut. Precut conditions that exceed allowable tolerances shall be resolved with NAVSEA by submitting a Request for Departure according to MIL–STD–480, **Configuration Control – Engineering Changes, Deviations and Waivers**. This report should be forwarded to NAVSEA as soon as possible after the measurements have been taken, but shall be no later than 3 weeks before hull patch reinstallation.

074–7.3.3 Post-installation measurements shall be made according to Table 074–7–1. Approved precut, out–of–tolerance conditions shall not be made worse upon reinstallation of the patch. Post-installation conditions that exceed allowable tolerances shall be resolved by obtaining NAVSEA approval of a Request for Departure (submitted according to DOD–STD–480) before undocking, except when the installation is made waterborne. In this case, NAVSEA approval shall be obtained before fast cruise.

074–7.3.4 All shipyards, repair and overhaul activities, and Type Commanders or designated Squadron Commanders, may approve only those openings listed in paragraph 074–7.1.2 except:

a. For subparagraphs a and c of paragraph 074–7.1.2, Squadron Commanders are limited in approval of openings 5 feet or less in hull circumferential girth and extending across no more than two frames.

b. For subparagraph e of paragraph 074–7.1.2, Type Commander or designated Squadron Commander approval is limited to cases where framing is not disturbed.

074–7.3.5 NAVSEA approval is required for openings not listed in the preceding paragraph or in paragraph 074–7.1.2. Approval requests shall include:

a. Reasons for required cutting and welding

b. Information on size

c. Specific location

d. Details of welding

e. Inspection procedures to be used

074–7.4 CUTTING REQUIREMENTS

074–7.4.1 If possible, cuts should be made in existing welds to avoid needless multiplicity of welds in pressure hull structure. Where existing multiple access cuts are not shown on access and closure patch drawings, and cutting is again required, the entire area of plating containing the multiple cuts shall be removed and replaced with new plating.

074–7.4.2 Where an existing access or closure plate will be removed, and it involves intersection with an existing butt weld at other than 90˚±15˚, the access or closure plate shall be replaced with new plating or the intersections shall be buttered according to Figure 074–7–6 upon reinstallation of the existing plate. Replacement with new plating (including requirements for access or closure plate cut) shall be accomplished according to the applicable fabrication document.

074–7.5 PATCH FORMING

074–7.5.1 Flat patches not rolled or formed to hull radius may be used. Maximum major dimensions of hull patch that may be used without shaping when installed in hulls are listed in Table 074–7–2, with diameter indicated. Other patches will require forming and machining to maintain hull circularity requirements.

074–7.6 HOLE REPAIR

074–7.6.1 Repair of holes through or into the hull structure shall be according to the applicable fabrication document. For purposes of hole repair, cast material shall be treated as plating.

074–7.7 PRESSURE HULL PENETRATIONS

074–7.7.1 STEEL ALLOYS REQUIRING SPECIAL WELDING TECHNIQUES. Steel containing 0.20 percent or higher carbon has shown serious problems when used in pressure hull penetration welds. These materials include HY–80 and HY–100 bar stock, 8620, 8630, and 4130 alloy steels.

074–7.7.2 PENETRATION SURFACING. All penetrations of steel such as those listed in paragraph 074–7.7.1, that contain 0.20 percent or more carbon and are to be welded into an HY–80/100 pressure hull envelope with a full penetration weld, shall be surfaced as shown in Figure 074–7–7 before fitting and welding.

Table 074–7–2. HULL PATCH DIMENSIONS WITHOUT SHAPING

Patch Maximum Major Dimension (inches)	Hull Diameter (feet)
7–3/4	10
8–1/2	12
9–1/4	14
9–3/4	16
10–1/2	18
11	20
11–1/2	22
12	24
12–1/2	26
13	28
13–1/2	30
13–3/4	32
14	34
14–1/4	36
14–1/2	38
14–3/4	40
15	42

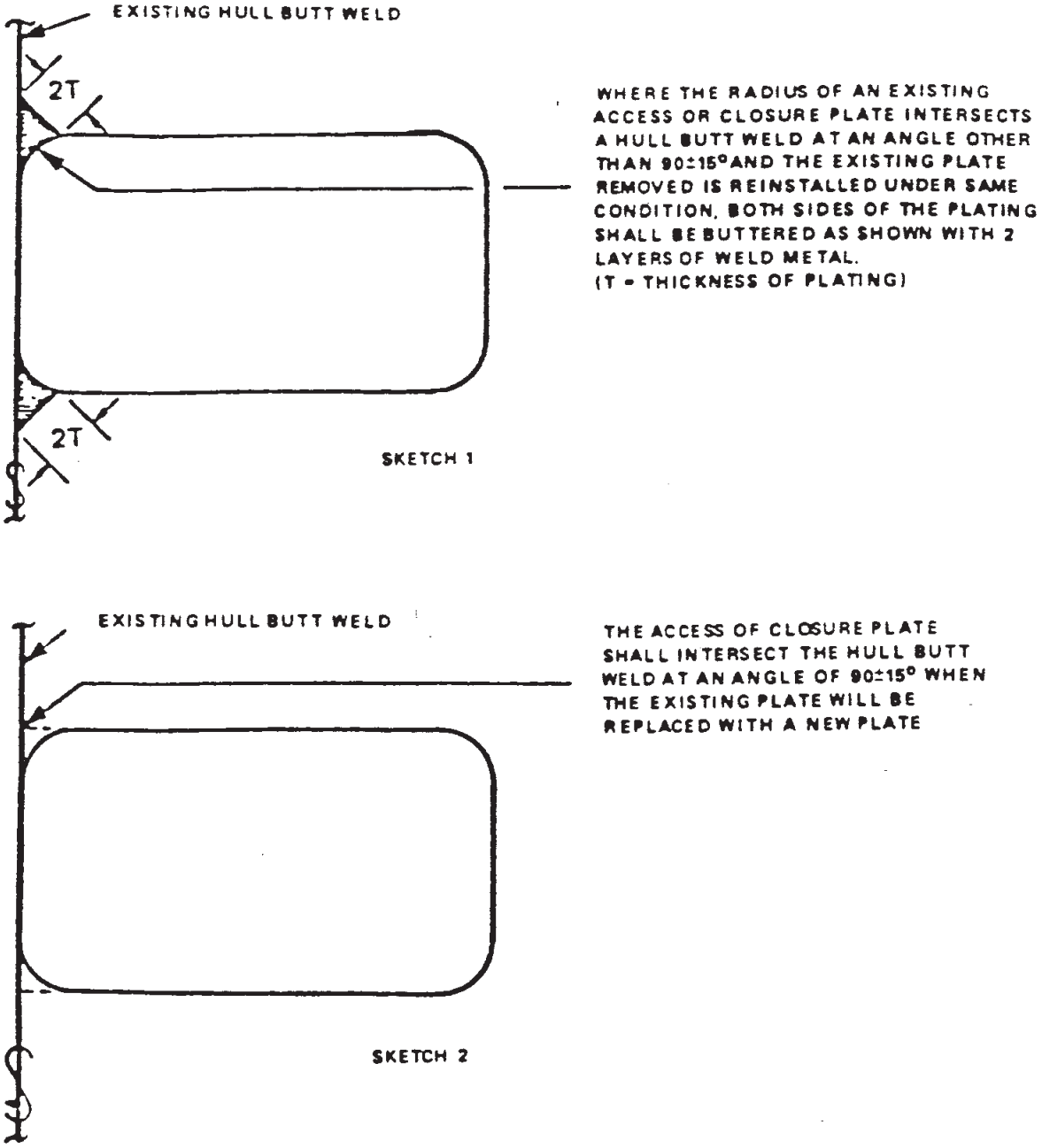


Figure 074–7–6. Existing Access or Closure Plates Intersecting Hull Butt Welds

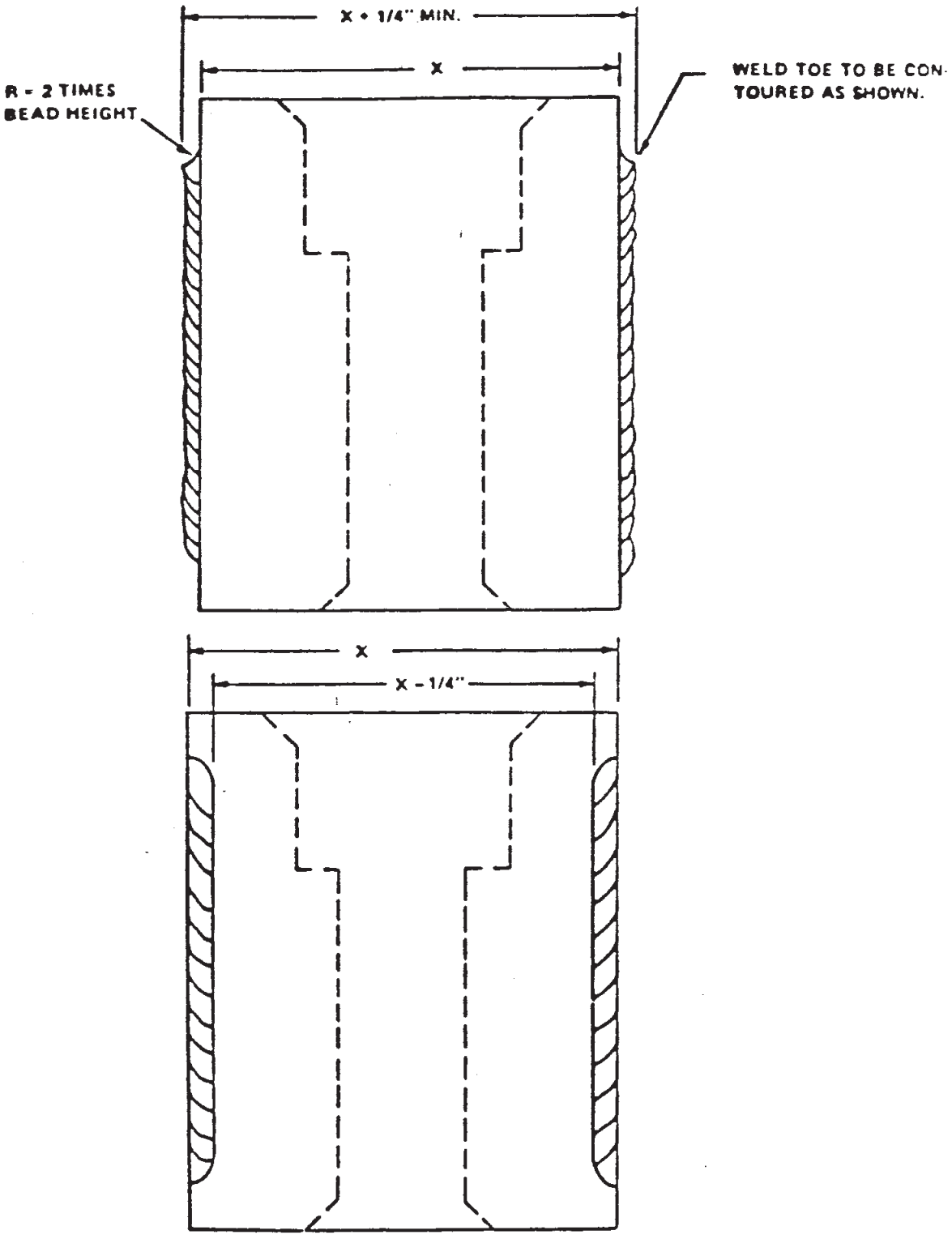


Figure 074–7–7. Submarine Penetration Surfacing Requirements

074–7.7.2.1 Where penetrations are to be welded into high–tensile steel (HTS) hulls, surfacing is not required when Brinell hardness number of the penetration is under 190. Control shall be maintained over welding according to the fabrication documents.

074–7.7.3 EXCESSIVE CARBON CONTENT. Steels with carbon content greater than 0.30 percent shall not be used for pressure hull penetrations without NAVSEA approval.

074–7.7.4 LOCATION OF PENETRATIONS. Location of penetrations shall be according to the applicable fabrication document.

074–7.7.5 PENETRATION BLANKING AND REMOVAL. Procedures for penetration blanking and removal in pressure hull envelopes are described in paragraphs 074–7.7.5.1 through 074–7.7.5.1.2. Procedures for penetration blanking and removal in other structures are described in paragraphs 074–7.7.5.2 and 074–7.7.5.2.1.

074–7.7.5.1 Pressure Hull Envelope. If a penetration is scheduled for reuse at a later date, the methods illustrated in Figure 074–7–8 and Figure 074–7–9 may be used and are considered to be temporary closures pending reuse of the penetrator. A closure of a two–sided stuffing box is illustrated in Figure 074–7–8, and a standard compensating hull penetration closure is shown in Figure 074–7–9.

074–7.7.5.1.1 If a penetrator will not be used again, it shall be removed and the pressure hull envelope restored. In cases where removal is difficult and not readily accomplished due to lack of time or facilities, the blanking methods illustrated in Figure 074–7–10, Figure 074–7–11, and Figure 074–7–12 may be used. These blanking methods are considered to be intermediate fixes pending removal of the penetrators and restoration of the pressure hull envelope.

074–7.7.5.1.2 When penetrators are blanked according to paragraphs 074–7.7.5 through 074–7.7.5.1.1, they should be listed and included in ship history and made an item on work lists for accomplishment at some future date, usually the next availability.

074–7.7.5.2 Other Structure. If a penetrator is scheduled for reuse at a later date, the methods described in Figure 074–7–8, Figure 074–7–9, and Figure 074–7–13, may be used and are considered to be temporary closures pending reuse of the penetrator.

074–7.7.5.2.1 If the penetrator will not be used again, it is desirable to remove the penetrator and restore the structure. In those cases where penetrator removal is difficult, costly, and not readily accomplished due to lack of time or facilities, blanking methods described in Figure 074–7–10, Figure 074–7–11, and Figure 074–7–12 may be used and may be considered permanent fixes.

074–7.7.6 INSTALLATION. Installation and welding of typical pressure hull penetrations are illustrated in Figure 074–7–14, Figure 074–7–15, and Figure 074–7–16.

074–7.7.6.1 Welding, fabrication, and inspection shall be according to the applicable fabrication document.The weld toe against all penetrations shall be ground smooth and tapered gradually into the base metal surface.

074–7.7.7 REPAIR OF PRESSURE HULL PENETRATORS. When cracks are discovered on previously installed penetrations, the penetrations shall be repaired or replaced according to applicable fabrication document except as specified in paragraph 074–7.7.7.1.

074–7.7.7.1 Cracks in the heat affected zone (HAZ) of the fitting shall be repaired as follows.

1. Identify fitting material and repair according to applicable fabrication document if the fitting is higher strength steel, AISI 8620, **Carbon and Alloy Steels**, or ASTM A441, **Std Specification for High Strength Low Alloy Structural Manganese Vanadium Steel**, for HTS hulls, or HY–80/100 for HY–80/100 hulls.

2. Make a new fitting if the fitting is not one of the materials specified in step 1. Install new fitting according to paragraph 074–7.7.6.

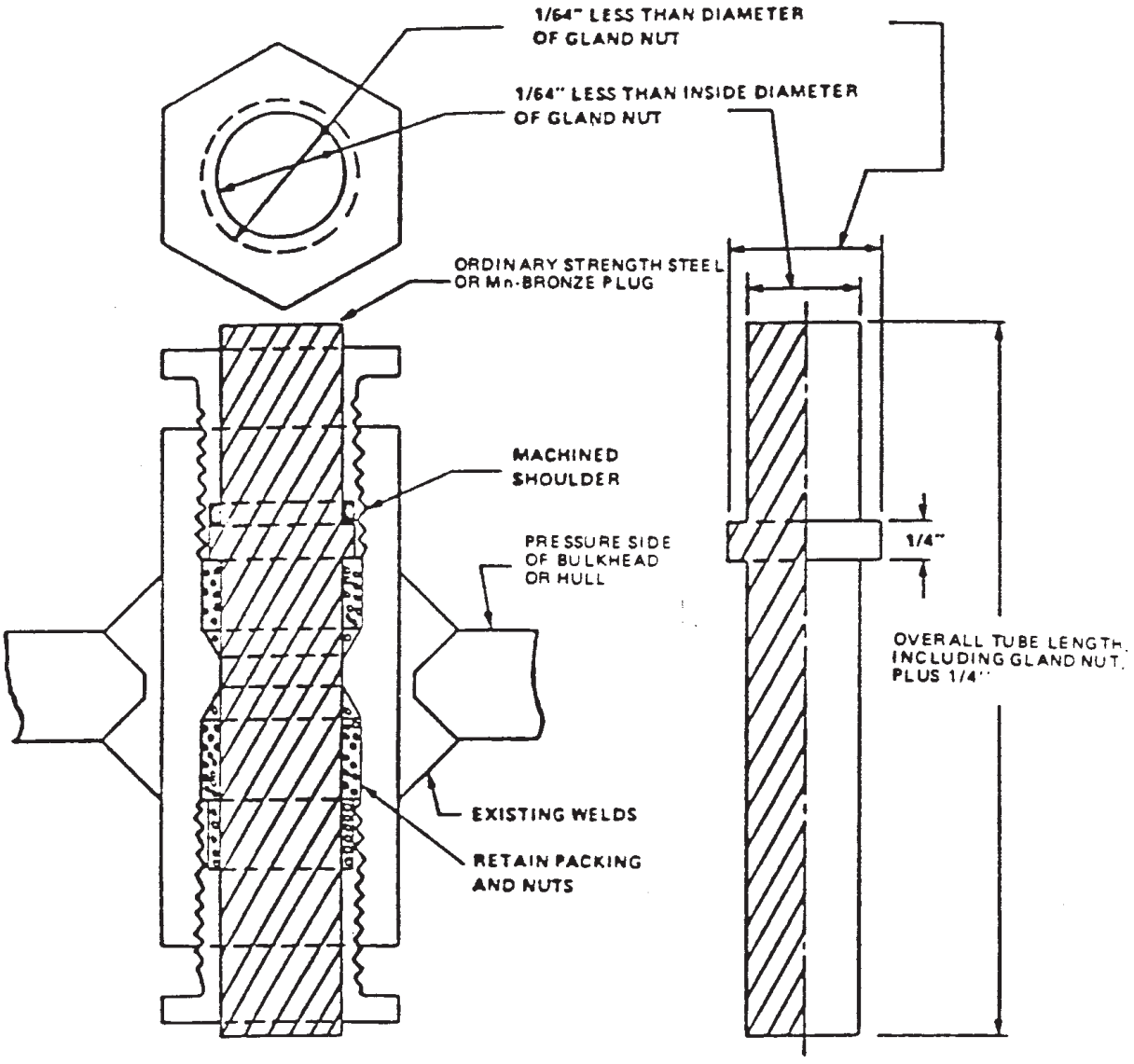
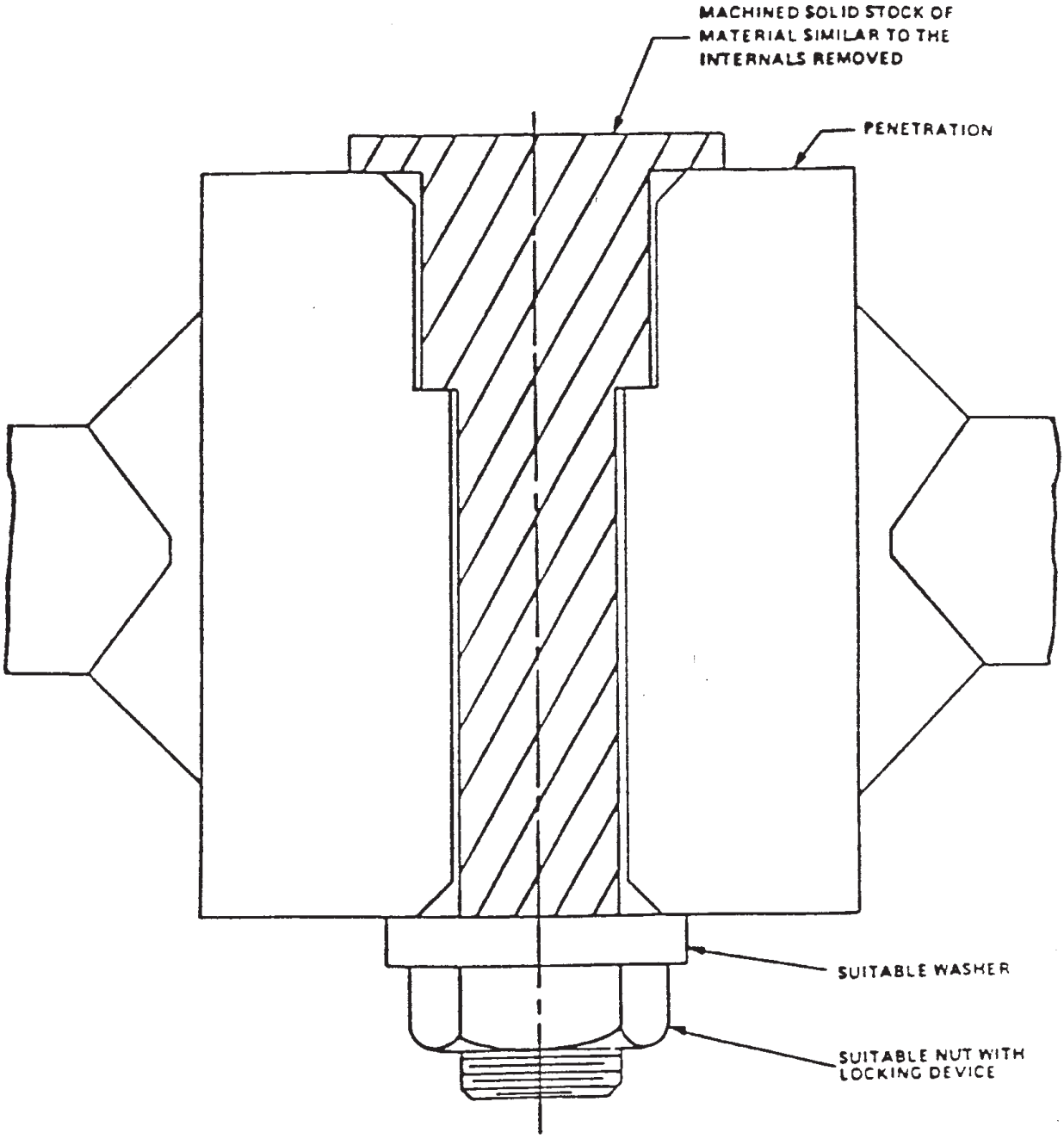
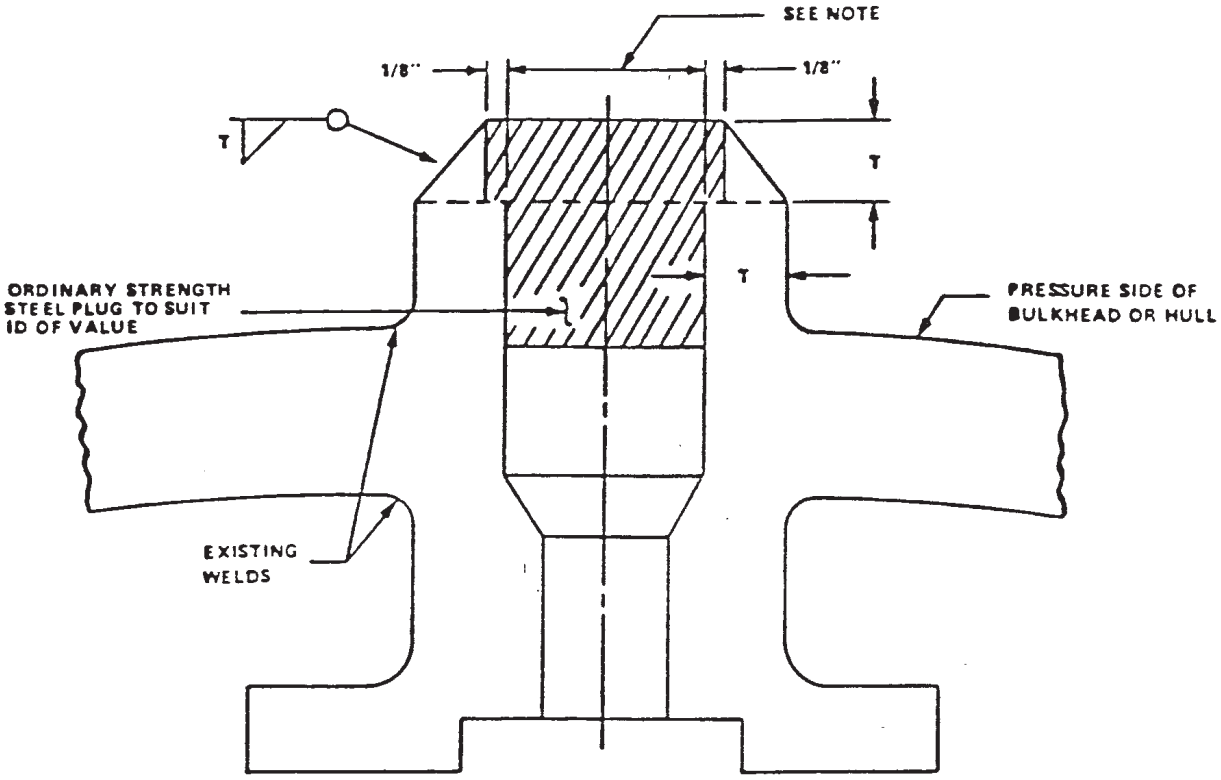


Figure 074–7–8. Closure of Two-Sided Stuffing Box



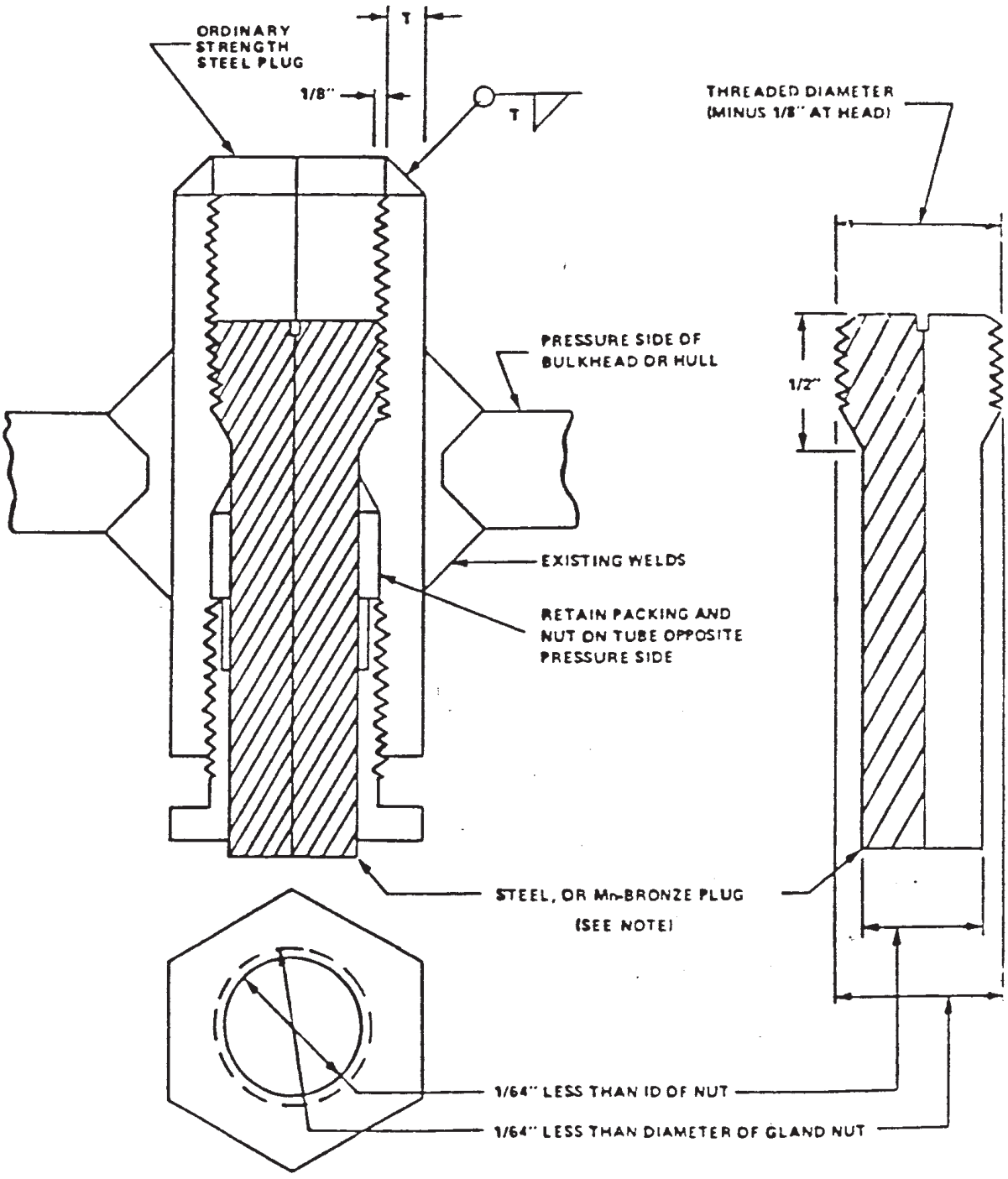
NOTE: O-RINGS ARE TO BE INSTALLED AS REQUIRED BY THE ORIGINAL FITTING.

Figure 074–7–9. Standard Compensating Hull Penetration Closure



NOTE CLEARANCE BETWEEN PLUG AND STUFFING BOX NOT TO EXCEED 0.010 INCH ON THE DIAMETER

Figure 074–7–10. Closure of Welding of Nonthreaded Stuffing Box or Sleeve Fitting



NOTE: FOR BRASS STUFFING BOXES USE Mn-BRONZE PLUG. FOR STEEL STUFFING BOXES, USE STEEL PLUGS.

Figure 074–7–11. Closure and Welding of One Side of Stuffing Box

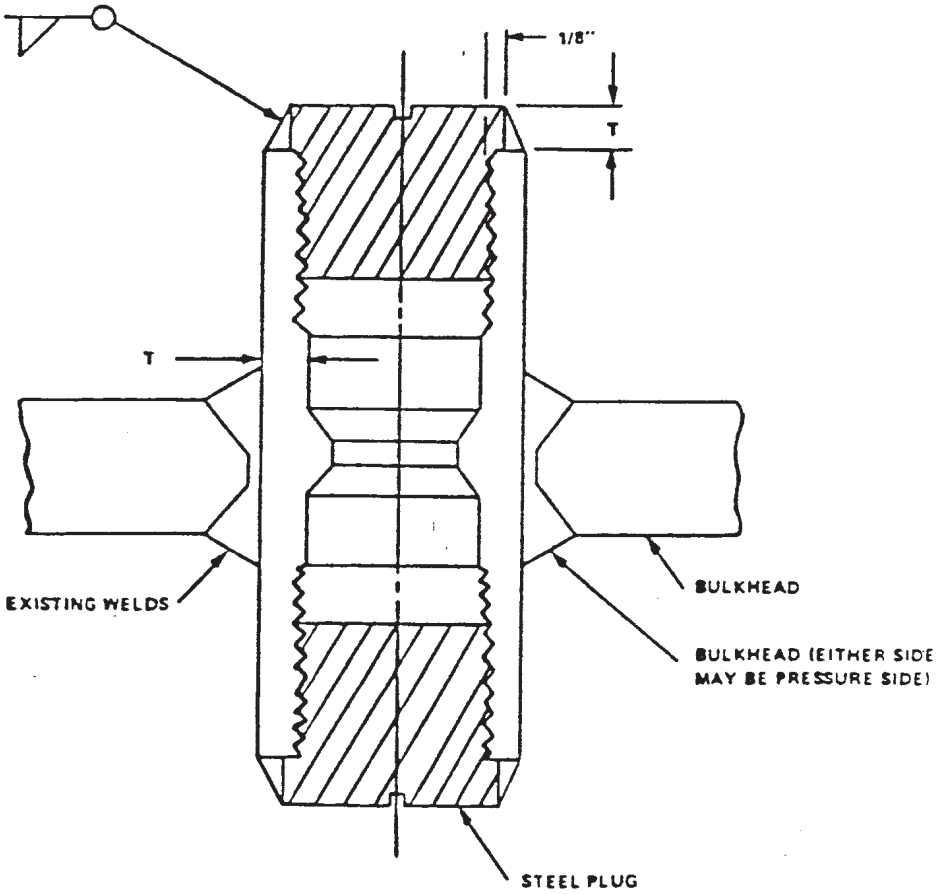


Figure 074–7–12. Closure and Seal Welding of Threaded Stuffing Box

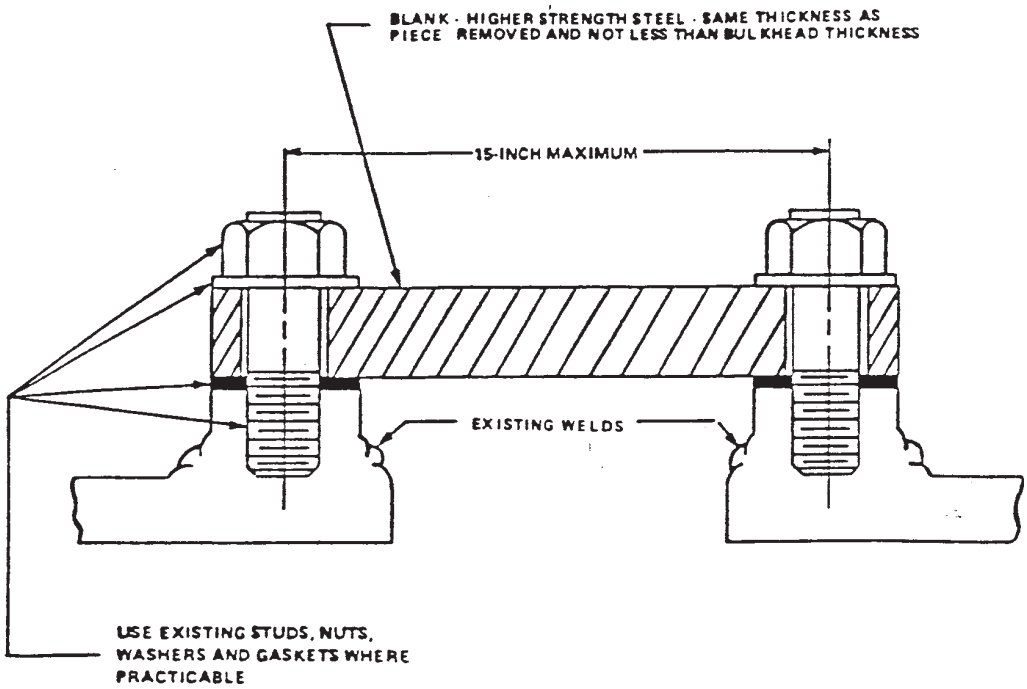
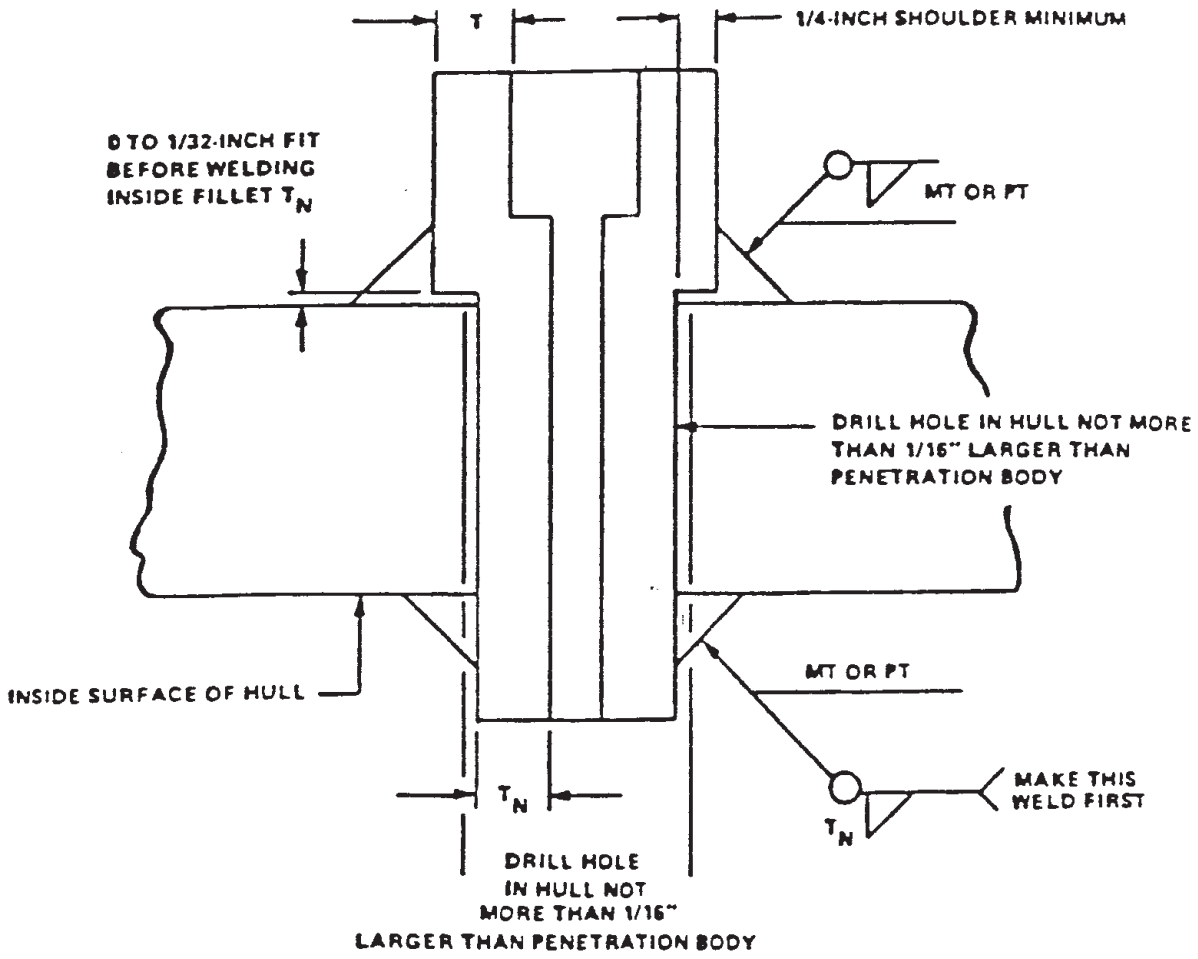
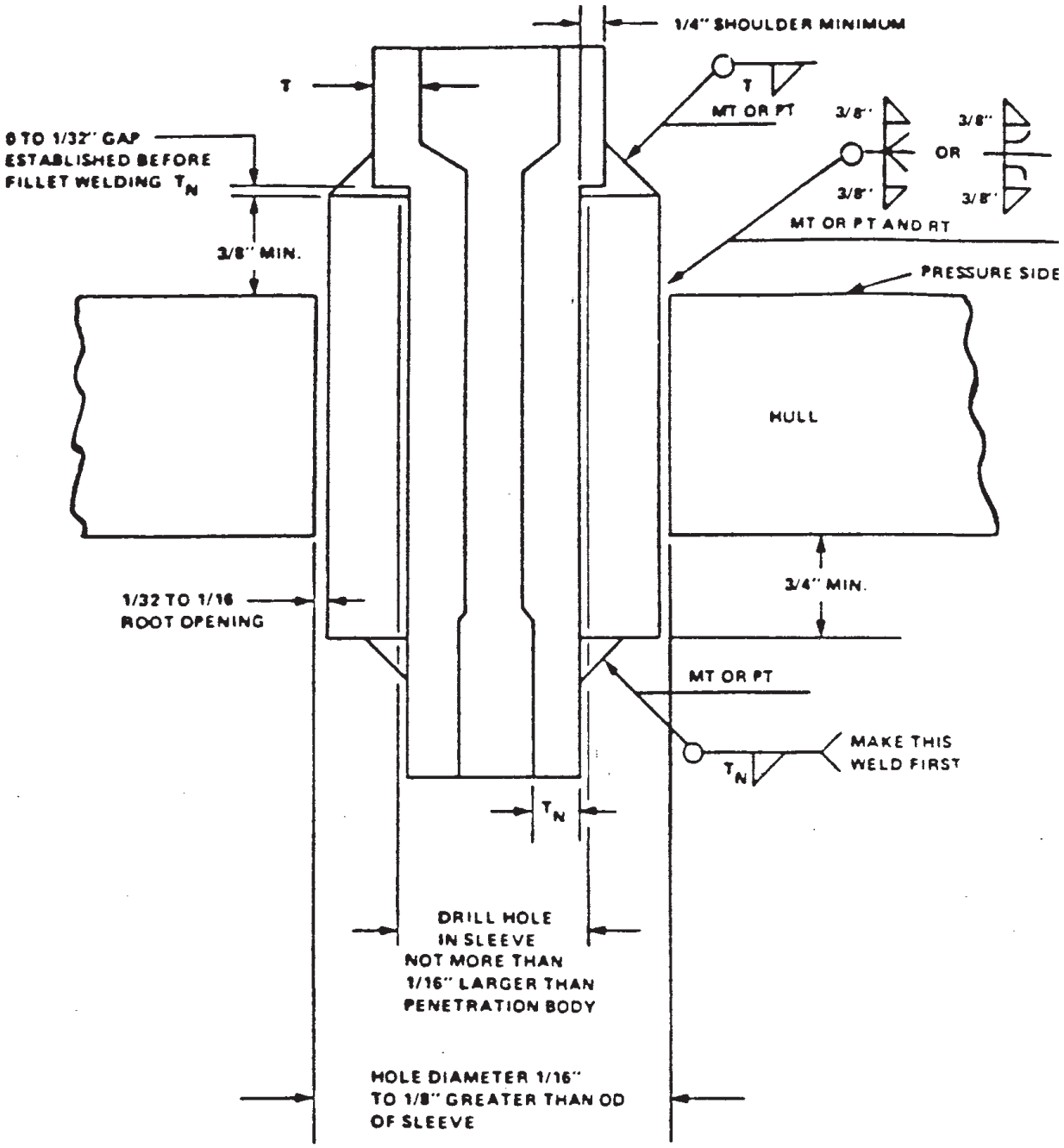


Figure 074–7–13. Patch or Cover for Pipe or Valve Connection Through Bulkheads Only, Where Liner Is Already Installed



NOTE: WELD SIZES T AND T_N SHALL BE NOT LESS THAN 3/8-INCH FILLET

Figure 074–7–14. Shoulder Type Fitting or Shoulder Type Sleeve



NOTES:

1. MINIMUM WALL THICKNESS OF SLEEVE SHALL BE 1/4 INCH + T.
2. FILLET WELDS T_N AND T SHOULD BE SHOP WELDED AND INSPECTED BEFORE WELDING OF SLEEVE INTO HULL. FILLET WELDS SHALL NOT BE CONCAVE.
3. JOINT BETWEEN SLEEVE AND HULL SHALL BE IN ACCORDANCE WITH APPLICABLE FABRICATION DOCUMENT (SEE FIGURE 074–7–16 FOR EXAMPLE OF ALLOWABLE FULL PENETRATION WELD JOINTS.)

Figure 074–7–15. Shoulder Type Fitting and Sleeve

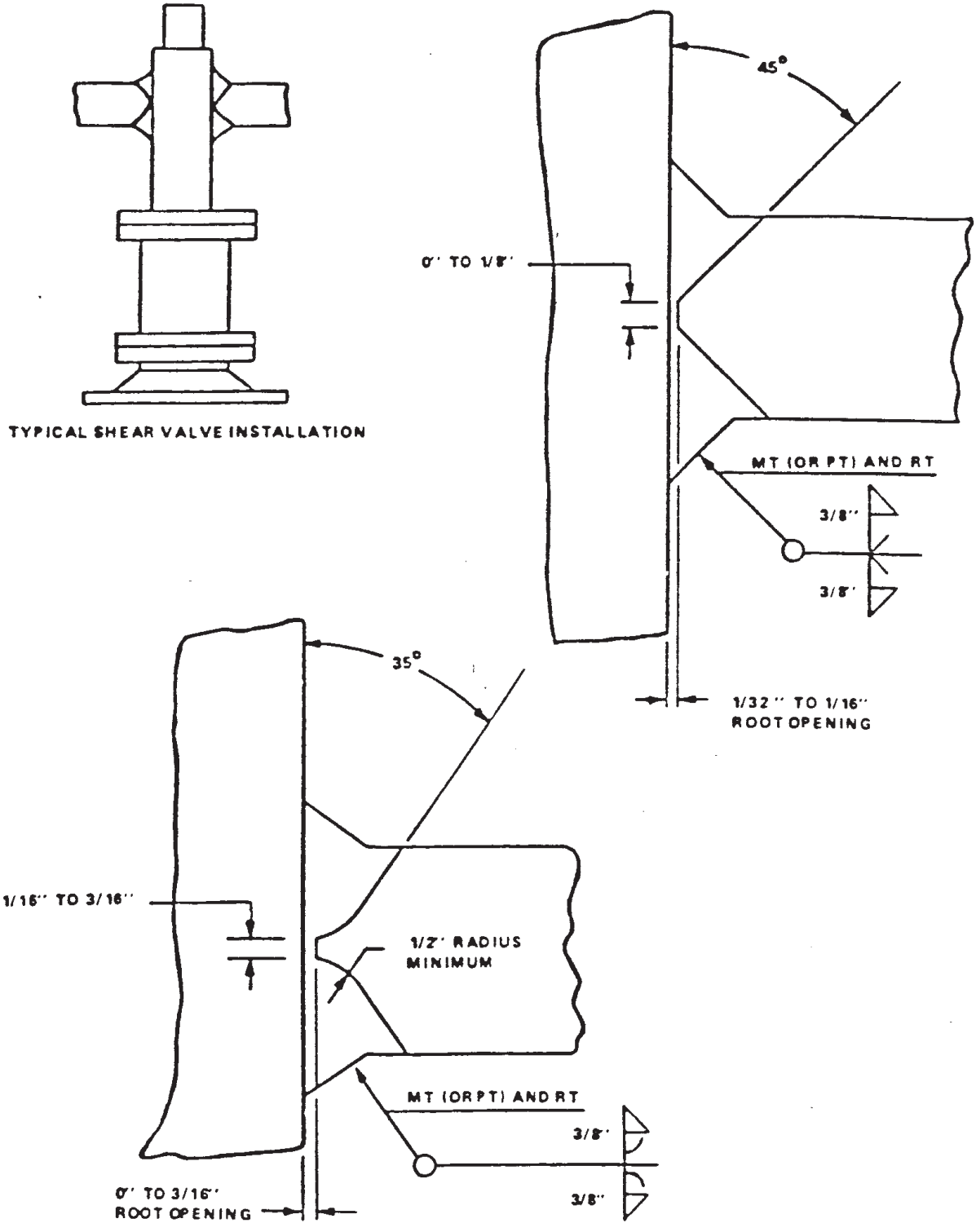


Figure 074–7–16. Pressure Hull Full Penetration Weld Joint Design

074–7.8 WELD REPAIR OF CORRODED STRUCTURE, CORRODED WELDS, AND FABRICATION SCARS

074–7.8.1 GENERAL. All corroded surfaces shall be ground smooth to sound metal and shall have a surface satisfactory for welding. Corrosion repairs to HY–80/100 castings shall be conducted according to the wrought material sections of MIL–STD–1688 (that is, the casting section of the military standard does not apply for corrosion repair).

074–7.8.2 CORRODED STRUCTURE. Generally corroded areas that have suffered a thickness reduction in excess of 45 percent of original thickness shall not be surfaced. Both sides of the plating shall be examined for thickness reduction. Corroded areas shall be surfaced only in those cases where thickness of plating is less than the minimum specified for corroded plating (see **NSTM Chapter 091, Submarine Hull Inspection**).

074–7.8.2.1 For purposes of this volume, a corroded area is considered to be a pit if it is 2 inches or less in diameter before preparation for welding. (Larger areas are considered to be general corrosion.) Isolated pits may be part of a generally corroded area. Isolated pits may be repaired as follows.

1. By drilling through and plug welding according to the requirements for repair of holes in the applicable fabrications document.

2. By welding, if. the remaining plate thickness under the pit is 1/4 inch or greater.

074–7.8.2.2 Surfacing or filling of pits and corroded areas of hull structure shall be within limitations listed in **NSTM Chapter 091**. When required by **NSTM Chapter 091**, weld repair shall be accomplished as follows:

1. Generally corroded areas (defined in paragraph 074–7.8.2.1).The average thickness of the material surrounding the corroded area shall be determined by ultrasonic measurements. If this average thickness exceeds the original design thickness, the generally corroded area shall be restored to at least the original design thickness. If the average thickness of the surrounding material is greater than the minimum allowable thickness, but less than the original design thickness, the corroded area shall be restored to at least the average surrounding material thickness.

2. Isolated pits (defined in paragraph 074–7.8.2.1). Isolated pits shall be restored to the thickness of the surrounding material.

074–7.8.2.3 HTS materials over 3/4–inch thick shall be Brinell hardness tested and materials with a Brinell hardness number over 192 shall be preheated to 150°F (65.6°C) before welding. Completed weld surfacing on submarine pressure hull plating shall be ground smooth.

074–7.8.3 CORRODED WELDS. Welds shall be weld repaired if the weld is below a noncorroded plate surface. The weld to be repaired must be below a noncorroded plate surface in excess of the allowable undercut specified by the applicable fabrication document. Welds shall be repaired if they are below a corroded plate surface in a generally corroded area. Completed weld repairs shall meet reinforcement and surface requirements of the applicable fabrication document.

074–7.8.4 FABRICATION SCARS. Scars that do not require repair according to **NSTM Chapter 091** shall be faired in by grinding.

074–7.8.4.1 After grinding, magnetic particle (MT) inspect the base material in way of fabrication scars to ensure that defects have been removed.

074–7.8.4.2 Weld repair scars that exceed the depth criteria of **NSTM Chapter 091** (fabrication scars shall be treated as either general corrosion or pitting depending on the size criteria of **NSTM Chapter 091**) shall be inspected to the requirements of paragraph 074–9.2.

SECTION 8.
PIPING, PRESSURE VESSELS, AND MACHINERY

074–8.1 INTRODUCTION

074–8.1.1 Except as specified in this section, fabrication, welding, inspection, and casting inspection and repairs for machinery, piping, and pressure vessel shall be according to MIL–STD–278, **Welding and Casting Standard**. Where a particular application or service dictates a change in requirement of MIL–STD–278, variation shall have Naval Sea Systems Command (NAVSEA) approval.

074–8.2 REPAIRS TO BOILERS

074–8.2.1 Unless otherwise approved by NAVSEA, welding and repair of boilers shall be according to the procedures of NAVSEA 0951–LP–031–8010, **Repair and Overhaul of Main Boilers, 1200 PSI, Steam Propulsion Plant** or NAVSEA 0951–LP–038–6030, **Repair and Overhaul Instructions, 1200 PSI Pressure Fired Boiler and Supercharger**, as applicable.

074–8.2.2 Under special limited-access conditions where qualification requirements are not otherwise specified, welders should complete a simulated repair weld. The mockup should simulate the actual job and shall be welded using welding procedure parameters specified for the actual weldment.

074–8.3 RESTRICTIONS

074–8.3.1 Welding of items a and b shall be accomplished only by shipyards unless specifically approved by NAVSEA.

a. Gears or category C weld items such as main propulsion units, reduction gears, clutch and coupling assemblies, and similar components (see paragraph 074–1.2.1.c.)

b. Cast or nodular iron other than category D and F weld components and assemblies, and components nonessential to the ship mission.

074–8.3.2 The following restrictions on repair welding of steam turbines shall be observed, except as authorized by NAVSEA approved drawing, a SHIPALT, a Technical Repair Standard (TRS), or other document issued or approved by NAVSEA:

a. Repair welding of rotors and blades is prohibited.

b. Repair welding of all turbine casings and diaphragms shall be permitted only when approved by NAVSEA or when accomplished under the supervision of the manufacturer representative and all requirements of MIL–STD–278, **Welding and Casting Standard**, are met.

c. Specific case exceptions may be made by NAVSEA.

074–8.4 REQUESTING APPROVAL FOR WELDING

074–8.4.1 When approval is requested for welding (of exceptions to paragraphs 074–8.2 and 074–8.3), the exact location, reason for welding, description of welding procedure to be used, and similar information shall be forwarded to NAVSEA with the request for approval.

074–8.5 WELDING REPAIR OF MAIN PROPULSION SHAFT

074–8.5.1 Unless otherwise a approved by NAVSEA, welding repair of main propulsion shaft shall be accomplished only by shipyards and shall meet requirements of MIL–STD–2191, **Repair Welding, Weld Cladding, Straightening, and Cold Rolling of Main Propulsion Shafting**.

074–8.6 STRAIGHTENING AND REPAIR WELDING OF BRONZE SHIP PROPELLERS

074–8.6.1 Straightening and welding of bronze ship propellers shall be accomplished according to DOD–STD–2185, **Requirements for Repair and Straightening of Bronze Naval Ship Propellers**.

074–8.7 REPAIR OF DIESEL ENGINE CRANKCASE FOUNDATIONS AND FRAMES.

074–8.7.1 Repair of diesel engine crankcase foundations and frames shall be accomplished according to the applicable manufacturer's technical manual Should detailed information regarding weld re– pair not be provided by the applicable manufacturer's technical manual, weld repair shall be accomplished according to the instructions given in **NSTM Chapter 233, Diesel Engines**.

SECTION 9.
INSPECTION REQUIREMENTS AND ACCEPTANCE STANDARDS

074–9.1 SURFACE SHIPS

074–9.1.1 INSPECTION REQUIREMENTS. Inspection requirements for surface ships are as follows.

074–9.1.1.1 Welds. Welds shall be inspected according to requirements of the applicable fabrication document. This includes expansion inspection of existing welds.

074–9.1.1.2 Base Material Inspection. Nondestructive test indications in base material detected during weld inspections, shall be inspected to and shall meet the acceptance criteria of the applicable fabrication document. Repair welding shall be performed according to requirements of the applicable fabrication document.

074–9.1.2 INSPECTION OF WELD REPAIRS TO CORRODED STRUCTURES AND WELDS. Weld repairs to all structures and welds shall be visually inspected as specified in the applicable fabrication document. Weld repairs to full penetration or 100 percent efficient welds in HY–80, HY–100, or special treatment steels (STS's) in primary structures shall be magnetic particle (MT) inspected according to the applicable fabrication document when the depth of the repair (depth of cleaned area) exceeds 1/4T where T is the thickness of the thinner member. This inspection shall extend 3 inches beyond the 1/4T repair area. Weld repairs to HY–80, HY–100, or STS material in primary structures shall be MT inspected according to the applicable fabrication document when the depth of the repair (depth of cleaned area) exceeds 1/4T where T is the thickness of the plate involved. Radiography or ultrasonic inspection of weld repairs to butt welds in primary hull structures for any material shall be performed according to the applicable fabrication document when required by weld repair dimensions.

074–9.1.3 ACCEPTANCE STANDARDS. Acceptance standards for new welding, including new repair welds, shall be as specified in the applicable fabrication document. When expansion inspection of existing service-proven welds is required, the acceptance criteria for the service-proven welds shall be:

a. The welds shall be free of cracks.

b. For shear wave ultrasonic (UT) inspection, discontinuities which become larger as a result of new welding shall be considered rejectable defects (cracks) and shall be repaired accordingly. Discontinuity enlargement shall be determined by performing UT inspection before and after welding, using the Class II acceptance standard as a recording level baseline.

074–9.1.3.1 Existing service-proven welds inadvertently inspected in the process of new welding inspection shall meet the acceptance standards of paragraph 074–9.1.3.

074–9.1.4 INSPECTION OF MECHANICAL FASTENERS. Inspect all mechanically fastened joints of welded closure patches and joints within 2 feet of closure patches for poor head contact. Pay particular attention to mechanically fastened joints involving longitudinal framing. Replace mechanical fasteners that have poor bead contact according to the applicable fabrication document. Repair counter sunk mechanical fasteners according to procedures in paragraph 074–6.3.

074–9.2 SUBMARINES

074–9.2.1 GENERAL. All welds shall be nondestructively tested according to the inspection requirements and to the acceptance criteria of the applicable fabrication document unless modified in this section. The inspection requirements of the fabrication document shall apply only to the length of new weld (welds completed during current ship availability) and expansion of inspection beyond the length of new weld shall be according to paragraphs 074–9.2.3 through 074–9.3.2.1.

074–9.2.1.1 All penetration or liner installation welds in the pressure hull envelope (or repairs of these welds), regardless of size, shall be MT inspected after each weld layer and shall be final MT inspected after a seven-day wait. If the material is non-magnetic, dye penetrant inspection shall be substituted for MT inspection and acceptance criteria shall be in accordance with the applicable fabrication document.

074–9.2.2 HARD TANKS (HY–80/100 ONLY). New hard tank welds shall be inspected according to the applicable fabrication document, except as follows:

1. All new hard tank welds (welds completed during the current ship availability) except butt welds shall be contour ground.

2. Hydrostatically test the hard tanks as specified in **NSTM Chapter 9880, Damage Control – Compartment Testing and Inspection**.

3. After hydrostatic testing as specified in subparagraph 2, MT inspect the new weld and expansion areas. If repairs are required after this inspection, the repairs shall be made as specified in the applicable fabrication document and the tank shall be retested hydrostatically. Note that the inspection wait times of the applicable fabrication document are not required when the tank is hydrostatically tested after the welding is complete.

4. The cycle of the repair, hydrostatic test, and MT inspection (subparagraphs b and c) shall be repeated until an acceptable MT inspection is accomplished. If the welds have been satisfactorily MT inspected during the current repair before hydro test, eddy current (ET) inspection per MIL–STD–271, **Nondestructive Testing Requirements for Metals**, may be used as an alternate to MT. Indications found by ET shall be resolved by MT inspection.

5. Hydrostatic testing may be eliminated when the weld repair is 18 inches or less in length and no more than 1/8 inch deep. Where hydrostatic testing is not accomplished, the inspection wait times of the applicable fabrication document shall apply.

6. Hydrostatic testing is not required for (a) fillet welds and (b) partial penetration welds that are 18 inches or less in length or components that are 6 inches or less in diameter. Where hydrostatic testing is not accomplished, the inspection wait times of the applicable fabrication document apply.

7. Hydrostatic testing is not required for weld repair of pitting and scars when such repairs do not exceed 10 percent of the area of any one panel or wore than 100 square inches for any individual area. The distance between the edges of any two adjacent weld repaired areas shall not be less than 12 inches. For small isolated pits less than 2 inches in diameter, this edge-to-edge distance may not be less than two times the diameter of the larger pit. In addition, all weld repaired areas are to be ground smooth and MT inspected. This inspection shall extend to include 1/2 inch of the adjacent surface.

074–9.2.3 INSPECTION EXPANSION REQUIREMENTS. Inspection requirements for weld joints in the applicable fabrication documents apply only to the lengths of new welds. New welds are those welds made during the current ship availability. Expansion of nondestructive testing methods and acceptance criteria into existing (service-proven) welds or weld areas (adjacent to new work) shall be as specified in paragraphs 074–9.2.3 through 074–9.3.2.

074–9.2.3.1 Radiographic or Ultrasonic Inspection. For radiographic (RT) or ultrasonic (UT) inspection:

a. Repairs in excess of 1/4 inch in depth or rewelding of service-proven welds in the pressure hull envelope shall be inspected for a distance of 3 inches beyond the area of rewelding. RT/UT expansion is required only where RT/UT was required for the repaired area. RT/UT expansion inspection on a full penetration hull butt weld in the pressure hull envelope need only extend to an intersecting full penetration weld to the pressure hull envelope when the intersecting member is one-quarter the hull thickness or greater and it falls within the 3–inch requirement.

NOTE

For clarification, an example of rewelding of service-proven welds is the reinstallation of access patches cut on existing welds (see Figure 074–6–3).

b. Conduct additional inspection expansion for that portion of intersecting full penetration and adjacent full penetration service-proven welds in pressure hull envelope within 3 inches (weld toe to weld toe) of:

1. New or rewelded full penetration welds except plug welds in pressure hull envelope.

2. Repairs to full penetration welds except plug welds the depth of which exceeds one-half the thickness of the pressure hull envelope.

c. Acceptance criteria for the existing service-proven welds shall be as follows:

1. For RT inspection, the welds shall be free of cracks.

2. For angle beam UT inspection, discontinuities which become larger as a result of new welding shall be considered as cracks. Discontinuity enlargement shall be determined by performing the UT inspection before and after welding (including applicable expansion areas). For HY–80/100 steels, record all discontinuities detected at the class I recording level of NAVSEA 0900–LP–006–3010, **Ultrasonic Inspection Procedure**, and for other materials, record all discontinuities at the Class II recording level.

3. Repair of the existing welds, if rejected by the above criteria, shall be repeated until specified inspection expansion areas are found that meet the above expansion area inspection acceptance criteria.

074–9.2.3.2 Magnetic Particle or Liquid Penetrant Inspection of HY–80/100 Structure. The extent of MT/liquid penetrant (PT) expansion inspection for service-proven full and partial penetration welds in pressure hull envelope or full and partial penetration welds to the pressure hull envelope is based on the depth of repair as measured from the plate surface as shown in Table 074–9–1.

Table 074–9–1. MAGNETIC PARTICLE OR LIQUID PENETRANT INSPECTION EXPANSION OF SERVICE-PROVEN FULL PENETRATION WELDS IN OR TO HY-80/100 PRESSURE HULL ENVELOPE

Depth of Repair	Inspection
1. Less than or equal to 1/3T	Inspect a minimum of 6 inches beyond each end of repair within the same welds on repair face.
2. Greater than 1/3T to and including 2/3T	Perform the inspection described in 1 for both the repairs and the opposite face.
3. Greater than 2/3T and including rewelding of service-proven welds.	Perform the inspection described in 2. In addition, perform the inspection required by paragraph 074–9.2.3.2.1
Note:	
1 T= thickness of member being repaired.	
2 MT or PT expansion inspection on a full penetration hull butt weld in the pressure hull envelope need only be extended to an intersecting full penetration weld to the pressure hull envelope, when the intersecting member is one-quarter the hull thickness or greater and falls within the 6-inch requirement.	

074–9.2.3.2.1 Additional expansion inspection is required for that portion of service-proven full penetration welds in the pressure hull envelope that are within 3 inches (weld toe to weld toe) of:

a. Newly installed full penetration welds in pressure hull envelope

b. Weld repairs in pressure hull envelope which exceed a total excavation depth of 2/3T (see Table 074–9–1).

NOTE

Inspection expansion is not required if the service-proven weld was previously contour ground and MT inspected.

074–9.2.3.2.2 Acceptance criteria for existing proven welds shall meet the fabrication document requirement for visual testing (VT), PT, and MT of new welds. Repair of the existing welds, if rejected by acceptance criteria for existing service-proven welds, shall be repeated until specified inspection expansion areas meet expansion area inspection acceptance criteria discussed in paragraphs 074–9.2.3 through 074–9.2.3.2.2. Where initial inspection of ferrous welds is made by PT, any expansion beyond the first 6–inch cycle shall be accomplished by MT.

074–9.2.3.3 Magnetic Particle or Liquid Penetrant Inspection of Higher Strength Steel Pressure Hull Envelope. Extent of MT/PT inspection expansion is based on depth of repair, as measured from plate surface (as shown in Table 074–9–2). Acceptance criteria for the existing service proven welds shall meet the fabrication document requirements for VT, PT, and MT of new welds. Repair of the existing welds, if rejected by the above criteria, shall be repeated until specified inspection expansion areas are found that meet the inspection expansion area acceptance criteria. MT/PT inspection expansion is required where weld repairs are made in service-proven full penetration welds in or to higher strength steel pressure hull envelope as a result of MT/PT inspection expansion. Where initial inspection of ferrous welds is accomplished by PT, any expansion beyond the first 3–inch expansion for ferrous welds shall be accomplished by MT.

074–9.2.4 BASE MATERIAL INSPECTION. Nondestructive test indications in base material, detected during weld inspections, shall be inspected to and shall meet the acceptance criteria of the applicable fabrication document. Repair welding shall be performed according to requirements of the applicable fabrication document.

074–9.2.5 WELD REPAIR OF CORRODED STRUCTURE AND WELDS. Weld repair of corroded structure and welds shall be accomplished as follows.

Table 074–9–2. MAGNETIC PARTICLE AND LIQUID PENETRANT INSPECTION EXPANSION OF SERVICE-PROVEN FULL PENETRATION WELDS IN OR TO HIGHER STRENGTH STEEL PRESSURE HULL ENVELOPE

	Depth of Repair	Inspection
1	Less than or equal to 1/3T	For MT, inspect a minimum of 6 inches beyond each end of repair within same weld on repair face. For PT, inspect 3 inches.
2	Greater than 1/3T	Perform the inspection described in 1 for both the repair and opposite face.

Note:

1. T= thickness of member being repaired.
2. MT or PT expansion inspection on a full penetration hull butt weld in the pressure hull envelope need only be extended to an intersecting full penetration weld to the pressure hull envelope, when the intersecting member is one-quarter the hull thickness or greater and falls within the 6-inch requirement.

074–9.2.5.1 Weld Repairs to Ordinary Strength and Higher Strength Steels and Associated Welds. Visually inspect weld repairs to structure and welds according to the applicable fabrication document. MT inspect weld repairs to higher strength steel welds and structures. RT or UT inspect weld repairs to structures in the pressure hull envelope when the depth of repair is greater than 1/3T, where T is the thickness of the original member involved.RT, UT, and MT inspection and the corresponding acceptance criteria shall be according to the applicable fabrication document. RT or UT inspect weld repairs to welds according to the applicable fabrication document as required by weld repair dimensions. MT inspection is not required when RT is accomplished.Inspection beyond the weld repaired area is not required for repair to structures. Inspection expansion for repairs to corroded welds shall be according to paragraphs 074–9.2.3.1 through 074–9.2.3.3 as applicable.

074–9.2.5.2 Weld Repairs to HY–80/100 Steel and Associated Welds.Visually inspect weld repairs to structure and welds according to the applicable fabrication document. MT inspect weld repair to welds and structures. RT inspect weld repairs to structure in the pressure hull envelope when the depth of repair is greater than 1/3T where T is the thickness of the original member involved. RT and MT inspection and the corresponding acceptance criteria shall be according to the applicable fabrication document. RT inspect weld repairs to welds according to the applicable fabrication document as required by weld repair dimensions. Inspection beyond the weld repaired area is not required for repair to structures. Inspection expansion for repairs to corroded welds shall be performed according to paragraphs 074–9.2.3.1 through 074–9.2.3.2.2 as applicable.

074–9.2.6 HOLE REPAIRS. All hole repairs shall be inspected according to the applicable fabrication document.

074–9.2.6.1 Repair and inspection of holes in castings shall be according to the applicable fabrication document and shall be the same as for wrought materials.

074–9.3 PIPING, MACHINERY, AND PRESSURE VESSELS

074–9.3.1 INTRODUCTION. All welds shall be inspected according to the applicable fabrication document except as may be permitted by paragraph 074–4.2.2.

074–9.3.2 PIPING, AND PRESSURE VESSEL INSPECTION EXPANSION REQUIREMENTS. Inspection expansion requirements for piping and pressure vessels shall be according to MIL–STD–278, **Welding and Casting Standard**.

074–9.3.2.1 Where cracks are found in the RT expansion, they shall be repaired and radiographed (including expansion) to the full requirements of MIL–STD–278. The radiography of any repaired area shall be extended 6 inches beyond each end of the repair for pressure vessels and to the entire weld circumference for piping (for longitudinal welds in piping, radiography shall be extended 6 inches beyond each end of the weld repair). The reinspected weld and adjacent base metal in the expansion area shall be free from cracks. The inspection steps shall be repeated as necessary to ensure 6 inches of crack free weld beyond each end of repair.

SECTION 10.
SAFETY PRECAUTIONS

074–10.1 INTRODUCTION

074–10.1.1 The convenience of arc and gas welding and cutting lies largely in the fact that the equipment can be carried to the job. This convenience leads to performance of construction or repair jobs in locations that have not been designed for such concentrated heat or mixtures of noxious or explosive gases. Failures of personnel, performing welding or cutting operations in such spaces, to take proper precautions often cause a very serious hazard and damage to the ship or structure. Fuel gases other than acetylene are allowed aboard ship.

074–10.1.2 Safety precautions of the American National Standards Institute (ANSI), American Welding Society (AWS) publication, ANSI/ASC Z49.1, **Safety in Welding and Cutting**, shall be carefully studied and practiced. These precautions are intended as a guide for the protection of workers from accidents or occupational diseases, and for avoidance of damage. Personnel engaged in welding or cutting operations should exercise imagination and common sense to ensure that hazards not specifically described, caused by a peculiar combination of unusual circumstances, are recognized and that all possible steps are taken to eliminate them or to provide emergency controls in event of their occurrence.

074–10.1.3 The safety requirements described in paragraphs 074–10.2 through 074–10.10 shall be met, in addition to those prescribed in ANSI–ASC Z49.1.

074–10.2 PIPING

074–10.2.1 Colors may be used as a means of piping identification. A color chart indicating the colors employed for this purpose shall be prominently displayed, or the piping shall be otherwise identified. MIL–STD–101, **Color Code for Pipelines and for Compressed Gas Cylinders**, should be used as a guide.

074–10.3 GAS CYLINDERS

074–10.3.1 Cylinders containing oxygen shall be stored separately from cylinders containing fuel gases. Cylinders in use, or in stores or cargo, shall be securely fastened to prevent their shifting or falling under any weather conditions. Cylinders should be moved by tilting and rolling them on their bottom edges. Dragging and sliding cylinders should be avoided. When cylinders are transported by vehicle, the cylinders should be secured in position. Cylinders shall not be dropped, struck, or permitted to strike each other violently. The use of any cylinder shall be discontinued before the pressure falls to zero. In particular, oxygen cylinders shall not be used in welding or cutting operations after the pressure falls below approximately 25 lb/in^2.

074–10.4 GAS HOSE

074–10.4.1 Hose shall be inspected frequently for leaks, burns, worn places, loose connections, or other defects which may render the hose unfit for service. Hoses found to be defective shall be removed from service immediately. Hose leaks should be verified by submerging the hose in water while the hose is under pressure.

074–10.5 TORCH HANDLING

074–10.5.1 Acetylene is a very reactive gas and personnel trained to operate gas welding, brazing, or cutting equipment with another fuel gas should be familiarized with the operating and safety procedures specifically required for acetylene. In addition to precautions relative to connecting and using apparatus, precautions concerning procedures for lighting, adjusting, and extinguishing torch flames shall be carefully followed.

074–10.5.2 Threads on oxygen regulator outlets, hose couplings, and torch valve inlets are right handed, and threads on acetylene apparatus are left handed. Fittings are notched for positive identification. Threads on

acetylene cylinder valve outlets are right handed but of different pitch from oxygen cylinder valve outlets. If threads do not match, the connections are mixed. Do not attempt to force unmatching or crossed threads.

074–10.5.3 When lighting a torch, first open the acetylene valve slightly and ignite the gas while the oxygen valve is still closed. Then open the oxygen valve slowly and adjust the flame. Do not allow the unburned acetylene to escape into small or closed compartments.

074–10.6 PLACEMENT OF CYLINDERS, OUTLET HEADERS, AND SIMILAR EQUIPMENT

074–10.6.1 GENERAL. When oxygen and acetylene or other fuel gases are used aboard ship (except repair ships for several simultaneous jobs), the cylinder should be moved close to the job so the operator, or an assistant stationed where he can observe the operator at all times, can reach the cylinder valves immediately to close them in an emergency. Cylinders shall be kept away from radiators, piping systems, layout tables, and other equipment that may be used for grounding electric circuits, such as circuits for arc welding machines. Hazardous practices such as the tapping of an electrode against a cylinder to strike an arc shall be prohibited.

074–10.6.1.1 Alongside repair ships, it shall be the responsibility of the Commanding Officer of the repair activity to decide whether to allow the cylinders, outlet headers, or similar equipment inside the ship being repaired, or to keep them outside. The decision shall be based on an analysis of the circumstances of the work and an estimate of which set of hazards described in paragraphs 074–10.6.2 and 074–10.6.3 can be more readily safeguarded.

074–10.6.2 HAZARDS INSIDE THE SHIP. The principal hazards associated with cylinders, outlet headers, and similar equipment inside the ship are:

a. The number of simultaneous jobs and the division of responsibilities among the various sections complicate, enforcement of safety measures for securing cylinders when they are located in numerous compartments, each with a more or less difficult access.

b. There is danger of personnel injury or of cylinder damage when cylinders are manhandled through doors and hatches and up and down ladders.

c. The clutter accumulated during ship repair and overhaul increases the fire hazard. If cylinders are inside the ship and cannot be removed quickly, they may become involved in the fire.

074–10.6.3 HAZARDS OUTSIDE THE SHIP. Keeping cylinders, outlet headers, and similar equipment outside the ship exchanges one set of hazards for another. Hazards outside the ship are:

a. Higher gas pressures and additional couplings required for longer hose lines increase the danger of, gas leaks into the ship.

b. Hoses strung out along decks and through hatches are in more danger of being damaged or cut, releasing flammable gases or oxygen fuel gas mixtures in to the ship.

074–10.6.3.1 When personnel are working deep inside the ship and cylinders are topside, it is more difficult to enforce requirements for securing cylinders during periods of idleness. Under these circumstances, it is more likely that hoses left unattended will be filled with gases under pressure.

074–10.6.3.2 When torches, hoses, cylinders, and other welding equipment are used inside the ship, precautions relative to securing the equipment and removing it from confined spaces when not in use, and those relative to fire prevention and inspections before hot work, shall be given special attention. If this equipment is left outside, the special procedures listed in the following steps relative to stringing hoses through the ship shall be carefully followed.

1. Connect regulators to manifold or cylinders.

2. Connect hoses and torch, checking torch. valves to be sure they are closed.

3. Turn the torch valves on, then open the regulator; supply valves and set the regulator adjusting screws at the desired working pressure on both regulators. Shut the torch and regulator supply valves off and check gauges to see that pressure is maintained. A gradual drop in pressure indicates a leak; investigate and correct.

4. Close torch valves and open valves on regulators. Perform further inspection of all connections as necessary to assure leak tightness.

5. String the hoses, with torch attached, to the location of the work. If strung for a period of several hours or days, provisions should be made to suspend the hose off the deck or other precautions should be taken to minimize the danger of damage to the hose. Take all practical precautions to ensure that doors and hatch covers are securely held open to prevent the hose from being cut by the accidental closing of a door or hatch cover, and to protect the hose from traffic damage.

074–10.7 INSTALLATION AND OPERATION OF ARC WELDING AND CUTTING EQUIPMENT

074–10.7.1 GENERAL. Personnel designated to operate arc welding equipment shall have been instructed in the operation of such equipment. They shall be familiar with all precautions set forth in this volume and in **NSTM Chapter 074, V*olume 3*, *Gas Free Engineering.*** Only approved electric welding machines and accessories shall be used. All welding except that covered in the following subparagraphs shall be accomplished using direct current (dc) or rectified alternating current (ac). Exceptions will require approval.

a. When aluminum alloy is to be welded and the gas tungsten arc (GTAW) welding process is practicable, ac usage is allowed.

b. High frequency ac is allowed for use in arc initiation during all GTAW welding. It is also allowed for use as a continuous superimposed current during ac GTAW of aluminum alloy. The operator shall report any equipment defect or safety hazard to the supervisor and use of the equipment shall be discontinued until its safety has been ensured. Repairs shall be made only by qualified personnel. The primary power connections for welding machines should be maintained by electricians.

074–10.7.2 ELECTRODE HOLDERS.

a. Only electrode holders designed specifically for arc welding and with adequate capacity to safely handle the maximum rated current required by the electrodes shall be used. Electrode holders, when not in use, shall be placed so they cannot make electrical contact with persons, conducting objects, fuel, or compressed gas tanks.

b. Any current–carrying parts passing through the portion of the holder gripped by the operator grips shall be fully insulated with nonconducting material capable of safe insulation against the maximum voltage to ground. Electrode holders with all metallic parts fully insulated, including the jaws gripping the electrodes, are recognized as affording superior protection to the operator.

074–10.7.3 WELDING SERVICE CABLE AND COUPLINGS.

074–10.7.3.1 Welding operators shall use only approved welding cables of the completely insulated flexible type conforming to applicable specifications and capable of handling the maximum current requirements of the work in progress.

074–10.7.3.2 When it becomes necessary to connect lengths of cable, suitable insulated connectors of a capacity at least equivalent to that of the cable shall be used. Fully insulated rigid couplings are carried in standard stock and should be used as standards whenever possible. If connections are effected by means of cable lugs, the lugs shall be soldered or brazed to the cable and securely fastened together to give good electrical contact. The exposed metal parts of the lugs, and the means used to fasten them together, shall be completely covered with rubber tape and protected with friction tape or an equivalent protective covering. Cables should be inspected to ensure that they are in good condition.

074–10.7.3.3 As a safety measure for welding machines, all welding machine terminals for welding leads shall be protected from accidental electrical contact by personnel or by metal objects. Exposed lug type terminals shall be protected initially by taping. The tape shall be replaced with commercial insulated safety terminal covers at the first opportunity. Only terminal covers that completely cover all current–carrying metal parts (the bus bar, lug, stud, and nut) shall be used. Lug type terminal covers shall be procured from local welding supply distributors. Covers shall be procured only for welding machines not having required covers or equivalent protection. The lug type terminals are manufactured by two companies. Jackson Products, AIRCO Welding Products Division of AIRCO Incorporated, manufactures Jackson's Lug Boot that completely covers rectangular, round, or hex bus bars, lug, stud, and nut. CAM–LOK Division of Empire Products Incorporated manufactures two terminal covers: one that will cover rectangular bus bars Model E–1008–9 and another that will cover round or hex bus bar Model E–1008–21. Both require that the welding lead lug be removed to make the connection. Safety instructions for the plug–in type terminals will be provided by separate Advance Change Notice (ACN) to the technical manual covering the individual welding machine.

074–10.7.4 GROUNDING. Precautions for operating arc welding and cutting equipment are:

a. Before starting operations, the operator shall make certain that the welding machine frame is grounded, that neither terminal of the welding generator is bonded nor grounded to the frame of the welding machine, and all electrical connections are attached firmly to the work, not merely laid loosely upon it.

b. The operator should stand on dry wooden mats or similar insulating material rather than on grounded metal structure.

c. When welding is carried on in a space which is entirely screened on all sides, the screens should be arranged so they clear the deck, thereby minimally restricting ventilation needed to carry off welding fumes and smoke. Compartments and tanks on ships shall have added forced air draft ventilation because ship ventilation systems are inadequate for welding operations.

d. Where conditions are crowded and operators are working close to other personnel special care should be taken by the welding operator to ensure that the electrode and bolder do not touch nearby occupants of the compartment while welding is in progress.

e. When using portable machines, care should be taken to ensure that the primary supply cables are separately laid and do not become entangled with welding supply cables.

f. Welders shall place welding cable and other equipment so it is clear of passageways, ladders, and stairways.

g. When a cable (either work lead or electrode lead) becomes worn, exposing bare conductors, the exposed portion shall be protected by rubber and friction tape or an equivalent protection.

h. Welding cables should be kept dry where practicable and free from grease and oil, to prevent premature breakdown of the insulation.

i. When it becomes necessary to carry cables some distance from the machines, they should be suitably supported overhead. If this cannot be done, and cables are laid on deck, they should be protected in such a manner that they will not be damaged or interfere with safe passage of personnel. Special care should be taken to see that welding supply cables are not in proximity of power supply cables, lighting circuits, or any equipment that bas magnetic tapes or depends on a magnetic principle for operation.

j. After welding operations are completed, the welders shall mark the hot metal or provide some other means of warning other workers.

074–10.7.5 PROTECTION FROM SHOCK. One of the principle dangers from low voltage welding circuits is the totally unfounded assumption that they can be handled without danger. The only way to be safe is to handle any electric circuit with extreme caution. The reference to any electric circuit is particularly emphasized because

the welding operator handles not only the welding circuit, but may also handle portable lights and portable motor driven tools. In many instances, the welding operator may handle switches or portable cables on the side of the arc welder connected to the power supply. For ac GTAW machines, a primary contactor controlled by the welder eliminates the need for controls to reduce no load voltage. Shielded metal arc (SMA) welding using ac is prohibited.

074–10.7.6 GAS METAL ARC AND GAS TUNGSTEN ARC WELDING. For welding operations involving GMAW and GTAW welding, the skin shall be covered completely to prevent burns or damage by ultraviolet light. Shirts should be dark in color to reduce reflection to the face underneath the helmet.

074–10.7.7 OPERATIONS INVOLVING THE WELDING OR MELTING OF LEAD.

074–10.7.7.1 Whenever operators are engaged in the welding or melting of lead or low–melting point lead alloys, they shall be provided with air line or filter type respirators approved for protection from lead fumes. In restricted access spaces, only air line masks shall be used. The use of proper respiratory protective equipment by personnel working with lead shall be strictly enforced.

WARNING

The accumulation of lead or lead oxides on clothing or hands shall be guarded against. The ingestion of lead can be as harmful as breathing the fumes.

074–10.7.7.2 All ventilating devices employed, particularly portable temporary devices, shall be scrutinized to ensure that fumes and dust are not being exhausted into the same space, or into other spaces, and creating unrecognized hazards. Steps shall also be taken to ensure that air replacing that being withdrawn is clean and breathable.

074–10.7.7.3 Permissible exposure limits of lead shall be according to those specified in title 29 of the Code of Federal Regulations, paragraph 1910.1025 (Lead), Occupational Safety and Health Administration (OSHA) regulations. Lead worker protection, environmental and medical monitoring, and record keeping for personal exposure to lead shall be as specified by OSHA.

074–10.7.8 THORIATED ELECTRODES. In addition to the hazards normally associated with GTA welding, the use of thoriated tungsten electrodes introduces a potential health hazard. This hazard is attributed to the small amount of thorium oxide, usually 1 to 2 percent, in the electrode material. Natural thorium is radioactive. The potential hazard could result in conditions described in paragraphs 074–10.7.8.1 and 074–10.7.8.2.

074–10.7.8.1 The grinding of electrodes can produce both airborne and surface thorium contamination. While occasional grinding will not produce airborne thorium concentrations high enough to jeopardize personnel safety, grinders used for grinding points on thorium¡ containing tungsten rods shall be equipped with a filter exhaust and grinders and surrounding areas shall be cleaned frequently.

074–10.7.8.2 The burnup of thoriated tungsten electrodes, caused by excessive amperage or improper technique during welding, results in airborne thorium. This contamination usually does not exceed the maximum permissible concentrations. Contamination can be controlled by providing exhaust ventilation for welding areas.

074–10.8 FIRE PREVENTION AND CONTROL OF DAMAGE FROM HOT WORK PROCESSES

074–10.8.1 SCOPE. This section prescribes general fire prevention precautions for hot work processes onboard ship. For hot work requirements in proximity to flammable liquids or flammable atmospheres, see **NSTM Chapter 074 Volume 3, Gas Free Engineering**. For hot work requirements on magazine boundaries, see NAVSEA OP–4, **Ammunition Afloat**. For additional hot work precautions in submarines, see paragraph 074–10.8.6.

074–10.8.2 HOT WORK

074–10.8.2.1 Hot Work Definition. Hot work includes:

a. Flame heating, welding, torch cutting, brazing or carbon arc gouging.

b. Any operation which produces temperatures of 400°F (204°C) or higher.

NOTE

Operations not producing hot sparks or flame such as spark-producing or arc-producing tools or equipment, static discharge, friction, open flames or embers, impact, and nonexplosion-proof equipment such as lights, fixtures, or motors are not considered hot work unless occurring in the presence of flammable liquids or in a flammable atmosphere.

074–10.8.2.2 Hot Work Classes. Where only class alpha materials (ordinary combustibles) (e.g., wood, cloth, paper, rubber, and many plastics) are exposed, hot work is divided into two classes. These are:

a. **Class I.** Most Hazardous Class. These processes produce either high energy sparks or slag that can be thrown or dropped at the work site or produce heat that can be transferred through the deck, overhead, bulkhead, or structure to a location not visible to the hot work operator. This class includes:

1. Flame cutting
2. Welding
3. Plasma cutting
4. Arcing and gouging
5. Electric arc welding
6. Thermal spraying
7. Other hot spark or flame producing process not included in Class II

b. **Class II.** Less Hazardous Class. These processes produce flames or minimal energy sparks or slag which are generally localized to the immediate work area. This class includes:

1. Stud welding with an electric stud gun
2. Gas-tungsten-arc (GTA) welding
3. Torch brazing
4. Ferrous metal grinding with abrasive disks

NOTE

Abrasive disk grinding on non–ferrous material is not included in Class II due to its low energy output.

074–10.8.3 FIRE PREVENTION PRECAUTIONS DURING HOT WORK. Any hot work operation can start a fire in combustible materials. It shall be the responsibility of the hot worker and the hot worker's supervisor to take precautions to prevent fires caused by the exposure of combustibles to the effects of hot work.

074–10.8.3.1 Flammable Liquids and Atmospheres. Do not perform hot work when flammable liquids or flammable atmospheres are present without specific instructions from the Gas Free Engineer.

074–10.8.3.2 Inspect Far Side. Inspect the other side of the bulkhead, deck, overhead, or other structure to ensure that hot work will not damage materials or equipment that may be on the other side of the hot work operation.

074–10.8.3.3 Deenergize Equipment. Deenergize all electrical equipment exposed to the hot work.

074–10.8.3.4 Remove Hazardous Material. Remove explosive materials, flammable liquids, or vapors, and take suitable precautions against the reaccumulation of such materials.

074–10.8.3.5 Relocate or Protect Combustibles. Where practicable, relocate all combustibles at least 35 feet from the work site. Where relocation is impracticable, protect combustibles with metal or guards and curtains constructed of MIL–C–24576 material. Tighten edges of covers at the deck to prevent sparks from going under the covers. This precaution is also important at overlaps where several covers are used to protect a large pile of combustibles.

074–10.8.3.6 Protect Equipment. Protect intricate and vulnerable machinery and equipment from falling sparks or other potential sources of fire with metal guards or curtains constructed of MIL–C–24576 material. Secure the protection in place before commencing hot work.

074–10.8.3.7 Protect Openings. For hot work processes that generate slag, weld splatter or sparks, cover openings in decks, bulkheads or overheads within 35 feet which can be a path to prevent ignition sources from passing into adjacent compartments, spaces or decks below. A complete containment system as described in paragraph 074–10.8.6.2 meets this requirement. If the opening cannot be covered, a firewatch shall be posted on the far side.

074–10.8.3.8 Protect Ducts. Blank off ducts and conveyor systems that might carry sparks to distant combustibles or otherwise suitably protect.

074–10.8.3.9 Protect Combustible Construction. When hot work is done near decks, bulkheads, partitions, or overheads of combustible construction, take precautions to prevent ignition.

074–10.8.3.10 Protect Pipes. Do not undertake hot work on pipes or other metal in contact with insulation or combustible decks, bulkheads, partitions, or overheads if the work is close enough to cause ignition by heat conduction.

074–10.8.3.11 Notify Ship. Do not start hot work in areas other then those specifically designated for such purposes, such as a welding shop, without approval of the Commanding Officer or designated representative. Abrasive disk grinding with a small wheel (typically three inch diameter or less) does not require notification or approval. Notify the damage control assistant (DCA) or fire marshall before starting hot work. Conduct hot work in or on fuel tanks, in spaces in which fuel tank vents terminate, or in other confined spaces known to contain flammable fuel, only with the Commanding Officer's approval. See **NSTM Chapter 074 Volume 3.**

074–10.8.4 FIRE WATCHES. This section prescribes fire watch requirements for most hazardous class I and less hazardous class II hot work in way of ordinary combustible materials. For firewatch requirements in way of flammable liquids or flammable atmospheres, see **NSTM Chapter 074 Volume 3**.

074–10.8.4.1 Fire Watch Requirements.

a. In confined or enclosed spaces, machinery rooms, catapult rooms, bilges, and other locations proximate to flammable atmospheres (e.g., near fuel tank vents and sounding tubes), fire watches shall be posted at the worksite when hot work is undertaken. After completion of the hot work operation, fire watches shall remain on station for a minimum of 30 minutes, ensure that the area is cool to the touch, and ensure that no smoldering embers remain. See **NSTM Chapter 074 Volume 3.**

b. For class I hot work, post fire watches when hot work is undertaken. The fire watches shall stand watch for fire for 30 minutes after hot work is completed.

c. For Class II hot work, the DCA or fire marshall shall determine the need for a fire watch in addition to the hot worker, based on his or her assessment of the worksite prior to undertaking hot work. When posted, the fire watch(es) shall stand watch for 30 minutes after hot work is completed. During an industrial availablility, a Memorandum of Agreement (MOA) may be signed between the ship and the naval shipyard which can delegate responsibility to the naval shipyard to determine the need for an additional fire watch based on shipboard conditions.

NOTE

Abrasive disk grinding on a ferrous material with a large wheel (larger than 3 inches in diameter) typically throws large sparks long distances. A fire watch is recommended for large wheel grinding when class alpha materials (ordinary combustibles) are exposed. The DCA or fire marshall shall determine the need for a fire watch.

d. When a fire watch is not required for class II hot work, the hot worker shall have the appropriate fire extinguishing equipment available. The hot worker may leave the site after hot work is completed and after he/she has conducted a thorough survey of the area to check for smoldering fires. When grinding a ferrous material with a large abrasive disk wheel (larger than 3 inches in diameter), the hot worker shall stand watch for 30 minutes after the hot work ends.

e. When any type of hot work is being performed on bulkheads, decks, or overheads where sparks or heat transfer may ignite combustibles on the opposite, accessible side, set a fire watch on the far side.

f. The hot worker and the hot worker's supervisor are responsible for ensuring fire watches are in place prior to starting work.

g. Train fire watches per paragraph 074–10.8.4.2.

h. Equip fire watches with personal protective equipment (PPE) as required for the operation being conducted (e.g., appropriate eye protection (goggles, glasses, face shield), helmet, respiratory protection, fire retardant clothing).

i. When more than one fire watch is required, establish a communication means between fire watches.

074–10.8.4.2 Fire Watch Training. Fire watches shall be adequately trained. An adequately trained fire watch shall:

a. Know how to determine if an extinguisher is fully charged and properly sealed.

b. Know the different classes of fires as defined in **NSTM Chapter 555 Volume 1, Surface Ship Firefighting or NSTM Chapter 555 Volume 2, Submarine Firefighting**.

c. Know the type of extinguishing agent that is effective on each class of fire.

d. Know procedures and use associated with personnel protection equipment. Normally, such equipment is provided for eye and breathing protection.

e. Demonstrate ability to operate an extinguisher on both a flammable liquid and ordinary combustible type fire.

f. Know that the hot worker and the hot worker's supervisor are responsible for inspecting all sides of a bulkhead or deck, ensuring that combustibles are removed to a safe distance from the hot work and ensuring the physical placement of the fire watch.

g. Know that he and the hot worker shall ensure that openings and combustible material that cannot be removed shall be covered and protected with fire retardant coverings.

h. Know how he will signal the hot worker in the event of a fire.

i. Know that he is to report an alarm to the Officer Of the Deck (OOD) at the quarterdeck if a fire occurs beyond his capability to extinguish.

j. Know how to transmit an alarm by using the shipyard fire alarm systems or the ship's interior communication system.

k. Know the designation and the location of the compartment in which he is standing watch and that he is responsible for leading ship's force back to the fire if requested.

l. Know that before securing the watch, he shall stand 30 minutes at the hot work site after hot work has been completed.

m. Know the procedures for confinement of hot work including use of welder's curtains.

n. Be familiar with hot work permit system in effect and what the system is intended to accomplish and who will monitor performance.

o. Know personnel qualification standards according to Naval Education and Training publication NAVEDTRA 43119 **(Series) Personnel Qualification Standard for Damage Control**. ■

074–10.8.5 FIRE EXTINGUISHING EQUIPMENT FOR FIRE WATCHES. Maintain suitable fire extinguishing equipment of approved types near all hot work operations. Judge the suitability of the equipment by an analysis of the conditions at the scene of operations. Where small amounts of ordinary combustible (class A) materials are the predominant material which could burn, water or aqueous film forming foam (AFFF) fire extinguishers are superior to carbon dioxide (CO_2). Portable 2.5 gallon pressurized water extinguishers (NSN 9C 4210–00–720–1815) are available through the supply system. Carbon dioxide extinguishers are preferable for electrical cables or equipment (class C) fires. In a small space, with a very small access opening, however, the operator may not be able to get out quickly in case of fire, and the use of carbon dioxide will be injurious to him. Under such conditions, use of water spray from a 1–1/2 inch fog nozzle would be preferable. In all cases a 1–1/2 inch fog nozzle shall be available as a backup to other equipment. Carbon-tetrachloride extinguishers shall not be used.

074–10.8.5.1 Fire Extinguishers Suited for Submarine Hull Insulation. Fire watches assigned hot work in areas of submarines where hull insulation is endangered shall be equipped with either of the following:

a. A portable freshwater extinguisher pressure type (NSN 4210–00–720–1815) or pump type with a 2.5 gallon minimum capacity.

b. A portable 2.5 gallon AFFF fire extinguisher (NSN 4210–01–147–1091).

c. A minimum 0.75-inch (ID) hose fitted with a fog nozzle supplied from a freshwater source.

074–10.8.5.2 Fire Extinguisher Maintenance. All installed fire protection equipment located within the compartment where work is to be conducted, and in adjacent compartments, should be maintained in working order at all times when hot work operations are in progress.

074–10.8.6 ADDITIONAL REQUIREMENTS FOR HOT WORK ON SUBMARINES. Existing submarine hull insulation (MIL–P–15280) is extremely vulnerable to ignition and will burn with extreme heat, giving off toxic gases and acrid black smoke. The new submarine hull insulation has better fire performance than MIL–P–15280 insulation, but still burns readily. Submarine hull insulation fires are primarily started by:

a. Sustained ignition of other combustibles; such as a trash fire, or strip heaters in contact with the insulation.

b. Presence of oil film on the insulation or oil soaked into the insulation.

c. Elevated temperatures greater than 400°F may occur from a strip heater.

074–10.8.6.1 When doing hot work of the most hazardous class, additional protective measures shall be taken along with normal measures. The additional protective measures shall consist of installation of a noncombustible containment or barrier system, and removal or complete shielding of all hull insulation within the system of containment. When doing hot work of the less hazardous class, a system of containment is not mandatory; however, normal protective measures (such as removal or shielding of combustibles) shall be taken.

074–10.8.6.2 A system of containment forms a complete barrier around the work site to prevent hot sparks and weld splatter from coming into contact with combustible materials, using metal guards or curtains constructed of MIL–C–24576 materials. The containment system erected is governed in large measure by the type of hot work being accomplished and the peculiarities of the work site. Containment systems can include one or more of the following:

a. Slag catch basins or pans installed against work area, such as between frames while making hull cuts.

b. Vertically hung curtains erected around the entire hot work area.

c. Raised platforms used in conjunction with vertically hung welders' curtains.

d. Combustibles covered with heavy weight class 1 MIL–C–24576 curtains.

e. Covers over openings, ducts, or cracks in bulkheads or decks which form a part of the containment system to prevent sparks and weld splatter from entering adjacent areas.

074–10.8.6.3 For all hot work on submarines, any oil–soaked hull insulation immediately outside the containment area shall be removed. Hot work should not be performed during battery charging operations and for 20 minutes after the completion thereof. Strip heaters shall not be installed within 12 inches of hull insulation. Precautions shall be taken when energizing strip heaters to prevent ignition of hull insulation on the opposite side of the hull plating.

074–10.8.6.4 As a guideline, submarine hull insulation should be stripped away beyond the hot work site, including the metal area which is preheated, when working conditions permit as follows:

a. Gas Tungsten arc welding: 2 feet

b. Stud welding: 1 foot

c. Torch brazing: 2 feet from joint to be brazed

d. All other welding: 2 feet

e. Flame cutting: 3 feet

f. Grinding: 1 foot

g. Strip heaters and preheating: 2 feet on heat side and 2 feet on opposite side of the metal being heated.

074–10.9 PROTECTION OF PERSONNEL

074–10.9.1 FALL PREVENTION. If it is necessary for a welding operator to work on platforms, scaffolds, or runways at an elevation of more than 5 feet, provisions should be made to prevent his falling. This can be accomplished by use of railings, safety belts, lifelines, or some other equally effective safeguard.

074–10.9.2 PROTECTIVE GEAR. Welding personnel shall wear suitable protective gear as described in the following paragraphs.

074–10.9.2.1 Hearing Protection. Ear protection shall be worn when the ambient sound level exceeds 85 decibels when measured on an A network of an approved sound level meter or 140 decibels on an impact noise analyzer. Noise levels exceeding 120 decibels A shall require the wearing of double protection, that is, ear plugs and muffs.

074–10.9.2.2 Helmets and Goggles. Signs warning of the danger of flash burn shall be posted in the vicinity of any type of arc welding or cutting operations. These signs shall meet the requirements of OPNAV 5100.19, **Navy Safety Precautions for Forces Afloat**.

074–10.9.2.2.1 Helmets and hand shields of FED Spec GGG–H–211, **Helmet, Welders, Handshield, Welding, and Plates, Welding**, shall be arranged to accommodate and hold securely window lenses of the specified dimensions, with cover glass, and of a design permitting easy removal of the lenses. Absorptive lenses shall be mounted in helmets so they are at least 2 inches from the eyes. Specification for goggles and lenses are:

a. Goggles designated as style 1 are those having a rigid nonadjustable bridge, or adjustable metallic bridge, without side shields.

b. Goggles designated as style 1 are those having a rigid nonadjustable bridge, or adjustable metallic bridge, with side shields.

c. Goggles designated as style 3 are those having flexibly connected lens containers shaped to conform to the configuration of the face.

d. Lens containers shall be suitable to hold firmly the lenses of the specified dimensions.

e. Goggles of style 2 shall be provided with side shields of metal, leather, or other durable material. The material shall be pliable to permit adjusting the shield to the contour of the face. If side shields are of metal, they should be of wire mesh or of perforated sheet having openings not larger than 0.394 inch.

f. Goggles of style 3 shall consist of eyecups and shall be shaped to fit the configuration of the face. They shall exclude light, except through the lenses, but shall afford adequate ventilation.

g. Lenses for helmet and hand shield windows shall have a height of 2 inches (50.8 mm) and a width of 4.25 inches (108 mm) where one window is provided.

h. Lenses for goggles shall have dimensions not less than 1.5 inches (38 mm) in the vertical direction and 1.75 inches (44.5 mm) in the horizontal direction. It is recommended that circular lenses, not involving optical correction, be a uniform diameter of 1.97 inches (50 mm). Cover glasses should be provided to protect each helmet, hand shield, or goggle lens.

074–10.9.2.2.2 Table 074–10–1 is a guide for selection of the proper lens shade number. The recommendations may be varied to meet the needs of the individual.

074–10.9.2.3 Protective Clothing. Where there is exposure to falling objects, or a bumping hazard, hard hats or head protectors shall be used. Many cotton and polyester fabrics are flammable when subjected to sparks. Aprons made of leather, or other suitable material, may also be desirable as protection against radiated heat and sparks. Low cut shoes with unprotected tops and Corfam shoes shall not be worn when engaged in spark producing operations. Safety shoes that lace above the ankle are preferred.

074–10.9.3 WORKING IN RESTRICTED ACCESS SPACES. Before entering or working in restricted access spaces, the provisions of volume 3 shall be reviewed. A restricted space is:

a. A space with only one exit

b. A space with a passageway that prohibits a walking entry and exit

c. A space where equipment or structural barriers prevent easy entry and exit

074–10.9.3.1 Ventilation is a prerequisite for working in restricted access spaces. For ventilation requirements, see paragraphs 074–10.10.1 through 074–10.10.5.1.

074–10.9.3.2 When welding or cutting is being performed in any restricted access space, the gas cylinders and heavy welding or cutting equipment shall be left on the outside. Before operations are started, heavy portable equipment mounted on wheels shall be securely blocked to prevent accidental movement.

074–10.9.3.3 An attendant shall be stationed outside a restricted space and should be able to observe or communicate with the welding operator at all times. In case of emergency, he should immediately shut off the gas or welding machine and render or seek help as warranted.

074–10.9.3.4 When a welder must enter a restricted access space through a manhole or other small opening, means shall be provided for his quick removal in case of emergency. When safety belts and lifelines are used for this purpose, they shall be attached to the welder's body in such as way that the welder may be safely removed in an unconscious condition without his body being jammed in a small exit opening.

074–10.9.3.5 When the restricted access spaces are a part of remotely controlled equipment, or the access could be closed by remote operation (such as sea chest flood doors), positive measures shall be used to secure the equipment or block its operation.

074–10.9.4 WORKING WITH ARC WELDING EQUIPMENT. When work in a restricted access space is to be suspended for any substantial period of time, such as during lunch, overnight, or for drills, all electrodes shall be removed from the holders. If work is to be suspended for a period of 1 hour or more, one of the following precautions shall be taken:

a. All arc welding equipment shall be removed from the restricted access space.

b. All arc welding equipment shall be disconnected from the power source. This shall always be done when the equipment is to be left overnight.

c. All arc welding equipment, including the electrode holder, shall be positively insulated so that no accidental contacts can be made, even if the equipment is moved during this period.

074–10.9.5 WORKING WITH OXYFUEL OR INERT GAS WELDING, CUTTING, AND BRAZING EQUIPMENT. To eliminate the possibility of gases escaping through leaks or improperly closed valves, torch valves shall be closed and the gas supply to the torch positively shut off at some point outside the confined area. The precaution does not apply to shop spaces in which active stowage of welding equipment has been authorized. Oxygen(fuel) or inert gas torches shall remain in restricted access spaces only for the period necessary to perform the actual torch operations. Oxygen(fuel) or inert gas torches not attended during periods such as lunch, drills, or overnight shall be removed from restricted access spaces or the oxygen(fuel) or inert gas shall be shut off and the hoses disconnected at the supply connection.

Table 074–10–1. EYE PROTECTION LENS SHADE GUIDELINES

Welding Operations	Shade Number
Shielded Metal-Arc Welding – 1/16, 3/32, 1/8, 5/32-inch electrodes	10
Inert-Gas Metal-Arc Welding – (Nonferrous) 1/16, 3/32, 1/8, 5/32-inch electrodes	11
Inert-Gas Metal-Arc Welding – (Ferrous) 1/16, 3/32, 1/8, 5/32-inch electrodes	12
Shielded Metal-Arc Welding – 3/16, 7/32, 1/4-inch electrodes	12
Shielded Metal-Arc Welding – 5/16, 3/8-inch electrodes	14
Arc-Air Cutting and Gouging	12–14
Soldering	2
Torch Brazing	3–4
Light Cutting, up to 1 inch	3–4
Medium Cutting, 1 inch to 6 inches	4–5
Heavy Cutting, 6 inches and over	5–6
Gas Welding (Light), up to 1/8 inch	4–5
Gas Welding (Medium), 1/8 inch to 1/2 inch	5–6
Gas Welding (Heavy), 1/2 inch and over	6–8

074–10.10 VENTILATION AND HEALTH PROTECTION

074–10.10.1 GENERAL. In addition to the personnel hazards from burns, electricity, and radiation and the hazards of fire, explosion, asphyxiation, or suffocation, all of which have been discussed in this section, under certain conditions there may be health hazards due to gases, fumes, or dusts caused by the welding operations. These hazards make it necessary that welding be done either in properly ventilated spaces with the use of effective local exhaust ventilation, or with the use of approved respirators, or both. The actual hazards are almost entirely due to the presence of gases, dusts, and fumes such as those containing lead, zinc, cadmium, fluorine, or their compounds, oxides of nitrogen, or extreme heat. Consideration shall be given to the hazards of the accumulation of purge gases in compartments. Questions concerning the adequacy of ventilation and respiratory protection for specific operations should be directed through the medical department to the local industrial hygienist.

074–10.10.2 RESPIRATORS. Respiratory protection equipment shall be used where the use of local exhaust ventilation is not practical and, in the case of very toxic material, to supplement local exhaust ventilation. Air–line respirators will give adequate respiratory protection for all types of contaminants and are generally the preferred equipment. Provided they are selected, used, and maintained correctly, toxic fume respirators approved by National Institute for Occupational Safety and Health (NIOSH) or Mine Safety and Health Administration (MSHA) will give protection against metal fumes not more toxic than lead. Toxic fume respirators will not protect against mercury vapor. No filter or cartridge respirator will protect against carbon monoxide or nitrogen dioxide; an air–line respirator is required.

074–10.10.2.1 An atmosphere immediately hazardous to life exists in confined spaces where there is a lack of oxygen; therefore, auxiliary air tanks for emergency exit should be incorporated into the airline respirator system.

074–10.10.2.2 When welding operations are carried out in restricted access spaces requiring respirators, all personnel in the space shall be provided with approved air line or filter type respirators. When galvanized steel, brass, or bronze is being welded inside tanks or other closed containers, the operator shall be furnished an approved type of air line or filter type respirator and its use shall be strictly enforced.

WARNING

Oxygen from a cylinder or torch shall never be used for ventilation.

074–10.10.3 VENTILATION. To prevent the accumulation of noxious gases and fumes in the atmosphere or possible oxygen deficiency, mechanical ventilation shall be provided when welding or cutting in a confined space. The rate of ventilation air flow shall be 2,000 cubic feet per minute (ft^3/min) per welder or sufficient to maintain air quality in the welder's breathing zone which meets Navy Occupational Safety and Health (NAVOSH) standards (except where air line respirators meeting the requirement in paragraph 074–10.10.2 are used). A confined space shall mean any one of the following.

a. A space less than 10,000 ft^3 per welder

b. A space having an overhead height of less than 16 feet

c. A space in which there are structural barriers to the extent that they significantly obstruct cross ventilation

074–10.10.4 LOCAL EXHAUST HOODS AND BOOTHS. Hoods should be provided with an air flow ventilation rate sufficient to maintain a velocity, in the direction of the hood, of 100 feet per minute (ft/min) in the welding zone when the hood is at the most remote distance from the welding point. Ventilation rates required to accomplish control velocity, using a 3–inch wide flange or conical section around the suction opening, are shown in Table 074–10–2.

074–10.10.4.1 The minimum air flow ventilation rate, when welding in an open face booth, shall be 100 ft^3/min for each square foot of face opening.

074–10.10.5 INERT GAS SHIELDED ARC WELDING. The GMAW and GTAW welding processes involve production of Ultraviolet radiation of intensities 5 to 30 times that produced during SMA welding and will cause decomposition of chlorinated solvents by ultraviolet rays and thereby the liberation of toxic fumes and gases. Personnel engaged in GMA and GTA welding shall observe the following precautions. In addition to the positive ventilation requirements for the use of chlorinated solvents such as perchloroethylene and trichloroethylene, chlorinated solvents shall be kept at least 200 feet from the exposed arc. Surfaces prepared with chlorinated solvents shall be dry before welding is permitted on such surfaces.

074–10.10.5.1 The use of inert gases within structural enclosures creates a potential personnel hazard. The inherent danger of the use of inert gases is that sufficient quantities may be released into an occupied compartment or space to reduce the oxygen content of the atmosphere below that required to support human life. Positive exhaust systems shall be in operation to reduce the possibility of an inert gas buildup, should accidental leakage occur.

Table 074–10–2. VENTILATION REQUIREMENTS

Maximum Distance From Arc or Torch (Inches)	Suction Opening Diameter* (Inches)	Minimum Air Flow (ft^3/min)
4 to 6	3	150
6 to 8	3-1/2	275
8 to 10	4-1/2	425
10 to 12	5-1/2	600

* Nearest 1/2-inch duct diameter based on 4,000 ft/min velocity in pipe.

NOTES

1. All exhaust from operation shall be discharged to the outdoors or outside the shop.
2. Minimum air flow should be increased by 20 percent for hoods not provided with flanges.
3. The selected suction opening to arc distance shall not interfere with the protection afforded the weld by the gas coverage produced from the electrode coating and shielding gas used in GMA or GTA welding processes. Use easily movable hoods intended for placement as near as practical to the work being welded.

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