MIL-STD-1681(SH)
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MILITARY STANDARD

FABRICATION, WELDING, AND INSPECTION OF HY-130 SUBMARINE HULL

FSC MISC

DEPARTMENT OF THE NAVY

NAVAL SEA SYSTEMS COMMAND

WASHINGTON, D.C. 20362

Fabrication, Welding, and
Inspection of HY-130
Submarine Hulls
MIL-STD-1681(SH)

1. This Military Standard is approved for use by the Naval Sea Systems Command and is available for use by all Departemnts and Agencies of the Department of Defense.

2. Repair ships, tenders, repair facilities, Supervisors of Shipbuilding and Naval Shipyards shall use this document for repair or overhaul as invoked in Chapter 074 (NAVSHIPS 0901-LP-920-0003) of the Naval Ships Technical Manual.

3. Recommended corrections, additions, or deletions should be addressed to Commander, Naval Ship Engineering Center, Department of the Navy, Center Building, Prince George's Center, Hyattsville, Maryland 20782.

FOREWARD

This standard provides instructions for the fabrication, welding, and inspection of submarine hulls constructed of HY-130 material. The requirements are to insure the integrity and reliability of submarine construction for combatant service and may be used for non-combatant construction as well as other structures utilizing the alloys contained herein.

This Military Standard is for use in new construction by designers, contractors, and fabricators as invoked in the individual Ship Specification for a particular ship or contract; it is also for use by Naval Shipyards and when invoked in a Department of Defense or Navy procurement document.

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THIS DOCUMENT IS SUBJECT TO SPECIAL EXPORT CONTROLS AND EACH TRANSMITTAL TO FOREIGN GOVERNMENTS OR FOREIGN NATIONALS MAY BE MADE ONLY WITH PRIOR APPROVAL OF THE COMMANDER, NAVAL SHIP ENGINEERING CENTER, CODE 6120D

FIGURES

FIGURES (con.)

1. SCOPE

1.1 This standard contains minimum requirements for submarine structural fabrication, standards for materials, weld joint design, workmanship, inspection, and record-keeping requirements for combatant submarine and non-combatant submersible construction of HY-130 material. The requirements for material other than HY-130 for submarine application are contained in NAVSHIPS 0900-LP-000-1000 and NAVSHIPS 0900-LP-006-9010.

1.2 Where reference to this standard is made in the General Specification for Ships, or in the Ship Specifications for a particular ship, the requirements of this document supersede any conflicting requirements of other referenced specifications and standards, unless otherwise noted herein or in the particular Ship Specifications.

1.3 Any requirements contained in this standard specifically requiring Naval Sea Systems Command/Naval Ship Engineering Center (NAVSEA/NAVSEC) approval shall be forwarded to the Naval Sea Systems Command, Washington, D.C. 20362.

2. REFERENCED DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein.

GOVERNMENTAL

SPECIFICATIONS

MILITARY

MIL-E-19822 - Electrodes, Welding, Bare, High Yield-Steel.
MIL-E-19933 - Electrodes and Rods - Welding, Bare, Chromium and Chromium-Nickel Steels.
MIL-E-21562 - Electrodes and Rods - Welding, Bare, Nickel Alloy.
MIL-E-22200 - Electrodes, Welding, Covered; General Specifications for.
MIL-E-22200/1 - Electrodes, Welding, Mineral Covered, Iron Powder, Low-hydrogen Medium and High Tensile Steel, As-welded or Stress-Relieved Weld Application.
MIL-E-22200/2 - Electrodes, Welding, Covered (Austenitic Chromium-Nickel Steel, for Corrosive and High Temperature Services).
MIL-E-22200/9 - Electrodes, Welding, Covered, HY-130 Steel Applications.
MIL-E-22200/10 - Electrodes, Welding, Mineral Covered, Low-Hydrogen, Iron-Powder for HY-100 Weldments for As-Welded Applications.
MIL-E-23765/1 - Electrodes and Rods - Welding, Bare, Solid, Mild and Low Alloy Steel.
MIL-E-23765/2 - Electrodes and Rods - Welding, Bare, Solid, Low Alloy Steel.
MIL-E-24355 - Electrodes and Rods - Welding, Bare, Solid, for HY-130 Steel Applications.
MIL-S-24371 - Steel Plate, Alloy, Structural, High Yield Strength (HY-130).
MIL-S-25412 - Steel Forgings, Alloy, Structural, High Yield Strength (HY-130).
MIL-I-25135 - Inspection Materials, Penetrant.

STANDARDS

MILITARY

MIL-STD-22 - Welded-Joint Design.
MIL-STD-248 - Welding and Brazing Procedure and Performance Qualification.
MIL-STD-271 - Nondestructive Testing Requirements for Metals.
MIL-STD-1628 - Fillet Weld Size, Strength and Efficiency Determination.

PUBLICATIONS

NAVSHIPS
0900-LP-003-8000 - Surface Inspection Acceptance Standards for Metals.
0900-LP-003-9000 - Radiographic Standards for Production and Repair Welds.
0900-LP-005-6000 - Surface Standards for High Yield Strength, Nickel Bearing Alloy Steel.
0900-LP-006-3010 - Ultrasonic Inspection Procedure & Acceptance Standards for Hull Structure Production & Repair Welds.
0900-LP-006-9010 - Fabrication, Welding and Inspection of HY-80/100 Submarine Hulls.
0900-LP-999-9000 - Acceptance Standards for Surface Finish of Frame - or Arc-Cut Material.
0901-LP-920-0003 - Naval Ships Technical Manual, Welding and Allied Processes, Chapter 074.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

NONGOVERNMENTAL

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
E 10 - Brinell Hardness of Metallic Materials, Test for.

(Application for copies should be addresed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

AMERICAN WELDING SOCIETY (AWS)
A2.0 - Welding Symbols.
A2.2 - Nondestructive Test Symbols.
A3.0 - Definitions - Welding and Cutting.

(Application for copies should be addressed to the American Welding Society, Inc., 2501 NW 7th Street, Miami, Florida 33125.)

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)
ASNT-TC-1A - Nondestructive Test Personnel Qualification and Certification.

(Application for copies should be addressed to the American Society for Nondestructive Testing, 914 Chicago Avenue, Evanston, Illinois 60202.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. DEFINITIONS

3.1 General. Except as noted herein, welding nomenclature and definitions shall conform to AWS A2.0, AWS A3.0, and AWS A2.2.

3.2 Acceptable. Complies with or conforms to the applicable standard or specification.

3.3 Access plates. Sections of plating removed, and later re-installed, for access or removal of equipment.

3.4 Activity. The physical plant of an organization performing work to which this document is applicable.

3.5 Approval (approved). The item under consideration requires acceptance by NAVSEA or its authorized representative. Approval or approved as used herein shall be by NAVSEA authorized representative unless NAVSEA approval is specified.

3.6 Arc strikes. Any inadvertent localized heat-affected zone or change in the contour of the finished weld or adjacent base metal resulting from an arc or heat generated by the passage of electrical energy between the surface of the finished weld or base metal and a current source, such as welding electrodes or magnetic inspection prods.

3.7 Block weld. An increment of a continuous multiple pass weld that is completely or partially built-up in cross-section before adjacent lengths are deposited.

3.8 Buttering or build-up. The deposition of filler metal on a base metal surface to restore base material or weld surface demensions, or to interpose a layer of weld metal on the material surface of the joint prior to joining the material members together.

3.9 Circularity. The degrees of deviation of a transverse section of the hull from a true circle.

3.10 Closure plates. Those shell plates left off or removed for access.

3.11 Coamings. Structure surrounding holes in, and extending on through or on one or both sides of the plating or pressure hull structure, usually connected by a corner or groove tee weld and which may provide all or partial compensation for the hole.

3.12 Completed weld. Welding is done, preheat and postweld heat soak (when applicable) is removed and plating has cooled to ambient temperature and the weld has been visually inspected, accepted, and is ready for other nondestructive test (NDT) inspection.

3.13 Corner crack. A crack occurring in weld metal in way of a temporary access snipe, a drain or vent opening or at the intersection of three members (see figure 1).

3.14 Fabrication. The term "fabrication" covers construction, alteration, or repair operations as involved in the building of HY-130 submarine hulls.

3.15 Fabrication procedure. A fabrication procedure is a written description of the details of operations such as welding, forming, cutting, inspection, and quality control.

3.16 Fillet weld. A weld of approximately triangular cross-section joining two surfaces approximately at right angles to each other in a lap joint, tee joint, or corner joint. See joint PT-2S.1 in MIL-STD-22.

3.17 Finished weld. Welds which have received final inspection and have been accepted.

3.18 Forming - cold. Cold forming operations are defined as those performed with material temperature below 500° Fahrenheit (°F) (see 9.3).

3.19 Forming - hot. Hot forming operations are defined as those performed with material temperature between 1700°F and 2150°F.

3.20 Hard tanks. Tanks designed to withstand pressure at collapse depth.

3.21 Hard tank plating. Tank boundary plating in tanks designed to withstand pressure at collapse depth.

3.22 Heat soak. Application of heat to a weld joint to promote hydrogen removal.

3.23 Holding bulkheads. Any complete transverse watertight bulkhead within the pressure hull envelope.

3.24 Inserts. Inserts are those components welded into the pressure hull envelope or other component by some type of butt joint, which may be the same or greater thickness than the surrounding structure. Inserts reinforce the structure at openings or areas of high stress.

3.25 Inspector. Contractor, Naval shipyard, and other government agency employees qualified as required by this document to accept or reject materials or workmanship from specified test results.

3.26 Interlayer heat soak. Heat applied to a weld joint after deposition of each layer of weld metal.

3.27 Interpass temperature. In a multiple-pass weld, the temperature of the metal, at the site of operations before the next pass is started (see table I).

3.28 Intraweld heat soak. Heat applied to a weld joint at specified interval(s) during welding of the joint.

3.29 Joint efficiency. Joint efficiency is the strength of a welded connection, expressed as a percentage of the specified strength of the base material.

3.30 NAVSEA authorized representative. Any government representative specifically authorized to approve equipment, material, or procedures within the scope of this document for NAVSEA. They are as follows:

(a) For Government shipyards - The delegated representative of the shipyard Commander.
(b) For Commercial shipyards - The delegated representative of the Supervisor of Shipbuilding, Conversion and Repair (SUPSHIP).
(c) Naval Ship Engineering Center.

3.31 Overlay or cladding. The deposition of filler metal on a base metal surface for the purpose of providing a wear-resistant or corrosion-resistant surface.

3.32 Patches. Patches are section of plate installed to replace other materials such as deleted inserts or penetrations, to correct discrepant materials or errors in constructions.

3.33 Penetrations. Penetrations are those components such as pipe, sleeves, or trunks welded into the pressure hull envelope or other components by some type of groove tee, corner, or fillet weld. Penetrations pass through the structure and extend beyond one or both sides of the structure.

3.34 Subject to submergence pressure. Designed to collapse depth.

3.35 Preheat temperature. The temperature in way of and along the joint or site of operation, prior to any welding (see table I).

3.36 Pressure hull envelope. All material in water tight boundary structure designed to collapse depth, such as pressure hull plating, patches, coamings, sea chests, trunks, missile tubes, hatches, inserts, penetrations, sonar sphere, access plates, hull closure plates, and hard tank plating.

3.3 Pressure hull structure. All structure designed to collapse depth including the pressure hull envelope and supporting structure.

3.38 Qualified. The term "qualified" means that the item under consideration has been approved as required by this document.

3.39 Re-entrant angle. A re-entrant angle is the angle formed between the base plate and weld, at the weld edge (see figure 2).

3.40 Shapes. One piece hot-rolled or extruded material other than flat plate or strip, tube or bar having a cross-section in the shape of a Tee L (angle), Zee, channel, I, H., etc., such as pressure hull frames.

rocess inhibition is related to the chloride ... inhibit biological treatment ...

3.41 Structural intermediate pressure tanks. Internal tanks subject to pressure between a gage pressure of 125 pounds per square inch (lb/in^2) and ship test pressure (test depth).

3.42 Supporting structure. Structure supporting the pressure hull envelope which is designed to collapse depth, such as pressure hull frames, stiffeners and transverse structural floors when acting as frames.

3.43 Small access plates. Sections of plating removed, and later reinstalled having a maximum diameter of 12-inches.

3.44 Tack weld. A tack weld is a weld made to hold parts of a weldment in proper alignment until the final welds are made.

3.45 Tank Welds. Tank welds are full penetration welds in tank plating or to the pressure side of the tank plating (such as floor to tank top, side, or shell; stiffener webs to end bulkheads; butt and seam in tank plating) (see figure 3).

3.46 Temporary snipe. A small snipe or opening in an abutting member to permit the deposition of a sound weld in a joint passing beneath the abutting member.

3.47 Weld pass. A single longitudinal progression of a welding bead along a joint or weld deposit for the length of one block or more.

4. QUALIFICATION REQUIREMENTS

4.1 Scope. This section covers the requirements necessary for the qualification of welding procedures; welders and welding operators; NDT procedures; nondestructive test personnel and NDT equipment for HY-130 submarine construction.

4.2 General requirements. The purpose of these qualficiation requirements is to insure that the qualified procedures are used with adequate equipment by properly trained personnel. It shall be the responsibility of the activity to insure that only qualified personnel, procedures and NDT equipment are used for fabrication and inspection to comply with this standard. Procedures and personnel previously qualified or approved for welding HY-130 shall not require requalification, provided the qualifications have not lapsed, and provided the qualification records are available.

4.2.1 Welding and NDT processes, procedure limitations, equipment, and materials, other than those specified in this standard or as permitted by MIL-STD-248, may be used on a case basis when specifically approved by NAVSEA.

4.3 Welding procedure qualification. Before any welding is performed on structure covered by this standard all procedures shall be qualified in accordance with the requirement of MIL-STD-248, except that dynamic tear testing shall be used in lieu of Charpy V-notch impact testing. Dynamic tear testing shall be performed as required by the applicable electrode specification.

4.3.1 Records. Records of procedure qualification shall be as specified in section 5.

4.4 Welding performance qualification. Prior to performing any production welding, each welder or welding operator who is to perform manual, semi-automatic, or fully automatic welding covered by the standard, shall be qualified in accordance with the requirements of MIL-STD-248, except qualficiation on HY-80/100 shall not qualify for welding HY-130. Welding operator qualification is not required for operators of stud welding equipment.

4.4.1 Welders and welding operators shall be familiarized with the HY-130 welding procedure requirements and controls (e.g., preheat and interpass temperatures, weld energy input, and hydrogen removal methods) prior to performing production welding in or to HY-130. A formal training program, including an oral or written examination, shall be employed to assure adequate familiarization.

4.4.2 Each welder and welding operator (except spot and stud welders) shall be required to pass an annual vision test as specified in 4.8.

4.4.3 Records. Records of welder qualification shall be as specified in section 5.

4.5 Nondestructive testing procedure qualification.

4.5.1 Radiographic inspection. Qualification of radiographic inspection (RT) procedures, including film processing procedures, shall be in accordance with MIL-STD-271. Records of procedure qualification shall be as specified in section 5.

4.5.2 Ultrasonic inspection.

4.5.2.1 Ultrasonic inspection for plate quality and thickness. Qualification of ultrasonic inspection (UT) procedures and equipment functions for material quality and thickness shall be in accordance with MIL-STD-271.

4.5.2.2 Ultrasonic inspection of welds. Qualification of UT procedures and equipment functions for inspection of welds shall be in accordance with NAVSHIPS 0900-LP-006-3010.

4.5.2.3 Records of UT procedure qualification shall be as specified in section 5.

4.5.3 Hardness testing. Hardness testing and calibration of hardness testing equipment shall be in accordance with ASTM E 10.

4.5.4 Other nondestructive tests. Nondestructive tests, procedures, techniques, equipment, and materials not specified in this document may be used provided the procedure and performance qualification is approved by NAVSEA.

4.6 Qualification of nondestructive test personnel. Activities performing nondestructive tests (radiography, ultrasonic, magnetic particle, and liquid penetrant) shall be responsible for certifying the technical competence of their NDT personnel and that all nondestructive tests performed are in conformance with contractual inspection technique requirements and acceptance standards. NDT personnel shall be qualified in accordance with ASNT-TC-1A or other NDT standards approved by the NAVSEA authorized representative.

4.6.1 Personnel engaged in the following nondestructive tests shall be qualified and certified by a NDT examiner certified by the contractor:

(a) Magnetic Particle (MT)
(b) Liquid Penetrant (PT)
(c) Ultrasonic (UT) (Except for welds, see 4.6.1.1)
(d) Radiography (RT)

NDT personnel, including visual inspectors, shall be required to pass an annual vision test as specified in 4.8. NDT personnel shall remain qualified unless there is a subsequent lapse of employment continuity or change of work assignment extending beyond six months, except for NDT personnel involved with UT inspection of welds. In this latter instance, the requirements of NAVSHIPS 0900-LP-006-3010 shall govern.

4.6.1.1 Qualification and certification of ultrasonic inspection personnel for welds. Personnel engaged in UT of welds shall be qualified and certified in accordance with NAVSHIPS 0900-LP-006-3010.

4.6.1.2 Visual inspection personnel. Visual inspectors shall possess the knowledge necessary to satisfactorily perform the visual inspections required in the various sections of this standard.

4.6.2 Records. Records of NDT personnel qualification and certification shall be as specified in section 5. For visual inspectors, only records of vision tests are required.

4.7 Nondestructive test equipment qualification. All NDT equipment, when used by qualified NDT operators or inspectors, employing the appropriate procedure, shall be capable of detecting flaws wiithin the limits of the acceptance standards specified in section 7. In addition, for weld inspection, UT equipment shall meet the requirements of NAVSHIPS 0900-LP-006-3010.

4.7.1 Records. Records of NDT equipment qualification are not required except as specified in NAVSHIPS 0900-LP-006-9010.

4.8 Vision tests.

4.8.1 Personnel vision tests. Personnel, as specified in 4.4 and 4.6, shall be required to pass an annual vision test. The tests shall be conducted by a trained technician using standard test methods for determining visual acuity. The standard of acceptance for the vision test 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 may be substituted for the Jaeger chart.

4.8.2 Records. Records of the date of vision test and test results shall be maintained, as specified in section 5.

5. RECORD REQUIREMENTS

5.1 Scope. This section details the records for HY-130 fabrication within the scope of this standard.

5.2 General. Each activity shall maintain a capability for meeting the requirements of this standard. Written procedures shall assign responsibility and provide accountability for performing work and inspections. Records are required only to the extent specified in this section. Where specified, records for traceability to individual items, pieces or parts are a requirement of this standard.

5.3 Records.

5.3.1 General requirements. Each activity will maintain a quality control system which shall include the preparation and maintenance of written records. Record forms shown are for guidance only. However, records shall, as a minimum, contain the information as noted in the following subparagraphs.

5.3.1.1 Welding discrepancy feed-back. In addition to the general requirements above, the items shown in the following subparagraphs require a formal welding discrepancy feed-back program. The program shall be established to insure that significant discrepancies are brought to the attention of Welding Engineering personnel within a reasonable time frame for resolution. Resolution and any required corrective action shall be accomplished in a manner which will preclude loss of welding control during production welding. Each activity shall retain records of all weld discrepancy feet-backs, resolutions, and corrective actions. In addition to the following subparagraphs, the welding discrepancy feed-back program shall also apply to the nondestructive testing of 5.3.1.8, 5.3.1.9, 5.3.1.10, and 5.3.1.11.

5.3.1.1.1 Welding procedure qualification. These records shall consist of the approved procedure qualification test reports required by MIL-STD-248.

5.3.1.1.2 Welding performance qualification. Records for performance qualification shall be as required by MIL-STD-248.

5.3.1.1.3 Records of welding electrode control. Records of inspections, (for guidance only, see figure 4), required by section 8 shall contain the following:

(a) Manufacturer's certification and test results for compliance with the applicable specification.
(b) Records of receipt inspection verification of electrode conformance as required by section 8.
(c) Records of moisture content of electrode covering as required in 10.5.2,

10.6.1, and 10.7.2
(d) Date of inspection and signature of inspector(s).

5.3.1.1.4 Records of in-process welding inspection. Records of inspections (for guidance only, see figure 5), as required by section 6, shall contain the following:

(a) Base material identification
(b) Heat input (satisfactory or unsatisfactory)
(c) Preheat/interpass temperature of the joint being welded (satisfactory or unsatisfactory)
(d) Interlayer, intraweld, or postweld heat soak temperature and time, as applicable (satisfactory or unsatisfactory)
(e) Welding process being used
(f) Filler metal type
(g) Location on ship or assembly where welding is being performed
(h) Type of weld; original or repair
(i) Date of inspection and signature of inspector making check
(j) Record of corrective actions taken in case of discrepancy.

5.3.1.1.5 Records of SMA welding process reporting. Records of use of the shielded metal-arc (SMA) process for welding HY-130, as required by section 13, shall be prepared and submitted to NAVSEC quarterly.

5.3.1.2 Nondestructive test procedure qualification. These records shall be as required by MIL-STD-271 for RT and by MIL-STD-271 or NAVSHIPS 0900-LP-006-3010, as applicable, for UT.

5.3.1.3 Nondestructive testing personnel qualification. Records of personnel qualfication shall be maintained. They shall consist of:

(a) Identification (name, clock number, or social security number)
(b) Date of test and qualification expiration date
(c) Nondestructive testing processes qualified
(d) Vision test results
(e) Activity examiner's signature

5.3.1.4 Records of plate quality inspection. These records (for guidance only, see figure 6), shall contain the following:

(a) Ship or hull number
(b) Ultrasonic soundness findings (mill record may be used)
(c) Ultrasonic gage measurements (mill records may be used)
(d) Micrometer edge thickness measurements (mill record may be used)
(e) Chemistry and mechanical properties (mill record may be used)
(f) Record of visual inspection with notation on the size and location of weld repairs (mill record may be used)
(g) Specific location of plate in the following areas of submarine pressure hull envelope:
  (1) Hull plating
  (2) Hard tank plating
  (3) All components which are fabricated from plate and which are welded into and become an integral part of the pressure hull envelope. This includes inserts, penetrations, and patches.
(h) Heat or slab number (mill record may be used)
(i) Date of inspection and signature of inspector(s).

5.3.1.5 Records of extruded shapes. These records (for guidance only, see figure 7), shall include the following:

(a) Ship or hull number
(b) Heat or shape number (mill record may be used)
(c) Record of visual inspection with notation of the size and location of

weld repairs (mill record may be used)
(d) Chemistry and mechanical properties (mill record may be used)
(e) Dimensions (mill record may be used)
(f) Soundness (UT or MT where applicable) (mill record may be used)
(g) Date of inspection and signature of inspector(s)
(h) Location in ship when in pressure hull envelope

5.3.1.6 Records of forgings. Records (for guidance only, see figure 8), shall include the following:

(a) Ship or hull number
(b) Heat number (must be a unique identification) (mill record may be used)
(c) Soundness (RT, MT, and UT, as applicable) (mill record may be used)
(d) Test coupon results (mill record may be used)
(e) Dimensional inspection (mill record may be used)
(f) Location, size, and orientation or repairs (mill record may be used)
(g) Location of all forged components which are welded into and become an integral part of the pressure hull envelope
(h) Date of inspection and signature of inspector(s)

5.3.1.7 Workmanship. The quality and completeness of workmanship in submarine hull construction shall be assured either by a continuous record of responsibility (signoff of work accomplishment) as the submarine progresses from prefabrication through completion (for guidance, see figure 9), or by a completion (including alteration or repairs) inspection record which will account for work in a compartment or specified area.

5.3.1.7.1 Circularity measurements, as required by sections 6 and 12 shall be recorded and reported to NAVSEA. For guidance only, see figures 10, 11, or 12.

5.3.1.7.2 Records of pressure hull frame dimensions. These records, (for guidance only, see figure 13), as required by section 12, shall contain the following:

(a) Ship or hull number
(b) Frame number
(c) Dimensions including web and flange tilt, flange width and unbalance, and frame depth
(d) Station number (circumferential locations)
(e) Distance between frames

5.3.1.8 Records of magnetic particle inspection. These records of inspections, (for guidance only, see figure 14), required by section 6 shall include the following:

5.3.1.8.1 Welds.

(a) Type of magnetic particle test (e.g., prod or yoke)
(b) Weld location (assembly and joint identification)
(c) Type of weld (e.g., tee, butt, or fillet)
(d) Category item (see table II)
(e) Approximate length of weld inspected
(f) Length and number of cracks found
(g) Approximate location of cracks, found, if any
(h) Type of cracks (transverse, longitudinal, or corner)
(i) Date of original inspection
(j) Date of repair and reinspection (if required) and results
(k) Signature of inspector(s)

5.3.1.9 Records of liquid penetrant inspection. These records of inspection (for guidance only, see figure 15), required by section 6 shall contain the following:

(a) Type of penetrant used (section 15)
(b) Weld or material location (ship, assembly, and joint identification)
(c) Type of weld (e.g., butt, tee, fillet, or overlay)

(d) Type of indications, satisfactory or unsatisfactory
(e) Surface condition (e.g., as-machined, as-welded, ground)
(f) Date of original inspection
(g) Date of repairs and reinspection (if required) and results
(h) Signature of inspector(s)

5.3.1.10 Records of radiography. Records of inspection, (for guidance only, see figures 16 and 17) required by section 6 shall contain the following:

5.3.1.10.1 Welds.

(a) Date of exposure of radiography
(b) Location of weld radiographed (positive identification system)
(c) Thickness of material
(d) Energy source (isotope type, size of source of KVP and amperage or X-ray)
(e) Surface condition (e.g., as-machined, as-welded, ground)
(f) Type of film, screens, source-to-film distance, and exposure time
(g) Flaws (note acceptable slag, porosity, or other discontinuities)
(h) Disposition (satisfactory or unsatisfactory)
(i) Date and signature of film interpreter

5.3.1.11 Records of ultrasonic inspection. Records of inspection required by section 6 shall contain the following:

5.3.1.11.1 Welds. Records, (for guidance only, see figure 18), shall be as specified in NAVSHIPS 0900-LP-006-3010.

5.3.1.11.2 Materials.

(a) Description and unique identification
(b) Approved procedure identification
(c) Type and model of machine
(d) Transducer size and type
(e) Search beam angle
(f) Frequency used for test
(g) Couplant
(h) Reference calibration standards
(i) Observations and their acceptance/rejection evaluation
(j) Surface condition (ground, machined, other)
(k) Acceptance standard used (when other than specified in this document)
(l) Date of original inspection
(m) Date of repair and reinspection (if required) and results
(n) Signature of inspector(s)

5.3.2 Record instructions.

5.3.2.1 Forms should be marked "N/A" for sections not applicable to the particular job.

5.3.2.2 Each activity (prime contractor) shall be responsible for the records, including radiographic films, on materials or components furnished by his vendors or sub-contractors. A complete "set" of records, as required by this document for a ship, shall be maintained by the activity (prime contractor) for use on demand by NAVSEA.

5.3.3 Circularity record reporting.

5.3.3.1 Copies of the circularity records shall be forwarded to NAVSEA upon delivery of the submarine.

5.3.4 Maintenance of records.

5.3.4.1 All required records shall be maintained by the activity and be available to NAVSEA or its authorized representative throughout the life of the contract. After delivery, all required records shall be maintained for the period specified by contract or specifications, but not less than three years, except circularity records shall be forwarded to

NAVSEA at the time of delivery as required in 5.3.3. At the expiration of the record retention period, all records shall be made available to NAVSEA or its authorized representative by written notification. If no disposition is provided within six months, the records may be destroyed.

6. INSPECTION REQUIREMENTS

6.1 Scope. This section contains the requirements for inspection associated with fabrication, workmanship, materials, and welds in HY-130 submarine construction. Receipt inspection requirements are outlined in section 8. Record requirements are outlined in section 5.

6.2 Material inspection. HY-130 plate, forgings, bars, and extruded or rolled shapes employed in submarine applications shall be receipt inspected in accordance with the requirement of section 8 of this standard to the acceptance standards of section 7. Records of inspection and repair shall be maintained as required by section 5.

6.3 Visual inspection.

6.3.1 Joint fitup.

6.3.1.1 Full and partial penetration weld joints. Joints preparation for full and partial penetration weld joints in pressure hull structure shall be inspected to insure that the joint tolerances, misalignment, and cleanliness are in conformance with the requirements of this standard. Weld joints shall not be released for welding until the inspection procedure is carried out. Records of these inspections are not required.

6.3.1.2 Fillet weld joints. The opening between the elements to be welded shall be inspected, prior to welding, to determine that the nominal dimension of this opening complies with the requirements of section 14. Records of this inspection are not required.

6.3.2 Welding preheat/interpass temperature, welding heat input, and weld metal hydrogen removal. Where ferritic welding filler materials are used, preheat/interpass temperature, welding heat input and postweld/intraweld/interlayer heat soaking (if required) shall be checked as follows:

(a) For full penetration welds in or to pressure hull structure, check all welds for compliance with section 13.
(b) For other welds: check welds to an approved surveillance inspection plan to assure compliance with section 13

Corrective action on discrepancies shall be taken upon detection and such action shall be recorded. Records of inspection shall be maintained as required by section 5. Inspection of preheat/interpass temperature and welding heat input is not required for welds made with other than ferritic welding filler materials.

6.3.3 Workmanship. Pressure hull structure shall be inspected during or after assembly, or after final erection and welding if the inspected structure will be affected by subsequent fabrication operations. This inspection shall be made with respect to:

(a) Flame or arc-cut surfaces for surface finish in accordance with the requirements of NAVSHIPS 0900-LP-999-9000.
(b) Flame or arc-cut surfaces of plates, bars, forgings, or shapes, which will not subsequently be covered by weld metal, for linear indications.
(c) Welds in or to HY-130 in accordance with the requirements of section 14. This inspection shall be performed after completion of the weld and should be performed prior to the removal of preheat and postweld heat soaking (if applicable).
(d) Root areas of welds and repairs, after back-gouging or excavation, for cleanliness and contour to the extent required by section 14.
(e) Structural component dimensional tolerances and hull plating deviation and fairness, as specified in section 12.
(f) Elimination of scars, irregularities, arc strikes, depressions,

or other surface defects to the extent required in sections 8 and 14.

(g) Elimination of projections of any description on the submarine exterior surfaces which are not required by approved drawings.

(h) Hull circularity, as specified in section 12. Records of circularity inspection shall be maintained as required in section 5.

6.4 Magnetic particle inspection.

6.4.1 General. MT inspection shall be performed as required in section 15 and by qualified equipment, procedures, and personnel as required in section 4. All areas inspected shall comply with the acceptance standards in section 7. Records shall be maintained as outlined in section 5 to the extent required in tables II, III, and IV. PT inspection may be substituted for MT inspection where MT inspection is impractical.

6.4.2 Exemptions.

(a) Inspection is not required for areas where percussive (capacitor discharge) stud or resistance spot welds, 1/4 inch or less stud or spot diameter and automatically timed studs less than 1/4 inch, have been removed; nor for permanent stud or resistance welds.

(b) Inspection is not required for welds in the interior of rudders and planes.

(c) Weld surface areas which are to be subsequently covered by other structural welds do not require final MT inspection; i.e., surface areas of longitudinal butt welds (under frame webs and their associated welds) and frame and stiffener areas of weld (covered by intercostal welds).

(d) All flame or arc cut surfaces including beveled surfaces of inserts and penetrations that will be covered by weld metal, except as stated in 7.3.5.

(e) The weld surfaces in (b), (c), and (d) above are not subject to the expansion inspection requirements of table II, note 2.

6.4.3 Welds. All ferritic welds in or to HY-130 except as exempted in 6.4.2 shall be subjected to MT inspection. Inspection shall be performed to the sequence and method specified in tables II, III, and IV.

6.4.4 Partial welds. When preheat is interrupted on partially completed welds, MT inspection shall be performed as required in 13.7.6.3.

6.4.5 Inserts and penetrations. MT inspection shall be performed on that portion of the prepared surfaces of all inserts (including transition and insert rings) and penetrations in the pressure hull envelope which are prepared by flame or arc cutting processes, or by machining, chipping, or grinding, and which will not be subsequently covered by welding. Final inspection shall be performed on flame or arc cut surfaces after subsequent machining or grinding as required by 14.2.3. Prepared surfaces that will be covered by weld metal or prepared surfaces for bolts, studs, pipe penetration holes less than 4 inches in diameter do not require MT inspection.

6.4.6 Formed material. MT inspection shall be performed on surfaces of cold formed material elongated in excess of 12 percent as well as on all cold formed weld joints and temporary weld sites on hot formed material which were welded prior to heat treatment, as required in section 9.

6.4.7 Weld root and repair excavations. MT inspection shall be performed in the root area of welds after backgouging, and in weld repair areas after excavation.

6.4.8 Hard tanks. Final MT inspection of hard tank welds shall be made after contour grinding or peening and grinding of the welds to the extent required in section 14. The inspection sequence shall be as outlined in table IV. If subsequent work is performed which involves the penetration of the boundary plating of a hard tank that has successfully

passed hydrostatic and final MT tests in accordance with table IV the new welds shall be contour ground or peened and ground, if required by section 14, and the tank retested hydrostatically and inspected. MT inspection after hydrostatic testing may be limited to the additional welding plus, in the event that the new weld is a full penetration weld through the tank plating, the previously inspected full penetration welding in or to the tank plating within 6 inch of the toe of the new weld. This reinspection shall also include that 6 inch of any butt weld in attached members falling within this area, which is nearest the tank plating.

6.4.9 Final inspection. Final MT inspection shall be performed after all machining or grinding is completed.

6.5 Penetrant inspection.

6.5.1 General. Inspection shall be performed by procedures established in accordance with section 15 and using the acceptance standards of section 7. Records shall be maintained as required in section 5. Inspections shall be performed employing procedures and personnel qualified in accordance with section 4.

6.5.2 Non-ferrous or austenitic welds. All non-ferrous or austenitic stainless steel welds in or to the pressure hull envelope shall have the final weld and back-gouged surfaces PT inspected unless exempted by 6.5.3. Also clad weld overlays subject to submergence pressure in way of the O-ring grooves and seats and extending approximately twice the width of the O-ring groove on either side of the O-ring groove or seat area shall be PT inspected.

6.5.3 Exemptions. PT inspection is not required for non-ferrous or austenitic stainless steel fillet welds which do not involve penetration through the pressure hull envelope.

6.5.4 Final inspection. Final inspection shall be performed after all machining and grinding has been completed.

6.6 Radiographic inspection.

6.6.1 General. RT inspection shall be performed at locations specified in table V. RT inspection shall be performed with equipment procedures and personnel qualified as outlined in section 4. RT shall be performed as outlined in section 15 and interpreted to acceptance standards of section 7. Records shall be maintained as required in section 5.

6.7 Ultrasonic inspection.

6.7.1 General. UT inspection shall be performed in accordance with procedures approved for the specific applications. The inspection shall be made by personnel and equipment qualified in accordance with section 4, employing methods outlined in section 15. Ultrasonic weld inspection shall be performed in accordance with the requirements of NAVSHIPS 0900-LP-006-3010.

6.7.2 Plate and rolled and extruded shapes. HY-130 plate shall be ultrasonic tested for gage and soundness in accordance with the requirements of section 8. Rolled and extruded shapes shall be ultrasonic tested for soundness in accordance with the requirements of section 8. Acceptance standards shall be as stated in sections 7 and 8.

6.7.3 Hot formed materials. After heat treatment, each piece of hot formed material shall be ultrasonic tested for gage and soundness in accordance with the requirements of section 8 to the acceptance standards of sections 7 and 8.

6.7.4 Welds. UT inspection of welds (see table V), when performed in accordance with NAVSHIPS 0900-LP-006-3010, may be substituted for RT.

6.7.5 Approval. Applications of UT as a substitute for specified nondestructive tests, other than as specified in 6.7.4, shall be subject to approval.

6.8 Stud welding.

6.8.1 General. Studs shall be inspected by bending to an angle of 15 degrees and return with a device similar to that shown in figure 19 or may be tested by torque testing.

6.8.2 Pressure containing openings. All studs used in connection with openings in watertight and pressure containing compartments shall be inspected as outlined in 6.8.1.

6.8.3 Non-pressure containing. At the beginning of each setup (diameter change) and each day's operation, the first five studs for permanent applications for non-pressure containing purposes such as attachment of sound damping, electric cables, fixtures, and equipment shall be inspected as outlined in 6.8.1.

6.8.4 Torque testing. Studs may be tested by the use of the torque test. Any convenient means may be used for applying the tensile load axially to the stud, such as, the application of a sleeve over the stud using a washer and nut with force being applied by a torque wrench. Studs shall be subjected to the maximum loads specified in figures 20, 21, and 22 for the applicable size involved.

6.8.5 Temporary attachment. No test is required for temporary attachment studs, (see 6.4.2 and 6.4.3 for inspection of areas where studs are removed).

6.8.6 Rejection procedure. All studs which show signs of failure shall be removed, the surface of the metal ground smooth, the condition causing failure rectivied, and new studs welded and tested.

6.9 Electrode coating moisture determination. Electrode coating moisture determinations shall be performed as specified by section 10. Records shall be maintained as required by section 5.

7. INSPECTION ACCEPTANCE STANDARDS

7.1 Scope. This section details the inspection acceptance standards for nondestructive tests, including visual inspection, which apply to materials and welds in or to HY-130 within the scope of this document.

7.2 General. Acceptance standards are contained for the following:

(a) Visual inspection.
(b) Magnetic particle inspection.
(c) Liquid penetrant inspection.
(d) Radiographic inspection.
(e) Ultrasonic inspection.

7.3 Visual inspection.

7.3.1 Base materials. HY-130 plate, extruded shapes, forgings, and formed material shall meet the requirements of section 8.

7.3.2 Welds. The as-deposited surfaces at the weld edge shall be satisfactory provided they do not form a re-entrant angle of less than 90 degrees (see figure 2). The acceptance standards of NAVSHIPS 0900-LP-003-8000, class 2, apply except that welds and adjacent base metal ground to below normal surface level shall be acceptable provided one of the following criteria is met.

(a) The depth of grinding does not exceed the limits specified for undercut.
(b) The depth of grinding does not reduce the material below the minimum specified on drawings.

7.3.2.1 Repair excavation and backgouged roots. Repair excavations and backgouged roots shall be ground and contoured in accordance with section 14.

7.3.2.2 Acceptance/rejection of visible porosity. For welds, repair excavations and backgouged roots, when other NDT methods are not employed, acceptance/rejection of visible porosity shall be as follows when observed without visual aids other than eyeglasses necessary to restore normal vision: in any six inches of weld, the following shall be refected:

(a) Rounded (length = 2 width maximum) indications exceeding 3/32 inch in diameter or more than 6 smaller indications the sum of whose diameters exceeds 5/16 inch, excluding pinpoint porosity (1/32 inch or smaller).
(b) Linearly disposed porosity (larger than 1/32 inch) otherwise acceptable by (a) above. Linear disposition shall mean the location of 4 or more indications in a line no more than 3/8 inch long.

7.3.3 Fitup inspection. When inspected in accordance with section 6, joint preparation shall be in accordance with section 11 or other approved configurations, including those in approved welding procedures.

7.3.4 Structure. Completed HY-130 structure shall meet the requirements of sections 12 and 14 when inspected as required in section 6.

7.3.5 Flame and arc cut surfaces. Flame or arc cut surfaces shall meet the surface finish requirements of NAVSHIPS 0900-LP-999-9000. Flame or arc cut surfaces which are visually inspected for linear indications as required by section 6, shall not have linear indications lying approximately parallel to the major surface, over 1/4 inch long. Cut surfaces containing such linear indications over 1/4 inch in length and those containing linear indications normal to the major surface shall be MT inspected for 6 inches at either end of the indications and shall meet the acceptance standards of 7.4.2.

7.4 Magnetic particle inspection.

7.4.1 Welds. Welds shall be free of cracks and shall not exhibit any linear indication in excess of those permitted in NAVSHIPS 0900-LP-003-8000. Indications which are removed by grinding to a depth of 1/16 inch or less, subject to the limitations of 14.5.3.1 are considered non-relevant indications and shall not be recorded as cracks.

7.4.2 Flame, arc cut, or machined surfaces. When inspected as required in section 6, all indications in excess of the following shall be cause for rejection. Repair of these rejected indications may be accomplished in accordance with sections 13 and 14.

(a) Any single linear indication lying approximately parallel to the major surface of the material whose length exceeds 2 inches.
(b) Linear indications lying approximately parallel to the major surface of the material whose accumulated length exceeds 4 inches in the least favorable 6 inch length.
(c) Any linear indication normal to the major surfaces of the material.
(d) Indications over 1/2 inch long, lying approximately parallel with the major surface of the material, or indications the sum of whose accumulated length exceeds 4 inches in the least favorable 6 inch length, on prepared surfaces which will not be covered by welding.

7.4.3 Formed materials. The inspected surfaces of cold formed material shall be free of linear indications in excess of 1/8 inch long. Temporary weld sites on hot formed material, which were welded prior to heat treatment, shall meet the requirements of 7.4.1.

7.5 Liquid penetrant inspection.

7.5.1 Welded joints. Welds examined by the PT method shall be free of cracks and shall not exhibit any linear indications in excess of those permitted in NAVSHIPS 0900-LP-003-8000.

7.5.2 Welded overlays. In any 12 square inches of welded overlay, the following shall be subject to rejection:

(a) Indications of cracks or other linear indications except that one linear

indication 1/8 inch long on the low pressure or inboard boundary of the overlay is acceptable.

(b) Rounded (length = 2 width maximum) indications exceeding 1/8 inch diameter, or total indication diameters in this area exceeding 3/8 inch.

(c) Indications of porosity (1/32 inch diameter or smaller) are acceptable if randomly dispersed.

(d) For areas in way of O-ring, grooves and seats, extending twice the O-ring groove width on either side of the O-ring seat and groove area within the weld area only.

(1) No linear indications shall be permitted.

(2) No rounded indications exceeding 1/32 inch in diameter after 10 minutes bleedout time shall be permitted.

(3) All smaller rounded indications shall be separated from any adjacent indication by a minimum distance of 1/4 inch.

7.6 Radiographic inspection.

7.6.1 Welds. Welds shall meet the acceptance standards of NAVSHIPS 0900-LP-003-9000, class 2.

7.6.2 Inadvertent RT. Weld or base metal defects revealed by inadvertent RT i.e., the radiographic presentation (on a required weld radiograph) of a weld or portion of weld or base material which does not itself require RT, shall receive special consideration. Acceptance or rejection of defects so revealed shall be based on an engineering evaluation of the performance reliability of the part or parts involved, the prescribed inspection methods and standards, and the normal quality of similar parts which meet the designated inspection requirements. Any engineering actions taken in connection with inadvertently detected defects shall be noted in the RT records. Repairs occasioned by such review shall require reinspection as originally specified for the affected area.

7.6.3 Base metal defects. Spatter, arc strikes, grinding marks, surface roughness, or handling marks which may interfere with the interpretation of the radiograph should be removed by wire brushing or grinding from inspected areas prior to RT. When doubt exists as to the acceptability of a radiographic indication of weld spatter, arc strike, grinding mark, surface roughness, or handling mark, a visual inspection shall be made of the area in question. Final acceptance or rejection shall be based on the results of such visual inspection and notation of this action shall be made on the RT record.

7.7 Ultrasonic inspection.

7.7.1 Materials. Materials shall meet the UT acceptance standards of the applicable specifications.

7.7.2 Welds.

7.7.2.1 Butt welds. Butt welds shall meet the acceptance standards of NAVSHIPS 0900-LP-006-3010 butt welds, class 1.

8. RECEIPT INSPECTION OF MATERIALS

8.1 Scope. This section details the requirements for the receipt inspection of HY-130 plates, extrusions, forgings, and filler materials for HY-130 fabrication within the scope of this standard.

8.2 Records. Records showing compliance with the requirements of this section shall be as required by section 5.

8.2.1 Responsibility. The receiving activity shall be responsible to verify that the inspections required by the material specification and the inspection required in this section are performed and documented.

8.2.2 Inspection by vendors. Where the required inspection is performed by a vendor or by other subcontract representatives prior to receipt, the receipt inspection by the receiving activity shall consist of checking the required inspection documentation and for welding filler materials performing the inspections as required by 8.9.

8.2.3 Inspection by receiving activity. Where the required inspection has not been performed prior to receipt, the receiving activity shall perform and record the inspection required by the procurement document as well as the inspections specified in this section.

8.3 Surface cleaning and preservation. Prior to inspection, the HY-130 material shall have been cleaned by blasting. Pickling shall not be employed.

8.3.1 Wrought HY-130 materials. Plates, extrusions, and forgings shall be free of mill scale and extraneous matter in accordance with the applicable material specifications.

8.3.2 Priming. After cleaning, priming of HY-130 materials shall be accomplished in accordance with the applicable material specification. When reheat treatment is employed, the material shall be recleaned as specified in 8.3.1 and reprimed as above.

8.4 HY-130 plate material. Records, as required by section 5, shall be maintained of all plates or sections of plates used in structural weldments.

8.4.1 Test results. Certified test results of all HY-130 plate showing chemical and mechanical properties and results of ultrasonic soundness and thickness testing shall be obtained and reviewed for conformance to MIL-S-24371.

8.4.2 Visual inspection. After the plate has been cleaned and primed, visual inspection shall be made of both surfaces and compared to standard plastic replicas described in NAVSHIPS 0900-LP-005-6000 to determine surface acceptability. Surface conditions unacceptable to NAVSHIPS 0900-LP-005-6000 shall be repaired as specified in 8.8. Surface roughness conditions acceptable to the requirements of NAVSHIPS 0900-LP-005-6000 should not be weld repaired.

8.4.3 Gaging. The required ultrasonic thickness and micrometer gaging measurements shall be in accordance with MIL-S-24371.

8.4.4 Soundness. Plates shall be ultrasonically inspected for soundness as specified in MIL-S-24371.

8.4.5 Identification. HY-130 plate shall be identified as specified in MIL-S-24371.

8.5 HY-130 rolled and extruded shapes. Records, as required in section 5, shall be maintained for shapes.

8.5.1 Test results. Certified test results of all HY-130 shapes showing chemical and mechanical properties and ultrasonic soundness shall be reviewed for compliance with the applicable material specification.

8.5.2 Dimensional inspection. Shapes shall comply with the applicable material specification requirements for dimensions, squareness, straightness, camber, and freedom from twist. This inspection shall be performed prior to fabrication and recorded as required by section 5.

8.5.3 Visual inspection. All surfaces of shapes shall be visually inspected for surface imperfections in accordance with the applicable specifications.

8.5.4 Soundness. Structural shapes used in pressure hull structure shall be ultrasonically inspected for soundness as required by the applicable material specification.

8.5.5 Identification. Shapes shall be identified as specified in the applicable material specification.

8.6 HY-130 formed material. Records of vendor repairs as required in section 5, welded in accordance with section 13 together with certified mechanical and chemical analysis tests and NDT results shall be maintained for all HY-130 formed material.

8.6.1 Surface and soundness. HY-130 formed materials shall have been inspected as required in section 9 and the applicable paragraphs of section 8 for material surface inspection and soundness. Certified test results of inspection of welds in formed material shall be obtained by the receiving activity and reviewed for compliance with this document and applicable specification.

8.7 HY-130 forgings. Records as required in section 5 shall be maintained for forgings used in pressure hull structure.

8.7.1 Test results. Certified test results of HY-130 forgings showing chemical and mechanical properties and specified soundness tests shall be reviewed for conformance with MIL-S-24512. Records of the locations of all weld repairs performed in accordance with 8.8 together with the required NDT results shall be obtained and reviewed for conformance with MIL-S-24512.

8.7.2 Visual inspection. HY-130 forgings shall be visually inspected for conformance with MIL-S-24512, and the dimensions checked for acceptability to procurement documents.

8.7.3 Soundness. HY-130 forgings shall be inspected for soundness as required by MIL-S-24512. The final machined surface shall be MT inspected in accordance with the requirements of section 7.

8.8 Grinding and welding repairs. Repairs to unacceptable HY-130 material surfaces disclosed during inspection shall be accomplished in accordance with the following requirements.

8.8.1 Plate surface repairs. Surface roughness in excess of that allowed by MIL-S-24371 may be ground to bring it within the acceptance standard provided the plate thickness is not reduced below the minimum specified in MIL-S-24371.

8.8.1.1 Weld repairs of mill defects on plate surfaces. Surface roughness of quenched and tempered plate in excess of that permitted in MIL-S-24371 and which cannot be repaired by grinding shall be weld repaired provided the total area of weld repair on both surfaces will not be greater than one-percent of one surface of the plate. These weld repairs may be performed prior to forming subject to the limitations of MIL-S-24371 and section 9. Record requirements shall be as specified in section 5.

8.8.2 Shape surface repairs. Grinding shall be employed to remove surface defects provided the depth of the ground areas will not reduce the material thickness below the minimum specified by the applicable specification. The ground repairs shall have a smooth contour with a minimum radius of 3/8 inch.

8.8.2.1 Weld repairs. Surface defects of sufficient depth to reduce the material thickness below that permitted by 8.8.2 shall be weld repaired provided the total area of weld repair on surfaces of any piece will not be greater than two percent of the total area of the piece. These repairs may be performed prior to forming subject to the limitations of the applicable material specification and section 9. Record requirements shall be as specified in section 5.

8.8.3 Forging repairs. Grinding shall be employed to remove surface defects provided the depth of the ground area will not reduce the material thickness below the minimum specified by the applicable procurement document. The ground area shall have a smooth contour with a minimum radius of 3/8 inch.

8.8.3.1 Weld repairs. Surface defects in excess of that permitted in 8.8.3 shall be repair welded in accordance with MIL-S-24512.

8.9 Welding filler materials. Records as required in section 5, shall be maintained for all electrodes listed in section 10. Welding electrodes (bare and covered) shall be accepted based on the quality conformance inspection tests of the applicable specification and the tests outlined in 8.9.1 below. A certified copy of the test results shall be reviewed for compliance with the applicable material specificaiton.

8.9.1 Ferritic filler metal verification. The mechanical properties of MIL-14018 and MIL-140S electrodes shall be verified for conformance to the applicable specification by the receiving activity as outlined below, except this verification is not required when the receiving activity performs all the quality conformance inspection tests of the applicable specification.

8.9.1.1 MIL-14018 electrodes. Samples shall be selected in accordance with table VI for mechanical property and electrode covering moisture content determination. Covering moisture determination shall be performed in accordance with MIL-E-22200. Mechanical property determination shall consist of tensile testing and dynamic tear testing of deposited weld metal. The weld test specimen shall be prepared and tested as outlined in the applicable electrode specification.

8.9.1.2 MIL-140S spooled bare wire. Chemical analyses shall be made from gas metal are spooled bare wire samples taken from each lot to determine specification compliance. Three samples per lot shall be taken for analysis, i.e., one sample shall be taken from each of three different spools in each lot. A lot of electrode shall be identified by the manufacturer in accordance with the applicable electrode specification.

8.9.1.2.1 Hydrogen analysis. Samples of gas metal-arc bare spooled electrode shall be selected in accordance with table VI for hydrogen analysis to determine compliance with the material specification. The testing procedure and acceptance/rejection criteria shall be in accordance with the material specification.

8.9.1.2.2 Mechanical property testing. Samples shall be selected in accordance with table VI for mechanical property determination, which shall consist of tensile testing and dynamic tear testing of deposited weld metal. The weld test specimen shall be prepared and tested as outline in the applicable electrode specification.

8.10 Records. Records of the receiving activity's testing shall be maintained as required by section 5.

9. FORMED MATERIALS

9.1 Scope. This section details the requirements for forming of HY-130 plate, forgings, and extruded or fabricated shapes beyond that permitted by the applicable material specifications for HY-130 fabrication within the scope of this standard.

9.2 Hot forming. Hot forming operations shall be performed between 1700°F and 2150°F. Maximum temperature upon heating shall be 2250°F. The finishing temperature shall not be below 1675°F.

9.2.1 Contaminants. Prior to hot forming operations, the surfaces of the material to be heated shall be free of oil, grease, zinc, lead, tin, copper, substances which contain these materials or elements, or other low melting point alloys.

9.2.2 Base material testing. After forming, the material shall be heat treated to produce properties conforming to those specified in applicable material specifications. Test specimens for determining properties shall be removed from material which is an integral part of each hot formed and heat treated piece after final heat treatment and completion of all forming operations. A separate heat piece may be used provided it is from the same heat of material, is of approximately the same maximum cross-section, is subjected to the same amount of hot work and thermal cycling and is heat treated with the formed material.

9.2.3 Thickness and soundness tests. After heat treatment, each hot formed piece of HY-130 material shall be subjected to thickness tests and UT to the extent required in section 6.

9.2.4 Surface inspection. After final heat treatment and cleaning, the surface of the hot formed HY-130 material shall be inspected in accordance with the requirements of section 8. When repairs are required, they shall be performed in accordance with the requirements of this document.

9.2.5 Hot formed and heat treated welds. Temporary welds made to aid in hot forming operation shall be completely removed after hot forming. The removal area shall be subject to magnetic particle inspection prior to any further work. Magnetic particle inspection shall be performed with a procedure conforming to section 15 and accepted in accordance with section 7. Permanent welds may be hot formed provided a special welding procedure qualification is obtained in accordance with section 4.

9.3 Cold forming. Cold forming operations shall be performed below 500°F. Cold forming may be done on fully heat treated material and on complete penetration butt welded joints in such material.

9.3.1 Requirements for cold formed HY-130 materials. Magnetic particle inspection shall be performed on all finished tension surfaces of HY-130 steel elements which are cold formed in excess of 12 percent total elongation. When these tension surfaces are machined, final MT inspection shall be performed after finishing machining. Figure 28 may be used as an aid in determining elongation.

9.3.2 Requirements for cold formed welds. Welds shall not be cold formed in excess of six-percent total elongation unless otherwise approved. All cold formed welds shall be MT inspected.

9.3.3 In-process heating for cold forming. If in-process heating is employed, it shall not exceed 500°F for cold forming.

9.3.4 Repair welding of cold formed materials. Repair welding of quenched and tempered material surfaces shall be performed in accordance with the requirements of this standard.

10 WELDING MATERIAL

10.1 Scope. This section details the welding filler materials to be employed for HY-130 fabrication within the scope of this standard.

10.2 HY-130 to HY-130 or other ferritic materials. Unless otherwise approved, the filler material type and specifications, the associated processes and positions of welding employed shall be restricted to the applications listed in tables VII and VIII.

10.3 HY-130 to non-ferrous and austenitic materials. Unless otherwise approved, the filler material type and specification, the associated processes and positions of welding employed shall be restricted to the applications listed in table IX.

10.4 Receipt inspection. Welding materials shall be receipt inspected as required by section 8. Records of receipt inspection shall be maintained as required by section 5.

10.5 Maintenance of MIL-9018, MIL-11018, MIL-12018, and MIL-14018 electrode. MIL-9018, MIL-11018, MIL-12018, and MIL-14018 electrode shall be maintained for issue by the activity concerned, in the sealed vendor containers or stored in holding ovens after the vendor containers are opened.

10.5.1 Storage in holding ovens. All electrodes from vendor containers which have been opened shall be issued or transferred to holding ovens. MIL-14018 and MIL-12018 electrode shall be stored in holding ovens separate from other covered electrode. The holding oven temperature for all electrodes shall be maintained in the range of 225°F to 300°F. If at any time the temperature of the holding oven drops below the minimum of 225°F, all MIL-14018 electrode involved shall not be used for fabrication of HY-130 material, unless a moisture determination of the MIL-14018 electrode is made as described in 10.5.2. If the electrode moisture content is determined to be below 0.10 percent the involved type MIL-14018 electrode may be issued or relocated to a satisfactorily operating holding oven and maintained at the specified temperature. If the electrode moisture content is determined to exceed 0.10 percent the electrode may be rebaked according to specification requirements (MIL-E-22200). Moisture determination testing shall be repeated after baking and if found acceptable, the electrode may be issued for HY-130 steel fabrication. The MIL-9018, MIL-11018, and MIL-12018 electrode may be treated as returned electrode (see 10.7.1) if

at any time their holding oven temperature drops below 225°F. If the temperature goes above 300°F, corrective action shall be taken to assure that the electrode is maintained at the specified temperature range.

10.5.2 Moisture determination. Periodic moisture determination shall be performed at least once a week on MIL-9018, MIL-11018, MIL-12018, and MIL-14018 electrode. These test samples shall be made on removal from each holding oven to determine that the moisture content of the electrode is below 0.10 percent for MIL-12018 and MIL-14018 electrode and below 0.20 percent for MIL-9018 and MIL-11018 electrode. The moisture determination shall be made in accordance with MIL-E-22200. Records shall be maintained as required by section 5.

10.6 Exposure of MIL-14018 electrode. On removal from vendor containers or holding ovens, electrode shall be placed in portable heated containers for use at the job site. The holding temperature of the portable containers shall be 225°F to 300°F. Empty portable containers shall be stored in a warm, dry area to preclude moisture contamination. The welder shall use the electrode immediately on removal from the portable container. If the temperature of the portable heated container drops below the minimum of 225°F, the electrode involved shall not be used for fabrication of HY-130 material. If the temperature of the portable heated container goes above 300°F, corrective action shall be taken to assure that the electrode is maintained at the specified temperature range.

10.6.1 Moisture tests. At least eight moisture test samples shall be taken per week from welders at their job sites, except when the average number of welders using MIL-14018 electrode is less than eight, in which case one sample may be taken from each welder. The moisture determination shall be made in accordance with MIL-E-22200. If two or more samples in the same week or one sample in each of two consecutive weeks are above 0.10 percent, corrective action shall be taken and the sampling frequency shall be doubled until the condition is corrected. Records shall be maintained as required by section 5.

10.7 Exposure of MIL-9018, MIL-11018, and MIL-12018 electrode. On removal from holding ovens, electrode shall not be used after being exposed to the atmosphere for a total period of more than five hours. During exposure, suitable means shall be provided to protect electrode from inclement weather.

10.7.1 Returned electrode. Electrode turned in after the above exposure period shall be returned to the holding ovens and held at temperature for a period of at least eight hours or shall be rebaked as required by NAVSHIPS 0900-LP-006-9010.

10.7.2 Moisture tests. At least four moisture test samples shall be taken per week from welding operators at their job sites, except when the average number of welders using types MIL-9018, MIL-11018, and MIL-12018 electrode is six or less, in which case the number of moisture samples may be 1/2 of this average number of welders. The moisture determination shall be made in accordance with MIL-E-22200. If two or more samples in the same week or one sample in each of two consecutive weeks are above 0.20 percent for MIL-9018 or MIL-11018, or above 0.10 percent for MIL-12018, corrective action shall be taken and the sampling frequency shall be doubled until the condition is corrected. Records shall be kept as required by section 5.

10.8 Exposure of austenitic stainless steel or nonferrous covered electrode. Electrode left in open containers or exposed for more than nine hours shall be placed in holding ovens at a temperature of 150°F to 300°F and held for a minimum of eight hours prior to reissue.

10.9 Bare electrode storage.

10.9.1 MIL-140S bare electrode. MIL-140S bare electrode shall be stored in a clean, dry environment. When not intended to be used for a period of more than 24 hours, spools shall be replaced in the receiving container with a desiccant and sealed. Desiccant material shall be dried or recharged as required to maintain its effectiveness and shall not be placed in direct contact with the bare electrode.

10.9.2 All other bare electrode except MIL-140S. Bare electrode and welding wire listed in tables VIII and IX not received in hermetically sealed containers, shall be stored in a warm dry area.

10.10 Identification. Coated electrode and bare welding wire shall be properly identified up to the point of usage.

10.10.1 Coated electrode. Each coated electrode shall have distinguishable markings as required by the applicable procurement specification. If markings are destroyed by baking or other means, electrode shall not be used until identification is restored.

10.10.2 Bare electrode. Each spool or coil of bare electrode shall be identified as to type.

11. WELDING DESIGN

11.1 Scope. This section details design requirements that shall be met when designing for fabrication of HY-130 within the scope of this standard.

11.2 Design for pressure hull structure welding. All welds in or to the pressure hull structure should be designed to permit fabrication by the gas metal arc welding process as required by 13.2. Manufacturing plans for detailing fabrication or erection sequences, welding processes and procedures, and nondestructive testing shall be developed concurrently with the detailed design plans. The manufacturing plan shall be approved by the shipyard welding engineer. The shipyard welding engineer shall determine: (1) if the gas metal arc process can be used based on the accessibility for welding equipment, etc., (2) if an alternate welding process should be used, (3) if structure redesign is necessary for welding.

11.3 Functional joint requirements.

11.3.1 Pressure hull structure. The required joint efficiencies of table X, column 3, are the minimum joint efficiencies which will develop the intended functional strength of the itemized connections and, as such, shall be used. The group of joint configurations permitted for use in fulfilling the required joint efficiencies shall be as specified in table X, column 4. The notes in column 5 are applicable to the specific item.

11.3.2 Non-pressure hull structure. Welds may be sized in accordance with the design loads or based on requirements of 11.3.1.

11.4 Design group classification.

11.4.1 General. Full or partial penetration welds joining HY-130 to HY-130, HY-80, high tensile steel (H.T.S.) or carbon steel shall be made using electrodes specified in tables VII and VIII. Full or partial penetration welds joining HY-130 to nonferrous and austenitic materials shall be made using electrodes specified in table IX.

11.4.2 Group I joints. Group I joints are those butt welds designated in MIL-STD-22 as B1V.1, B1V.2, B1V.3, B2V.1, B2V.3, B2U.1, B2U.2, B2U.3 B2U.4, and B2U.5.

11.4.3 Group II joints. Group II joints are those grooved tee welds designated in MIL-STD-22 as T1V.1, T1V.2, T2V.1, T2V.2, T2J.1, and T2J.2.

11.4.4 Group III joints. Group III joints are partial penetration tee joints designated in MIL-STD-22 as PT2S.1, PT2J.1, and PT2V.1.

11.4.5 Group IV joints. Group IV joints are corner joints designated in MIL-STD-22 as C2S.2, C2V.1, C2V.2, C2V.3, C2V.4, C2V.5, C2V.6, C2U.1, C2J.1, C2J.2, C2J.3, C2J.4, C2J.5, and C2J.6.

11.4.6 Joint efficiency and strength. Joints in groups I, II, and IV when welded from both sides have an efficiency of 100 percent unless otherwise indicated. When a backing strap is used, and not removed, the efficiency shall be 90 percent maximum. If the backing strap is removed and the exposed weld passes the required NDT, the joint has an efficiency of 100 percent. The strength and efficiency of group III joints, regardless of direction of loading, shall be based on MIL-STD-1628.

11.4.7 Canted tee joints. When tee joints of groups II and III are canted for form elements at an angle other than 90 degrees, the following shall apply.

11.4.7.1 For all group II joints and joints PT2J.1 and PT2V.1, the angle of bevel on the closed side of the joint shall be corrected to provide the minimum included angle for each joint type.

11.4.7.2 When group III joint PT2S.1 is required for attachment of structural members to pressure hull structure, and the angle formed between the tee member and the through member is greater than 105 degrees on the open or obtuse angled side of the joint, but less than or equal to 135 degrees, the tee member may be: (a) Beveled to fit the contour of the through member, (b) Beveled on the open or obtuse angled side of the joint sufficient to produce an included angle of at least 45 degrees. The effect of this option is to produce a joint similar to T2V.1, (c) Left square. In any case, the inspection requirements of section 6 for PT2S.1 apply and backgouging is not required.

11.4.7.3 When the angle formed between the tee member and the through member is greater than 90 degrees, a T2V.1 joint may be used for attachment. When the angle formed between the tee member and the ghrough member is greater than 135 degrees, A T2V.1 joint shall be used for attachment. Where the T2V.1 joint is used for these applications, the thickness limitation does not apply.

11.4.8 Joint configurations. When joint configurations other than those detailed in this section are employed, the joint shall be detailed on the approved drawing for the ship involved.

11.5 Design requirements.

11.5.1 Penetrations in pressure hull envelope. Penetrations in the pressure hull envelope shall be installed in accordance with the following.

11.5.1.1 The toes of full penetration welds connecting penetrations to pressure hull envelope should be separated from the toe of any other full penetration weld in the pressure hull envelope by 3/4 inch. If either is a partial penetration fillet weld, the minimum separation should be 1/2 inch.

11.5.1.2 Penetrations shall not intersect a full penetration weld except where absolutely necessary. In those instances where it is necessary for a penetration to intersect a butt weld, the penetration should preferably be centered on the butt weld or shall intersect a butt by overlapping the butt weld by at least 3/4 inch as shown in figure 29.

11.5.1.3 The distance between the centerline of a penetration and adjacent frame, floor, or bulkhead shall be a minimum of one-fifth the frame spacing (see figure 30).

11.5.1.4 Penetrations should be staggered rather than located in a line in the athwartship or fore and aft direction. No more than two penetrations per frame bay shall be located in line in the fore and aft direction.

11.5.2 Inserts, patches, and small access plates. The minimum diameter of an insert, patch, or small access plate in pressure hull envelope shall be 4T or 6 inches, whichever is larger, where T is the thickness of the member penetrated. The minimum diameter of an insert or patch in plating and structure other than the pressure hull envelope shall be 4T or 3 inches, whichever is larger, where T is the thickness of the member penetrated. Corners of inserts or patches and small access plates in pressure hull envelope have a minimum radius as shown in figure 31, except where these inserts, patches, or small access plates land on full penetration butt welds. Corners or inserts or patches in plating and structure other than pressure hull envelope shall have a minimum radius as shown in figure 32.

11.5.2.1 Inserts, patches, or small access plates shall not intersect any full penetration butt weld unless they land on these welds or cross them at approximately a 90 degree angle plus or minus 15 degrees as shown in figure 33. When the boundaries of inserts, patches, or small access plates in the pressure hull envelope land on existing full penetration butt welds, the common length of weld shall be not less than 12 inches.

11.5.2.2 When the boundaries of inserts or patches in pressure hull envelope do not land on existing full penetration butt welds, the toes of the insert or patch welds shall be a minimum of 3 inches from the toes of any other full penetration butt welds, except for the following:

(a) Circular inserts
(b) Circular patches
(c) Circular small access plates
(d) Penetrations

The above items (a) through (d) shall have weld toe-to-toe distances as specified in 11.5.1.1.

11.5.2.3 When inserts or patches in the pressure hull envelope terminate on longitudinal butt welds, these latter existing welds shall be cut back a minimum of 3 inches except where such cut back would result in less than 2 inches of existing longitudinal weld remaining between the end of the cut back and adjacent frame web or bulkhead surface. In such cases the minimum cut back shall be terminated not less than 2 inches from the adjacent frame web or bulkhead surface, but in no case shall the cut back be less than 2 inches long. When it is anticipated that this latter situation will occur, the weld toes of insert or patch welds shall be limited to a minimum of 4 inches from the weld toes of the adjacent frame web or bulkhead surfaces.

11.5.2.4 The requirements of 11.5.2 and 11.5.2.1 are not applicable to temporary access holes cut to facilitate welding as permitted in section 14.

11.5.3 Access and closure plates. Corners of access and closure plates in the pressure hull envelope shall have a minimum radius of 6 inches, except when a boundary lands on an existing hull longitudinal or circumferential butt weld. In the latter instance the corners shall intersect the butt weld at 90 degrees plus or minus 15 degrees.

11.5.3.1 Boundaries of access and closure plates in the pressure hull envelope shall either land on existing hull (circumferential and longitudinal) butt welds, or the weld toe-to-toe spacing from any adjancent hull butt weld shall be a minimum of 3 inches except for the items shown in 11.5.2.2. (a), (b), (c), and (d). These items shall have weld toe-to-toe distances as specified in 11.5.1.1. When a transverse boundary of an access or closure plate does not land on an existing butt weld it shall be located so that the center of the weld is approximately 20 percent of the frame space from the face of the adjacent frame or bulkhead.

11.5.3.2 When access or closure plate welds in the pressure hull envelope terminate on other full penetration butt welds, the existing weld shall be cut back a minimum distance of 3 inches from the point of intersection, except for longitudinal welds in the pressure hull. When access or closure plate welds in the pressure hull envelope land on longitudinal butt welds, the existing longitudinal welds shall be cut back as required for insert or patch welds (see 11.5.2.3).

11.5.4 Deviations. If the design requirements of 11.5.2.1 and 11.5.3.1 cannot be met due to fabrication variations for cut back and proximity limitations, deviation shall require approval.

11.6 Permanent snipes for tanks. The radiused type snipe shown in figure 34 shall be used for vents, drains, or permanent snipes.

11.7 Pressure hull envelope attachment. Every effort should be made to minimize welded structure and miscellaneous attachment to the pressure hull envelope. Attachments to the pressure hull envelope, which are on the opposite side of the pressure hull plating from the frames, shall be located on the frame line whenever possible. For this purpose, the frame line is defined as a width equal to the hull plate thickness on either side of the center line of the frame web. Capacitator discharge welded studs, not more than 1/4 inch diameter, may be applied anywhere on the pressure hull.

12. ERECTION REQUIREMENTS

12.1 Scope. This section details the requirements for fabrication and erection within the scope of this standard. Where more rigid erection tolerances are specified in the detailed specification they shall apply.

12.2 General requirements.

12.2.1 Welding in enclosed areas. All welding of HY-130 material, either to itself or other materials, should be performed in enclosed areas which protect the work from the weather.

12.2.2 Allowance for longitudinal shrinkage. Allowance shall be made for cumulative longitudinal shrinkage of the general hull structure due to welding.

12.2.3 Compensation of weld shrinkage. Sub-assemblies, such as bulkheads and deep frames, should provide excess material at the outer boundaries to compensate for weld shrinkage. When welding of the sub-assembly is completed, the excess at the outer boundaries shall be trimmed to design dimensions.

12.2.4 Restraining devices. The use of restraining devices during a welding operation to maintain joint fairness should be kept to a minimum.

12.2.5 Mechanical indentation. Mechanical indentation of material surfaces shall be kept to a minimum in the hull envelope. Material, or layout identifications when required to be made by die-stamping, shall be made using low stress die-stamps.

12.2.6 Peening. Peening may be used to correct distortion or to minimize residual stresses, except that peening shall not be performed on the last layer unless the peening operation is followed by a machining or grinding operation to remove the effects of peening.

12.3 Detail requirements.

12.3.1 Attachments.

12.3.1.1 Temporary attachments. Welded temporary attachments, such as erection clips, fairing bolts, staging braces, and brackets should be kept to an absolute minimum and should be used only when attachments which do not require welding cannot be used. Non-welded type attachments similar to those shown in figures 35 through 41 should be used wherever possible. If welded attachments are used, they should be similar to those shown in figures 42 and 43 and should be placed on weld joint edges to the maximum extent possible.

12.3.1.2 Removal of welded temporary attachments. Welded temporary attachments shall be removed at least 1/16 inch away from the permanent members to which it is attached by chipping, arc air gouging, or oxy-fuel cutting followed by grinding to restore plate or scarf surface as specified in section 14. Attachments may also be removed by grinding only. Removal shall not be accomplished by bending or hammering. All gouges, undercuts, or nicks produced during removal shall be faired out by grinding or repair welded in accordance with section 14. Percussive studs and spot welds 1/4 and smaller, are exempted from these requirements.

12.3.1.3 Inspection of welded temporary attachment sites. Upon removal of temporary attachments, the areas in way of such attachments which are ground, or repair welded shall be MT inspected as required by section 6.

12.3.2 Studs.

12.3.2.1 General. Studs shall be welded in accordance with section 13 and inspected in accordance with section 6.

12.3.2.2 Location. Studs should not be located directly welds but may be otherwise located without being subjected to the spacing requirements of 11.5.

12.3.3 Spiders, bracing, and temporary lifting pads.

12.3.3.1 General. Spiders may be used in all cylindrical and transition sections during fabrication and erection.

12.3.3.2 Alignment devices and staging braces. Every attempt should be made to use mechanically fastened frame alignment devices or staging braces similar to those devices shown in figures 37, 38, and 39.

12.3.3.3 Lifting devices. Lifting devices such as slings, belly bands, mechanically fastened lifting clamps, and pads should be used to the maximum extent possible in lieu of welded lifting pads.

12.3.4 Erection sequence.

12.3.4.1 General. The welding of submarine structures and all parts entering into their construction should progress symmetrically port and starboard, top and bottom so that the shrinkage and restraint on both sides of the structure or hull are equalized. When hull sections are joined into a single unit, a circumferential butt weld should be the joint by which the unit is added to the hull structure. Erection sequence shall be a part of the manufacturing plan specified in 11.2.

12.3.4.2 Circumferential butt welding sequence. Each circumferential butt should be welded by two or more welders spaced around the circumerence in a manner which will control distortion of the structure. Welding should be completed to a depth of at least 1/4T, where T is the thickness of the thinner member, prior to being chipped carbon arc air gouged or ground to sound metal on the opposite side. After the opposite side has been cleaned to sound metal, the areas shall be magnetic particle inspected as required by section 6. Preheat shall be maintained in accordance with section 13.

12.3.4.3 Block tack welds. Block tack welds should be used when welding is employed to maintain alignment of circumferential and longitudinal butt welds in the assembly of hull sections. These welds shall be made in accordance with section 13.

12.4 Structural requirements.

12.4.1 Circularity.

12.4.1.1 Circularity requirements. The circularity of the pressure hull throughout those portions of the ship which are intended to be circular shall be determined in accordance with the methods specified in 12.4.1.2 or other methods approved by NAVSEA and shall meet the following requirements:

(a) The trace of the actual contour shall not deviate from the mean circle by more than one half the thickness of the pressure hull plating or 1/2 inch whichever is less.
(b) The radius of the mean circle shall not depart from the design radius by more than one half the thickness of the pressure hull plating or 1/2 inch, whichever is less.

12.4.1.1.1 Location of final acceptance circularity measurements. Final acceptance circularity measurements of pressure hull envelope shall be recorded at the following stations: (The fore and aft tolerance off each station shall be plus or minus 6 inches and actual reading locations shall be recorded. In no case shall circularity be taken on a transverse hull butt weld.)

(a) One set on at least every third frame.
(b) One set midway between the frames adjacent to circumferential butts, except when the distance from the midspan to the adjacent frame is 12-inches or less as noted in (4) below.
(c) One set on the frame (exclusive of structural bulkheads) nearest each

circumferential butt.

(d) One set midway between structural bulkheads and the adjacent frame on the side of the structural bulkhead opposite the bulkhead stiffeners, except where a transition hull butt is in a 24-inch or less frame space.

12.4.1.1.2 Sequence of final acceptance circularity measurements. Measurements shall be taken after all major welding has been completed. Major welding is considered to be full penetration welds in the adjacent frames and in the pressure hull in the adjacent frame bays. Where at least one frame is cut completely in way of closure plates, the installation of closure plates shall also be considered major welding (see 12.4.1.3 for procedures). The installation of inserts and penetrations (which in themselves cause a deviation in the neutral axis of the section and do not cut frames) shall not be considered major welding and circularity of the hull may be taken as located by 12.4.1.1.1 before or after the installation of inserts and penetrations (see 12.4.3 for fairness requirements). All spiders, bracing, and other temporary structural supports shall be removed or released and the structure cooled to ambient temperature prior to taking circulatory readings.

12.4.1.1.3 Method of taking final acceptance circularity measurements. Circularity measurements shall be taken so that the actual hull contour at any station may be analyzed for eccentricity. When tank floors or bulkheads form a part of the hull structure, circularity measurements need not be taken below the tank tops or in way of the structural bulkheads. A circle whose area equals the area of the hull contour shall be established. This circle shall be the mean circle. The mean circle may be positioned over the neutral contour so that deviations between the mean circle and the contour are minimized. The deviations between the mean circle and the actual hull contour shall be measured at points not more than 10 degrees apart. These measurements shall be recorded to the nearest 1/32 inch for each station on the form as required in section 5.

12.4.1.2 Circularity measuring methods.

12.4.1.2.1 Internal swing arm. A mechanical arm shall be pivoted at the geometric center of the hull cross section and revolved in a plane perpendicular to the axis of the hull. This center is the intersection of the vertical and horizontal diameters to the inside of the hull plate. A movable part of the arm shall be used to produce a reduced size contour of the inside of the hull cross-section. The area within the contour shall be determined and the diameter of a circle of equal area determined. This is the mean circle. The mean circle shall be superimposed on the contour and may be positioned to minimize deviations.

12.4.1.2.2 Bridge gauge traverse (internal or external). A rigid beam gauge having three equally spaced legs, one of which shall be a measuring device (e.g., a dial gauge). The spacing of the legs shall be such that, when the gauge is laid transversely on a cylindrical portion of the hull, leg contact will be at approximately 10-degree intervals. Care shall be used in accurately holding the gauge and measuring offset distances from gauge to hull. Measurements shall be recorded on a suitable form for data processing and processed in accordance with a NAVSEA approved procedure similar to those set forth in San Francisco Bay Naval Shipyard Computer Program No. 250-2.

12.4.1.2.3 External templates. A complete rigid ring, or section thereof, shall be fabricated slightly larger than the pressure hull where the circularity measurement will be taken. The ring shall have a reference circle marked on it about two inches larger in radius than the outside design radius of the hull at the hull cross-section. After assembly around the hull, the ring template shall be secured to the hull by suitable means. Extreme care must be taken to maintain the circular shape of the reference circle. A check of this circle shall be made prior to taking deviation measurements by recording the erected reference circle diameter at the horizontal axis. This measured diameter shall be within 1/8 inch of the reference circle diameter as marked. Measurements from the reference circle to the hull surface shall be made at not more than 10-degree intervals or the hull contour may be scribed directly onto the template. The deviation of the hull contour from the reference circle shall be tabulated. These deviations at each interval of the hull from the mean circle are recorded.

12.4.1.2.3.1 Internal template method. Similar to 12.4.1.2.3 above except the template is taken as the inside of the section.

12.4.1.2.4 Optical square method (internal or external). This method determines the contour of the hull cross section from a referenced square. Rectangular coordinate readings are taken for every five degrees of the hull cross section. Measurements shall be recorded on a suitable form for data processing and processed in accordance with procedures similar to those set forth in San Francisco Bay Naval Shipyard Mare Island Division Computer Program No. STR-59F.

12.4.1.2.5 Internal radii. Individual radii shall be measured at 5-degree intervals from the geometric center of the hull cross-section established by the intersection of the vertical and horizontal diameters. The radius of the mean circle is the average of all measured radii. Individual actual radii are compared to the mean radius to determine deviations.

12.4.1.3 Circularity measuring procedures. The following procedures shall be employed to meet the requirements of 12.4.1.1.2, when full circularity measurements required by 12.4.1.1.1 are not taken after closure completion.

(a) Prior to cutting, the existing circularity of each frame to be cut shall be established in one of the following ways.
  (1) By taking of actual full circularity measurements in way of the structure involved. In addition, the radial location of end points beyond the edges of the proposed cut shall be established relative to bench marks on adjacent undisturbed frames forward or aft of the proposed cut. The transverse arc length between the end points shall equal twice the transverse arc length of the proposed cut, but not to exceed 30 degrees beyond each edge of the cut. The end points shall be equidistant from the center of the proposed cut.
  (2) By reference to prior full circularity readings made in way of structure involved. In addition, the radial location of the end points beyond the edges of the proposed cut shall be established relative to bench marks on adjacent undisturbed frames forward and aft of the proposed cut. The transverse arc length between end points shall equal to twice the transverse arc length of the proposed cut, but not to exceed 30 degrees beyond each edge of the cut. The end points shall be equidistant from the center of the proposed cut.
  (3) By determining partial hull contour of the structure involved. Partial circularity shall cover a transverse arc length equal to twice the transverse arc length of the proposed cut, but not to exceed 30-degrees beyond each edge of the cut and shall be centered on the proposed cut except where tank tops, or stiff or rigid (strong-back type) coaming intersect the pressure hull, in which case the particular circularity may terminate at the tank top or coaming. If the tank top or coaming is to be penetrated for any other reason, the partial circularity shall extend to its minimum requirements stated above. The radial location of the end points for the partial circularity check shall be established relative to bench marks on adjacent undisturbed frames forward or aft of the proposed cut, unless arc to be measured terminates at tank top or coaming. If partial circularity deviates more than 1/2 inch or 1/2 the thickness of the plating, whichever is less, a full circularity check shall be made.

(b) After all welding in connection with the renewal or replacement of the hull plating or framing has been completed, verification of acceptable circularity of each cut frame shall be accomplished by taking full circularity measurements per 12.4.1.1.1 or by taking

partial circularity measurements as defined in 12.4.1.3(a) (3). If partial circularity checks are to be made, the radial location of the end points shall be remeasured. If the end points have changed by more than 1/8 inch from the radial location prior to cutting, full circularity shall be taken at the station. If end point radial locations are satisfactory, accomplish one of the following:

(1) The partial circularity contour after welding may be compared to the prior reference full circularity readings (see 12.4.1.3(a)). The partial circularity contour is compared to the mean circle established in the prior reference full circularity. All partial measurements are corrected so that the end points of the partial have the same deviations as the corresponding locations on the prior reference full circularity. All deviations of the entire contour are then determined for a new mean circle. Allowable deviation of the entire contour from the new mean circle is plus or minus 1/2 the thickness of the hull plate or 1/2 inch, whichever is less. If this condition is not met, a full circularity check shall be made

(2) The partial circularity contour after welding may be compared to the partial hull contour taken prior to cutting (12.4.1.3(a) (3)). The two contours are compared directly. If the the contours differ from each other by more than 1/8 inch at any location, a circularity check shall be made by 12.4.1.3(b) (1) above or by a full circularity measurement, to determine if the section meets the circularity requirements.

(c) Records shall be kept of all circularity checks and the method of taking circularity shall be included in the record. Forms for records are shown in section 5.

12.4.1.4 Resolution of circularity deviations. Where circularity measurements show deviations beyond specified tolerances, resolution of action to be taken shall be made by NAVSEA.

12.4.2 Pressure hull frames.

12.4.2.1 Frame dimensional tolerances. After welding of the flange to web is finished (including all required NDT), the flange width and the flange unbalance of fabricated frames shall be within the tolerances of table XI. In process inspection of flange to web tilt tilt should be made. After finish welding the frames to the hull plating, including completion of all required NDT, the tilt of the flange to the web and the depth of all frames shall be within the tolerances specified in table XI. Such measurements shall be made at intervals of not more than 45 degrees.

12.4.2.2 Frame flange curvature. Flange curvature (transverse bow) shall not deviate from a reference line tangent to the top of the flange on flanges up to 12 inches wide by more than 1/8 inch and on flanges 12 inches wide and over by more than 3/16 inch. Such measurements shall be made at intervals of not more than 45 degrees.

12.4.2.3 Frame spacing. The distance between adjacent frame stations shall be measured and shall be within plus 1/8 inch, minus 1/4 inch of the designed dimension, except in way of circumferential butt welds where the distance shall be plus 1/8 inch, minus 1/2 inch of the designed dimension. This dimension shall be measured perpendicular to the frame web within 1 inch of one web toe of the hull attachment weld and may be adjusted for web tilt. Such measurements shall be made at intervals of not more than 45 inch. (Note: Care shall be taken to insure that accumulation of these tolerances allowances permits proper alignment of attached foundation or other components.)

12.4.2.4 Frame butt alignment. The transverse and vertical offset of abutting surfaces at weld joints in webs and flanges of pressure hull frames shall not exceed 1/8 inch at any point along the joint, unless so designed. Areas of the joint which do not meet this requirement may be corrected by weld buildup and grinding, care shall be taken however to provide a 4:1 taper of the weld buildup into the plating.

12.4.2.5 Records. Records of pressure hull frames shall be kept of all checks on frame dimensions and frame spacing. Forms for records are shown in section 5.

12.4.3 Fairness and alignment.

12.4.3.1 Pressure hull envelope plating alignment. When pressure hull plates to be butt welded are tacked and ready for welding, the misalignment of plating surfaces in way of joints shall not exceed the limits in table XII.

12.4.3.2 Plate panel unfairness. Unfairness of welded plate panels in free flooding areas and structural bulkheads shall be in accordance with the tolerances in figure 44.

12.4.3.3 Correction of misalignment and unfairness. Misalignment and unfairness exceeding the tolerances of this section shall be corrected by releasing the joints in way of the deformation and fairing by strong backing only. HY-130 material is not to be faired by use of heat.

13. WELDING REQUIREMENTS

13.1 Scope. This section details the requirements for welds in or to HY-130 within the scope of this document.

13.2 Welding process. Gas metal-arc (GMA) welding either automatic, mechanized, or semi-automatic should be used throughout the construction of HY-130 steel submarine hulls, but shall be used for welding full penetration welds in the pressure hull envelope. SMA welding may be used on a case basis where accessibility for GMA is inadequate and the weld joint cannot be designed for GMA welding in accordance with 11.2. The use of SMA welding for full penetrations welds in the pressure hull envelope shall require NAVSEA approval. For each weld joint where the SMA process (ferritic electrode) is used for welding HY-130, details of the weld joint and structure involved shall be documented by recording and reporting to NAVSEC (for information only) in accordance with section 5.

13.3 Qualification. Welding procedures, welders, and welding operators shall be qualified in accordance with the requirements of section 4, prior to performing production work.

13.4 Joint preparation. Plate edges shall have been prepared for welding in accordance with the requirements of section 14. In addition to weld build-up to correct oversize root openings, weld buttering or build-up may be used on surfaces or edges of HY-130 materials in way of penetrations or connections prior to making joint fit-up.

13.4.1 Joint configuration. Weld joint configurations, prior to welding, shall be in accordance with the requirements of section 11 with the following special considerations:

(a) Shifting of the centerline of the bevel angle is permissible within tolerance limitations of section 11.
(b) Unbalanced double bevel butt or tee joints are permissible within tolerance limitations of section 11.
(c) Unbalanced double bevel butt joints may be welded from either side first.
(d) Unbalanced double bevel tee joints or single bevel tee joints may be welded from either side first.
(e) Dissimilar metal joints shall be welded in a manner to deposit austenitic or non-ferrous weld metal over ferritic steel welds. When it is necessary to make ferritic welds over areas that contained austenitic of non-ferrous welds, an etch test shall be used to insure complete removal of the austenitic or non-ferrous weld metal.
(f) Single or double bevel groove joints within the same design group may be interchanged provided joint efficiencies are not reduced.
(g) Double bevel weld joint designs may be prepared by beveling one side prior to any welding, and the second side beveled after sufficient welding on the first side. Joint preparation technique shall be in accordance with section 14. The second side shall be ground to bright

metal prior to welding.

(h) Drawing changes are not required when the special considerations of (a), (b), (f), and (g) are employed during fabrication.

13.4.2 Root cleaning. Prior to welding the second side of full penetration welds, the root shall be cleaned to sound metal in accordance with the requirements of section 14 unless otherwise detailed in a NAVSEA approved procedure.

13.4.3 Base material identification. The material to be welded shall be identified as specified in section 8.

13.5 Welding materials. Welding materials shall comply with the requirements of section 10.

13.6 Erection requirements. Fabrication and erection requirements including sequence of welding and manufacturing plans shall comply with the requirements of 11.2 and section 12.

13.6.1 Tack welds. Tack welds shall be made using an approved type of electrode and shall be deposited in accordance with the requirements of this section. Cracked tack welds and those of poor quality shall be removed. All others shall be inspected in accordance with section 6, prior to being incorporated into the final weld. Tack welds made by the SMA process, which will not be incorporated into the final weld, are exempt from the requirements of 13.2.

13.6.2 Block tacks. Block tack welds in butt welds in pressure hull structure shall be made by qualified welders (not tack welders) and may be considered initial increments of the final weld.

13.7 Preheat and interpass temperature.

13.7.1 Welding. Temperature required for welding in or to HY-130 steel are listed in table I. The temperature shall be based on the thicker HY-130 joint member. When welding HY-130 to other ferritic materials, the preheat and interpass temperatures shall apply to the HY-130 joint members only, except when welding HY-130 to HY-80/100 the requirements in table I apply to both joint members.

(a) For welding in or to HY-130 with austenitic stainless-steel or non-ferrous type electrode listed in table IX the minimum preheat and interpass temperatures may be reduced to 60°F minimum.

(b) A preheat procedure shall be prepared for welding in close proximity to materials, such as polyethylene, where deviations from the above requirements are found necessary.

13.7.2 Arc-gouging. The preheat temperatures for arc-air gouging, based on the thickness of the heavier member shall be as listed in table 13.

13.7.3 Tack welding. The preheat for tack welding shall be the same as required in 13.7.1 for welding.

13.7.4 Stud welding. There shall be no temperature restriction for welding automatically-timed or percussive studs.

13.7.5 Methods. Preheat may be applied by any of the following methods used either singly or in combinations:

(a) Electrical resistance heaters
(b) Radiant or infra-red heaters
(c) Electrical induction
(d) Soft gas torch (gas-air) 1/
(e) Oxy-fuel torch 1/

1/ Within the limits specified in 13.7.6.5

13.7.6 Application.

13.7.6.1 Heating. The heating shall be of the uniform soaking type, applied preferably by means of electric heaters (resistance or induction) uniformly distributed on or around the area being welded. The spacing, wattage, and control of heaters shall be such as to insure that the entire welding area is up to the required minimum temperature without exceeding the specified maximum.

13.7.6.2 Control of heating (general). Cyclic heating and the occurrence of temperature differentials greater than 100°F along the joint during welding should be avoided. Structures being heated should be shielded from wind and inclement weather. Shielding shall be employed during welding and maintained until the structure has cooled to within approximately 50°F of ambient temperature. Control of the required temperature range during welding should be accomplished by distribution of welders or by the use of welding sequence.

13.7.6.3 Control of minimum temperature. The minimum required temperature shall be established prior to welding and should be maintained continuously until the completion of each weld joint. For inadvertent loss of temperature, if the temperature on HY-130 base material 1/2 inch and over in thickness drops below 100°F for the GMA process and 150°F for the SMA process when welding with ferritic filler materials, the partially completed welds shall be MT inspected and if proven sound to the requirements of section 7, shall be reheated to within the minimum specified temperature range and for SMA welding subjected to the applicable weld soaking requirements of 13.9 prior to the resumption of welding. For partially completed SMA welds, planned interruptions of preheat, e.g., turning a cylinder, dropping preheat for weekends, which could result in temperature below those specified above shall be preceded by a weld soak in accordance with 13.9.

13.7.6.4 Control of maximum temperature. The maximum required temperature should be controlled continuously until completion of each weld joint, except during deposition of a weld pass and except as specified in 13.9. The maximum required temperature shall be checked as specified in 13.7.7.1, 13.7.7.2, and section 6. If at any time during welding (except during deposition of a weld pass or as specified in 13.9) the base metal temperature is found to be above 300°F, the weld area shall be allowed to cool to within the required temperature prior to any subsequent welding.

13.7.6.5 Torch heating. Unless otherwise approved, torch heating shall be confined to tack or temporary welding operations. Base material shall be brought up to preheat temperature with sufficient time allowed for heat to soak through the thickness of the parts being welded. Heat should be applied over an area approximately six inches beyond the weld site in all directions. Exceptions to the above are those instances in which torch heating is used as an accessory device to decrease the time required for reaching preheat temperature on material which is being heated with electric heaters.

13.7.7 Temperature checks. Preheat and interpass temperatures shall be checked prior to and periodically during welding in accordance with the requirements of section 6. Temperatures of 125°F and above shall be checked using temperature indicating crayons or other approved means. For checking the 60°F minimum preheat and interpass temperature, the material temperature shall be considered the same as the ambient temperature in the general weld area. No check on the material is required.

13.7.7.1 Preheat temperature measurement. Preheat temperature shall be measured on the surface of the material on the side from which welding will be performed and within three inches of the area to be welded.

13.7.7.2 Interpass temperature measurement. Interpass temperature shall be measured on the surface of the base material on the side from which welding will be performed, within one inch of the weld joint edge and along the joint within three inches of the start of the next weld pass. Weld pass shall be defined as extending for the length of block or joint being welded and may consist of more than one start or stop. Temperature indicating crayons shall not be applied to the weld metal or weld groove.

13.8 Weld energy input.

13.8.1 General requirements. When welding with any process in or to HY-130, the limits for weld energy input as measured in kilo joules per inch, (kJ/in) based on the thickness of the thinner member, (i.e., except as modified in note 3 of table XIV) shall conform to the values listed in table XIV except as stated in 13.8.1.1 and 13.8.1.2.

13.8.1.1 Weld energy input for HY-130 to other ferritic materials. For welding HY-80/100 to HY-130 with filler metals specified for welding HY-80/100 (see NAVSHIPS 0900-LP-006-9010) the maximum weld energy input specified in NAVSHIPS 0900-LP-006-9010 for HY-80/100 shall apply.

13.8.1.2 Weld energy input for welding HY-130 with austenitic stainless steel or non-ferrous electrodes. The weld energy inputs specified in table XV shall be used for welding HY-130 with austenitic stainless-steel or non-ferrous electrodes.

13.8.1.3 Root passes. Root passes which will be backgouged are exempted from the above requirements.

13.8.2 Computation of heat input. For computing the weld energy input (J/in) the following formula applies:

$$\text{Weld energy input (J/in)} = \frac{\text{Arc voltage X welding amperage X 60}}{\text{Rate of travel (inches per minute)}}$$

13.9 MIL-14018 weld metal hydrogen removal requirements. All welds, except tack welds, (not block tacks), and temporary attachments, other than lifting pads, made either partially or completely welded with MIL-14018 electrode shall be exposed to one of the hydrogen removal techniques (as applicable) specified in table XVI.

13.9.1 Weld thickness determination. The weld thickness for single fillet welds shall be the throat thickness. For double fillet weld attachments, the throat thickness of the larger weld shall be the weld thickness. For full or partial penetration tee welds, the thickness of the intersecting member (beveled member) shall be the weld thickness. If the tee weld is fillet reinforced, 1/2 of the leg size for each fillet shall be added to the thickness of the intersecting member to determine the weld thickness. For butt and corner joints, the weld thickness is equal to the thickness of the thinner joint member. For weld build-up or repair of base metal gouges, etc., the weld thickness shall be actual depth of the build-up or depth of the gouge, as applicable. For partially completed welds the weld thickness shall be for fillet welds the actual weld throat thickness and for full and partial penetration welds the actual deposited weld thickness.

13.10 Temper bead techniques.

13.10.1 HY-130. The tempering-bead technique is not required when joining HY-130.

13.10.2 HY-130 to HY-80/100. When joining HY-130 to HY-80/100, the tempering-bead technique shall be employed on the HY-80/100 side of the joint only to the extent and manner specified in NAVSHIPS 0900-LP-006-9010, except the tempering-bead technique is not required for welding of HY-80/100 temporary attachments.

13.11 Repairs. For the purpose of this standard, all repairs shall be considered as falling into one of the following categories:

13.11.1 Repairs to HY-130 base material. Repair welding shall be performed in accordance with the requirements of this standard.

13.11.1.1 Mill defects. Repair welding shall be restricted to the limitations of section 8.

13.11.1.2 Scars and other fabrication damage. Repair welding shall be limited to those locations which cannot be corrected by grinding to the extent specified in section 14.

13.11.2 Repairs to welds. Removal and replacement of any weld metal from completed welds for any purpose shall be considered repair. Repair welding to correct undercut weld edges of permanent welds or temporary weld removal sites shall be limited to areas which are deeper than the allowances specified for grinding in seciton 14. Every effort should be made to avoid the necessity for repair welding of minor defects that can be corrected by grinding.

13.11.2.1 Repair welding. Repair welding shall be performed subject to all of the specification requirements which applied to the original weld. MIL-12018 electrodes may be used for repair of fillet or grooved tee welds originally made with other electrodes listed in table VII provided the length of such repair does not exceed 6 inches and adjacent repairs are more than 3 feet apart.

13.11.2.2 Inspection of repair welding. Weld repairs shall be inspected in accordance with section 6.

13.12 Slag removal. In multiple-pass welds, slag shall be removed from all-weld beads before starting to deposit subsequent beads. Slag should be removed by light grinding, power-wire brushing, or any other suitable mechanical means.

13.13 Stud welding. Stud welding (automatically-timed arc or percussive capacitor discharge) is permitted when procedures and equipment are qualified in accordance with section 4. Inspection of production stud welding shall be in accordance with section 6.

13.14 Stress relief and postweld heat treatment. HY-130 material shall not be stress-relieved or postweld heat treated, except as approved. The postweld heat soaking as detailed in 13.9 is not considered a postweld heat treatment.

14. WORKMANSHIP REQUIREMENTS

14.1 Scope. This section details the requirements for workmanship practices and methods associated with HY-130 fabrication within the scope of this standard.

14.2 Weld joint preparation.

14.2.1 Processes. Plate edges shall be prepared for welding by any one or combination of the following methods:

(a) Machining (planing, shearing, etc.)
(b) Oxy-fuel cutting
(c) Arc-air gouging
(d) Chipping
(e) Grinding or burring
(f) Automatic oxy-fuel gouging
(g) Other approved methods

NOTE; Manual oxy-fuel gouging shall not be used.

14.2.2 Weld joint surface preparation. Surfaces to be welded upon and adjacent surfaces for a distance of approximately 1/2 inch from the expected weld area shall be clean, dry, and free of surface matter and defects such as:

(a) Paint
(b) Oil, grease
(c) Moisture
(d) Objectionable scale
(e) Objectionable oxide or rust
(f) Objectionable nicks, gouges, and irregularities
(g) Zinc or galvanizing
(h) Excessive slag

The weld joint surfaces shall be inspected as required by section 6.

14.2.3 Flame or arc-cut surfaces. Flame or arc-cut surfaces not ground or not to be covered by weld deposit shall meet the requirements of NAVSHIPS 0900-LP-999-9000. Such surfaces shall be inspected in accordance with section 6. Flame or arc cut surfaces in pressure hull envelope which will not be covered by weld deposit shall be machined or ground to remove all visible evidence of flame or arc cutting. These surfaces shall be inspected as required by section 6.

14.2.4 Buttering or buildup. Buttering or buildup by welding on the joint surfaces to correct oversize root opening or errors in joint preparation should be done prior to fitting and shall not exceed 3/8 inch thickness on each joint edge or face without approval. Buttering or buildup may be employed for fairing or for other correction over and adjacent to welds. This buttering shall be considered part of the involved weld. The buildup shall be deposited with electrodes as specified in section 10 using methods and procedures in accordance with section 13.

14.3 Weld contour.

14.3.1 General. Welds shall be free of sharp irregularities between beads and shall fair into the base material at the weld edges without undercut or overlap in excess of the requirements of this section. Where possible, mechanical means such as grinding or burring shall be used in lieu of welding to reduce surface irregularity to an acceptable contour. When welding is required to correct improper contouring, it shall be performed in conformance with this standard.

14.3.2 Undercut and overlap. Weld edges which are undercut in excess of the acceptance standards of section 7 shall be repaired by welding or grinding. Weld bead overlap, excessive roughness at weld edge, or weld edges with re-entrant angles in excess of that shown by figure 2 shall be corrected by mechanical means.

14.3.3 Groove tee fillet reinforced welds. Except as allowed by contouring, groove tee weld reinforcement shall be at least equal to the size shown on the applicable drawings and should have a flat to slightly concave reinforcement contour or should be as shown by figure 2. Unacceptable convexity shall be corrected by grinding. Fillet sizes in excess of those required by plan are acceptable providing the contour requirements of figure 2 are met. Fillet reinforcing welds shall be extended around the ends of members to form closed loops where practical.

14.3.4 Butt weld reinforcement. Unless otherwise specified in the detail specifications or on the applicable drawing, butt weld reinforcement shall be in accordance with the requirements of section 7. In the case of butt welds joining plates of unequal thickness, where the plates have not been tapered, the welds shall taper as specified in MIL-STD-22. No point of the finished butt weld surface shall be below a line drawn from the edge of the weld preparation, except that undercut which is not in excess of that permitted by section 7 is acceptable.

14.4 Fillet weld requirements.

14.4.1 General. When the opening between elements of a fillet welded joint exceeds 1/16 inch as a nominal condition along the joint, fillet size shall be increased by an amount equal to the excess of opening above 1/16 inch. Fillet welds shall be extended around the ends of members to form closed loops, where practicable.

14.4.2 Fillet weld tolerances. Fillet welds up to and including 3/8-inch size shall not vary below the specified size by more than 1/16 inch for a total distance greater than 1/4 of the joint length nor more than 6 inches at any one location. Fillet welds 7/16-inch size and larger shall not vary below the specified size by more than 1/32 inch for a total distance greater than 1/4 of the joint length nor more than 6 inches at any one location. Fillet welds in excess of that required by drawing are acceptable providing the contour requirements of this section and figure 2 are met.

in figure 32. (which appears later in this section), except

14.5 Grinding.

14.5.1 Plate surface correction. When employed for plate surface correction, grinding shall produce a smooth depression, blended into the surrounding surface in such a manner as to remove visible evidence of abrupt change on the plate surface. Grinding for this purpose shall not reduce plate thickness beyond the allowances of section 8. Plate surface correction in areas where temporary attachment welds or studs have been removed for the repair of other fabrication damage shall be subject to the repair requirements of section 13.

14.5.2 Surface preparation for nondestructive tests. Weld surfaces shall be prepared for NDT as required by section 15.

14.5.3 Undercut and other weld edge correction.

14.5.3.1 Weld edges. Mechanical means should be employed to establish the relevance of MT indications at weld edges. The area ground for this purpose shall not require repair by welding provided the grinding depth does not exceed the limitations specified in section 7. If the indications are not removed at this depth, the area shall be excavated as necessary and rewelded, if required. Repair welded edges shall meet the requirements of 14.3.2.

14.5.4 Contouring.

14.5.4.1 Applications. Weld contouring be peening and grinding, grinding, burring, or other NAVSEA approved methods, may be done on any weld except fillet welds, but shall be done to the welds listed below (see figures 45 and 46). Final MT inspection shall be performed after contouring. Recontouring is required after weld repair.

(a) Groove tee and corner joint connection of the pressure hull to inserts (i.e., access hatches, sea chests).
(b) All groove tee bulkhead and bulkhead stiffener connections to pressure hull envelope.
(c) Hard tank welds (groove tee and corner joints only, see figure 3).
(d) All groove tee and corner welds in sea chests and trunks which are attached to the pressure hull envelope.
(e) All weld repair areas in groove tee and corner welds in pressure hull structure.

14.6 Arc-strike correction. Arc strikes which penetrate the plate surface shall be ground to the bottom of the depression and magnetic particle tested as required by section 6. The requirements of 14.5.1 apply.

14.7 Snipes.

14.7.1 Temporary snipes. Temporary snipes or access holes shall be provided as necessary in all systems of intersecting welds to allow the deposition of sound weld metal at such intersections. Temporary snipe locations shall be governed by the details of welding sequence, and snipe dimensions shall be the minimum required to allow satisfactory completion of welding in the through joint. Figures 47, 48, and 49 specify minimum dimensions of temporary snipes and access holes for the geometries shown. Bevels shall be provided on temporary snipes or access holes to allow proper closure welding and such welding shall be done in accordance with this document. Figure 49 temporary access holes should be used with welding processes other than SMA.

14.7.2 Permanent snipes. For tanks the snipe shown in figure 34 shall be used for vents, drains, and permanent snipes.

14.8 Weld root cleaning.

14.8.1 Requirements. Unless otherwise permitted by welding procedure approval (e.g., twin arc), the roots of grooved and beveled joints, welded both sides and requiring complete penetration, shall be chipped, ground, or carbon arc-air gouged after sufficient welding has been done on one side and before any welding is started on the opposite side. The

weld root area shall be cleaned to sound metal and contoured in accordance with 14.8.2. Prior to deposition of any weld from the second side, MT inspection shall be conducted in the root areas as required by section 6.

14.8.2 Weld root and repair excavation contour. Gouged roots and weld repair areas shall be contoured either by arc-air gouging or grinding to produce an excavation which is fully visible to the welder and allows access of the electrode or welding gun to all weld surfaces. If arc-air gouging is employed, the gouged area should be cleaned by mechanical means. The gouged or ground area configuration shall have side walls sloping without sharp breaks of "keyholing" from the surface to the bottom; a bottom radius of approximately 1/8 inch minimum and width sufficient to allow proper electrode accessibility and manipulation (see figure 50). Visual inspection of the gouged area by other than the welder is not required.

14.9 Edge laminations. Laminations not acceptable to the requirements of section 7 shall be closed by excavating to a distance of approximately 3/4 inch, or less if the indication is removed prior to reaching 3/4 inch, from the plate edge and filling the excavation with weld metal.

14.10 Mechanical surface indentations. Indentations in pressure hull envelope should be kept to a minimum. Material identification or layout indentations shall be made with low stress die stamps.

14.11 Weld repair of holes.

14.11.1 General. Holes cut, machined or drilled into or through HY-130 base materials may be repaired by welding provided the original hole diameter does not exceed two inches. Holes less than 1/2 inch shall be opened by drilling, burring, or grinding from 1/2 inch to one inch in diameter or preferably shall be elongated as shown in figure 51. All holes shall be shaped to 20 degrees minimum including taper as shown in figure 51. Weld repairs shall be made in accordance with section 13. Holes greater than two inch original diameter shall be repaired by expanding the hole size and inserting a patch as follows:

(a) Pressure hull envelope - 4T or 6 inches, whichever is larger,where T is the thickness of the member penetrated.
(b) Plating or structure other than pressure hull envelope - 4T or 3 inches, whichever is larger, where T is the thickness of the member penetrated.

14.11.2 Partial penetration welds. Hole depth 3/4T or less, where T = material thickness, may be repaired provided the original diameter does not exceed two inches. The holes shall be sizes and prepared as shown in figure 51. The completed weld repair shall be inspected in accordance with section 6.

14.11.3 Full penetration welds. The hole shall be sized and prepared as shown by figure 51. When the hole is not elongated, welding shall be a single vee on a backing plate as shown in figure 51. When the hole is elongated it shall be either a single vee or double vee joint, as shown in figure 51. All welding shall be in accordance with the requirements of section 13. The backing strap or backing bar shall be removed, the weld backgouged or ground to sound metal, magnetic-particle tested, and welded. The completed weld repair shall be inspected in accordance with section 6.

14.12 Mechanical peening of welds. When required by specification or procedure, the method described in this section shall be used for mechanical peening of welds. Peening shall be done in accordance with an approved procedure.

14.12.1 General. If weld bead overlap, excessive roughness, or reentrant bead contour is present, it should be corrected by grinding prior to peening. Movement of metal by the peening tool shall remove any sharp discontinuities between the toe of the weld and the plate surface, and the peened area shall taper gradually into the base material.

14.12.1.1 Peened contour. The finished contour of the groove shall be lightly ground or burred sufficiently to remove indications of peening prior to MT inspection. Radius of the finished contour shall be in accordance with figure 45.

14.12.1.2 Depth of peened contour. Nominal finished depth of indentation below the plate surface formed by peening and followed by a light grinding or burring shall be 1/32 inch or 1/16 inch provided the length does not exceed 12 inches in any 36 inches of peened and ground length. When welds are mechanically peened, the above requirements shall apply in lieu of 14.5.3. The weld face and plate adjacent to the weld shall be peened to obtain the nominal widths of peened surface on both weld toes as shown in figures 45 and 46.

14.12.2 Peening tools. Peening tools shall be ground as required to obtain specified weld toe contours. Suggested peening tool tips are shown in figure 52.

15. NONDESTRUCTIVE TEST METHODS

15.1 Scope. This section details the requirements for performing the following non-destructive tests on HY-130 structures fabricated within the scope of this standard.

(a) Visual inspection (VT)
(b) Magnetic-Particle Inspection (MT)
(c) Liquid Penetrant Inspection (PT)
(d) Radiographic Inspection (RT)
(e) Ultrasonic Inspection (UT)

15.2 General.

15.2.1 Special procedures. Nondestructive test processes, procedures, equipment, and materials other than those specified in this document, may be used provided prior NAVSEC approval is obtained.

15.3 Visual inspection.

15.3.1 General. Inspectors accomplishing VT shall be familiar with the inspection requirements and inspection acceptance standards of this standard.

15.3.2 Equipment. VT shall be accomplished without the use of magnifying glasses and other vision aids, except for corrective eye glasses required to restore normal vision, e.g. 20/20.

15.3.3 Surface preparation.

15.3.3.1 Welds. VT of welds may be done in the aswelded condition after slag removal except where weld contouring is required by this standard or the applicable drawing or detail specification. In this case welds shall be inspected in the ground condition.

15.3.3.2 Base material. VT of base material shall be accomplished with the surfaces to be inspected in a clean condition (free of scale). Surfaces which have been cleaned and primed as specified in the applicable base material specification are considered suitable for inspection except where this is prohibited by this document or the applicable drawing or detail specification.

15.4 Magnetic-particle inspection.

15.4.1 General. MT procedures and techniques shall be as specified in MIL-STD-271 and as specified herein. Inspection shall be by the dry powder d.c. prod method or a.c. Yoke method as required by section 6.

15.4.2 Equipment.

15.4.2.1 Circular magnetization equipment (d.c. prod). Equipment for circular magnetism shall involve the use of low voltage, high-amperage current, passed into the item being tested by the use of prods.

15.4.2.2 Equipment calibration.

15.4.2.2.1 d.c. prod equipment. The d.c. ammeters used to determine compliance with the amperage requirements of this section shall be checked for accuracy at least every three months. For d.c. prod equipment, a d.c. ammeter (moving coil or D'Arsonval type) shall be connected in series with suitable shunts and the current through the electrodes (prods) measured. The amperage measured by the d.c. ammeter during the test shall simultaneously be compared to that indicated on the meter of the MT unit: for full wave d.c. rectification units, the equipment meter shall agree within five percent of the current measured by the calibration meter. For single phase, half-wave d.c. units, the d.c. ammeter (moving coil or D'Arsonval type) will read approximately one-half the value of the rectified d.c. magnetizing current.

15.4.3 Technique.

15.4.3.1 Continuous technique. MT shall be carried out by the continuous technique; that is, the magnetizing current shall remain on during the period the magnetic particles are being applied, and also while excess particles are being removed.

15.4.4 Surface preparation.

14.4.4.1 Welds. Unless specifically approved by NAVSEA or its authorized representative, acceptance inspection of all welds shall be performed on the welds in the final surface condition (e.g., contour ground where required by this document or the applicable drawing). Inspection of root, or intermediate weld layers, may be performed in the as-welded condition without removal of preheat. Surfaces to be examined shall be dry and free from any contamination which might interfere with the proper formation or interpretation of the MT indications. Irregularities on the weld surface and undercut and overlap at the weld edges which would interfere with the evaluation shall be removed. If powder build-ups occur, the area shall be ground, or machined, and retested.

15.4.4.2 Base material. Surfaces shall be free of contamination which might interfere with the proper formation or interpretation of the MT indications. Where required, grinding, machining, or other mechanical methods shall be employed to remove surface irregularities which interfere with interpretation.

15.4.5 Non-relevant MT indications. On all welds involving HY-130 material, PT in lieu of MT inspection is permitted when interpretation of MT indications is being impeded by false indications. PT shall be in accordance with 15.5 to the acceptance standards of 7.5.1.

15.5 Liquid penetrant inspection. PT procedure and technique shall be as specified in MIL-STD-271 except as follows: Inspection materials shall be of the following groups, in accordance with MIL-I-25135:

Group I - Solvent removable visible dye-penetrant, a penetrant remover (solvent), and a dry, or nonaqueous wet developer.
Groups II, V - These groups may be used for welds when specifically approved by NAVSEA.

15.6 Radiographic inspection. RT equipment and technique requirements shall be as specified in MIL-STD-271 and as specified herein. The penetrameter shall be based on the actual thickness being radiographed. Penetrameters may be placed on the weld provided they are out of the area of interest. When penetrameters are placed on the weld, shims are not required.

15.6.1 Surface preparation. Grinding of welds for RT is not required. Areas of welds such as at the tie-in of intersecting welds or block tacks which contain surface irregularities that interfere with radiographic interpretation shall be blended to the degree required such that the resulting radiographic contrast due to surface irregularities cannot mask or be confused with the image of a rejectable defect.

15.7 Ultrasonic inspection.

15.7.1 Inspection of welds. Ultrasonic test methods and techniques for inspection of welds shall be in accordance with NAVSHIPS 0900-LP-006-3010.

15.7.1.1 Surface preparation. Surface preparation of welds shall be as specified in the qualified ultrasonic testing procedure.

15.7.2 Inspection of base materials for thickness and soundness. Ultrasonic test methods and techniques for inspection of base material shall be in accordance with the applicable base material specification.

Preparing activity:
Navy - SH
(Project MISC-N995)

TABLE I - Preheat/interpass temperatures.

Preheat/interpass temperature as a function of thickness for the GMAW processes		
Preheat/interpass temperature °F		
Thickness	Minimum	Maximum
Greater than 5/8 inch 5/8 inch and less	150 150	300 200
Preheat/interpass temperature as a function of thickness for the SMAW process		
Preheat/interpass temperature °F		
Thickness	Minimum	Maximum
Greater than 5/8 5/8 inch and less	200 150	300 200

TABLE II - Magnetic particle inspection.

Inspection category	Degree of inspection	Sequence of inspection	Method	Applicable notes
(a) Full penetration welds in or to pressure hull envelope such as (1) Butt and seam welds in pressure hull envelope. (2) Full penetration corner and groove tee welds in or to hard tank plating. (3) Inserts and penetrations in pressure hull envelope and hard tank plating. (Welds involving through penetration of pressure hull envelope) (4) Full penetration groove tee attachments of internal and external frames, bulkheads and structure to pressure hull envelope. (5) Full penetration groove tee attachments of holding bulkheads and holding bulkhead stiffeners to pressure hull envelope. (6) Full penetration corner and groove tee weld attachments of foundations to pressure hull envelope. (7) Full penetration attachment welds to pressure hull envelope in free flooding areas.	100 percent	Final inspection shall be made 7 or more days after completion of the weld and the assembly has cooled to ambient temperature, except in the case of tank welds in hard tanks. Inspection sequence for hard tank shall be in accordance with table IV.	a.d. Prod	1, 2, 3, 4, 5,6
(b) Supporting structure and intermediate pressure tank welds such as (1) Butt welds in pressure hull frames, and hard tank stiffeners and floors, all or part of which act as frames. (2) Corner, butt, and groove tee welds in or to plating of intermediate pressure tanks.	100 percent	Final inspection shall be made 24 hours or more after the weld is completed and the assembly has cooled to ambient temperature	d.c. Prod	1, 3, 5, 6
(c) Butt and groove tee welds in or to holding bulkheads and welds in or to pressure hulls structure (not covered in categories A, B, and D or table III) such as: (1) Welds joining frame webs to standing flanges of internal and external frames. (2) Full or partial penetration welds (except fillet welds) joining structure to standing flanges or webs of internal and external frames. (3) Fillet welds to pressure hull envelope.	100 percent	Final inspection shall be made 24 hours or more after the weld is completed and the assembly has cooled to ambient temperature.	d.c. prod or yoke	1, 3, 5, 6

TABLE II - Magnetic particle inspection (con.)

Inspection category	Degree of inspection	Sequence of inspection	Method	Applicable notes
(d) Miscellaneous welds such as (1) Corner, butt, and groove tee welds in or to plating of structural tanks other than hard or intermediate pressure. (2) Outside surfaces of welds in or to completed rudders and planes.	100 percent	Final inspection shall be made 24 hours or more after the weld is completed and the assembly has cooled to ambient temperature.	d.c. prod or yoke	3, 5, 6

NOTES:

1. If weld repairs are necessary, the excavation shall be MT inspected and the repaired area shall be reinspected after completion of the repair operation. MT inspection shall be performed by the d.c. prod method a minimum of 6 inch beyond the repair area on both faces of the affected weld after grinding has been completed to the extent required by section 14, and after the time delay specified above. Application of this requirement, as applied to repair welding, if further explained in section 13.
2. All full penetration welds made within six inches of previously inspected full penetration welds in or to pressure hull envelope lying in the same plane as the new weld, shall require all full penetration welds to be reinspected a distance of 6 inches in all directions from the boundary of the new weld. Web to standing flange tee joints on frames are exempt from the reinspection requirement unless involved in the new welding. Welds which are shown to have been previously contour ground and inspected by MT will not require this reinspection. Application of this requirement, as applied to repair welding, is further explained in section 13.
3. Final inspection shall be performed after all machining or grinding has been completed.
4. Seven day time delay is not applicable to hard tank structure which is subject to the requirements of table IV.
5. Records of inspection shall be maintained as required in section 5. MT inspection records are required for completed welds only.
6. See 15.4.5 for resolution on non-relevant MT indications.

TABLE III - Magnetic particle inspection applicable to welds and surfaces of HY-130 material.

Inspection category	Degree of inspection	Sequence of inspection	Method	Applicable notes
(1) Fillet and other partial penetration welded attachments to structure of plating other than pressure hull envelope.	100 percent	Final inspection shall be made 24 hours or more after the weld has cooled to ambient temperature.	d.c. prod or yoke	1, 3, 5
(2) Any full penetration welds in or to structure or plating other than those welds coverd in table II.	100 percent	Final inspection shall be made 24 hours or more after the weld has cooled to ambient temperature.	d.c. prod or yoke	1, 3, 5

TABLE III - Magnetic particle inspection applicable to welds and surfaces of HY-130 material (con.).

Inspection category	Degree of inspection	Sequence of inspection	Method	Applicable notes
(3) Welded plate repairs including mill defects or fabrication scars (mill defects requiring repair must be noted on receipt inspection record).	100 percent	Final inspection shall be made 24 hours or more after the weld has cooled to ambient temperature.	d.c. prod or yoke	1, 2, 3, 5
(4) Areas where temporary or deleted attachments are removed.	100 percent	Inspection to be made after removal of temporary structure and after grinding to the requirements of section 14.	d.c. prod or yoke	1, 3, 4, 5
(5) Areas where automatically timed arc-welded studs 1/4 inch diameter and larger have been removed (see 14.6).	100 percent	Inspection shall be made after visible evidence of studs or arc strikes has been removed by grinding.	d.c. prod or yoke	1, 3, 4, 5
(6) Root area of butt, corner, and tee-groove welds after backgouging and weld repairs after excavation.	100 percent	Inspection shall be made after removal of any slag, scale, or surface roughness which would interfere with interpretation of	d.c. prod or yoke	2, 3, 5
(7) Weld tacks to be incorporated in full penetration welds.	100 percent	indications. Inspection shall be made after final surface preparation.	d.c. prod or yoke	2, 3, 5
(8) That portion of the prepared surfaces of all inserts (including transition and insert rings) and penetrations in the pressure hull envelope which are prepared by flame or arc cutting processes, or by machining or grinding, and which will not be subsequently covered by welding.	100 percent	Final inspection shall be performed after machining or grinding as required by section 14.	d.c. prod or yoke	1, 2, 3
(9) The surfaces of cold formed materials as required by section 9 (see 6.4.6).	100 percent	Inspection shall be made after forming and subsequent heat treatment and surface cleaning.	d.c. prod or yoke	1, 2, 3

See notes on next page.

NOTES:

1. If weld repairs are necessary, the repaired area shall be reinspected after grinding, when specified, and after the specified time delay for the original weld.
2. Laminar indications in the base materials shall be evaluated in accordance with section 7. Repair shall be in accordance with sections, 8, 13, and 14.
3. Accountability of the MT covered by this table is not required. A log of accomplishment of the inspections grouped by category item, hull area, or location should be maintained. Auditing of accomplishment is required and shall be conducted in accordance with an approved procedure.
4. Inspection is not required for areas where percussive (capacitor discharge) stud or resistance spot welds 1/4 inch or less stud or spot diameter, and automatically timed studs less than 1/4 inch, have been removed.
5. See 15.4.5 for resolution of non-relevant MT indications.

TABLE IV - Hard tanks: sequence of inspection 1/ 2/ 3/.

(1)	MT inspect 100 percent of all tank welds (see figure 3) after contouring in accordance with section 14 and before hydrostatic test.
(2)	Repair weld and contour repaired areas as required by section 14.
(3)	Hydrostatic test.
(4)	MT inspect all tank welds. 4/ If no cracks are found the tank is acceptable.
(5)	If cracks are found, repair in accordance with section 14 and MT inspect all repaired areas plus 6 inches at each end (or to the end of the involved member if less than 6 inches) after 24 hour delay. Continue to repair and inspect the repaired areas until no cracks are found.
(6)	Hydrostatic test.
(7)	MT inspect all tank welds 4/: If no cracks are found the tank is acceptable. If cracks are found, treat as in (8), (9), or (10) below until acceptable MT inspection is obtained after hydrostatic test.
(8)	If transverse cracks are found, repair, re-hydro, and MT inspect all tank welds. 4/ Repair shall be accomplished as follows: Excavate by arc-gouging or grinding the cracked area plus 6 inches each side of this area along the weld, or to the end of the involved member is less than 6 inches. MT the excavation plus 6 inches of weld on each end. If further cracking is found in the inspected length, continue to excavate and extend until no further cracking is found for 6 inches beyond the final excavated area. Reweld and MT all repaired areas plus 6 inches on each end of each repaired area and the same length of the weld on the side opposite the repaired area. If cracking persists, continue to excavate, repair, and inspect as outlined above until acceptable MT is obtained after hydrostatic test. 5/
(9)	If longitudinal cracks are found, repair, re-hydro, and MT 100 percent of the weld involved in the cracked member only. The cracked member includes all of the weld in a joint uninterrupted by intersecting structure. A structural intersection or change in plane of the involved member of 90 degrees or more constitutes termination of the involved member.
(10)	If corner cracks (see 3.13 and figure 1) are found in corners and snipes, repair as outlined in sections 13 and 14, re-hydro and MT inspect repaired area plus 6 inches from the ends of the repair in each direction.

1/ See 6.4.8 for reinspection requirements when accepted hard tank is penetrated by a new full penetration weld.

2/ Records of inspection shall be maintained as required by section 5.

3/ For hull surveillance inspection, the inspection sequence for the required welds shall be in accordance with (4) thru (10) above.

Footnotes continued on next page.

4/ MT inspection of the outer surface (non-pressure side) of full penetration tank boundary tee and butt welds is not required after hydrostatic test.

5/ When transverse cracking is found in a full penetration tank boundary tee or butt weld, the outer surface of which is exempted from MT inspection after hydro, the exemption of 1/ shall not apply to that portion of the outer surface to be inspected by (8) above.

TABLE V - Radiographic inspection, applicable requirements to welds in or to HY-130 steel.

Inspection category	Degree of inspection	Sequence of inspection	Applicable notes
(1) Butt seam welds in the pressure hull envelope.	100 percent	At least 8 hours shall have lapsed after the completion of welding and removal of preheat before RT is made.	1, 2, 3, 4, 5
(2) Butt welds in holding bulkheads.	100 percent		1, 2, 3, 4, 5
(3) Butt welds in structural intermediate pressure tank plating.	100 percent		1, 2, 3, 4, 5
(4) Butt welds in flanges of pressure hull frames.	100 percent		1, 2, 3, 4, 5
(5) Butt welds in unflanged frames to the extent shown in figure 23.	100 percent	At least 8 hours shall have lapsed after the completion of welding and removal of preheat before RT is made.	1, 2, 3, 4, 5
(6) Butt welds joining standing flanges to unflanged frames. Shall be inspected by UT in lieu of RT. (See figure 23).	100 percent	At least 8 hours shall have lapsed after the completion of welding and removal of preheat before RT is made.	1, 2, 3, 4, 5
(7) Other full penetration welds in the pressure hull envelope such as inserts, liners, coamings, trunks, and penetrations more than 4 inches dia. (wherein the projection of one part beyond the other does not exceed the limits of figure 24.)	100 percent	At least 8 hours shall have lapsed after the completion of welding and removal of preheat before RT is made.	1, 2, 3, 4, 5
(8) Weld repair of holes in the pressure hull envelope (as specified in 14.11).	100 percent	At least 8 hours shall have lapsed after the completion of welding and removal of preheat before RT is made.	2, 3, 4, 5, 6
(9) Full penetration butt welds which have been hot formed as specified in 9.2.5.	100 percent	At least 8 hours shall have lapsed after the completion of welding and removal of preheat before RT is made.	1, 2, 4, 5
(10) Frame web butt welds which form a part of acess and closure assemblies (see figure 25.).	(see sequence Note)	NOTE: These welds shall be inspected for that portion of their length which is bounded by the web toes of the frame flange and pressure hull plating attachment welds.	2, 3, 4, 5, 6
(11) the web of the frame sections which are inserted into completed structure (see figures 26 and 27 for examples of where RT/UT is and is not required).			2, 3, 4, 5, 6

See notes on next page.

NOTES:

(1) (a) When repair welding is required as a result of RT/UT inspection the repaired area shall be reinspected by RT/UT for the length of the repair plus 3 inches on each end of the repair.
(b) When repair welding is required on RT/UT accepted welding, the area repaired shall is reinspected by RT/UT for a distance equal to the repair length plus 3 inches on each end except when the depth of the repair does not exceed 1/8 inch for a maximum of 18 inches in length; in which case MT of the repair plus 6 inches on each end and the corresponding area on the opposite side of the weld will suffice. This MT shall be made 7 or more days after the repair welding is completed.

(2) The surfaces of the weld shall be ground as required in section 15 for RT.

(3) When additional weld is deposited on the surface of RT or UT accepted welding, reinspection by RT/UT of the previously accepted welding is not required provided the additional weld deposit does not exceed two (2) layers in thickness nor 18 inches in length.

(4) Records of inspection shall be maintained as required by section 5.

(5) (a) UT may be substituted for RT as specified in 6.7.4. The same inspection method shall be used for acceptance of repairs as was used for original inspection, e.g., RT or UT, except the 3 inches expansion area adjacent to a repair may be accomplished with the same inspection method as was used to inspect the repaired area.
(b) When metal is removed from the surfaces of previously RT/UT accepted welds, reinspection by RT/UT is not required provided the weld meets all other specified inspections.

(6) MT may be substituted for RT/UT inspection of repair welds when depth of the repair does not exceed 1/8 inch for maximum of 18 inches in length. Such MT shall include the repair area plus 6 inches on each end and the corresponding area on the opposite side of the weld. This MT shall be made 7 or more days after the repair welding is completed.

TABLE VI - Samples for mechanical property testing.

Level I	Each lot of material submitted by a single vendor shall be sampled. Upon obtaining five consecutive acceptable lots, sampling shall be made at level II.
Level II	One lot selected at random from each five lots submitted by a vendor shall be sampled. Upon obtaining ten consecutive acceptable lots, sampling shall be made at level III.
Level III	One lot selected at random from each ten lots submitted by a vendor shall be sampled. Upon obtaining 15 consecutive acceptable lots, sampling shall be made at level IV.
Level IV	One lot selected at random from each 20 lots submitted by a vendor shall be sampled.

Note. If an unacceptable lot is obtained at level II, III, or IV, sampling level shall revert to the next lower (more restrictive) level until satisfactory performance is demonstrated by conformance with the requirements at that level.

TABLE VII - Filler materials - HY-130 to HY-130.

Filler material		Process	Position of welding	Application
Type	Specification			
MIL-140S-1 1/ MIL-140S-2 2/ MIL-140S-3	MIL-E-24355	Semi-automatic or automatic gas metal-arc, spray transfer arc	Flat or horizontal	All
		Semi-automatic or automatic gas metal-arc, pulsed spray arc	All	
MIL-14018M-1 1/ MIL-14018-2 2/ MIL-14018M-3	MIL-E-22200/9	Shielded metal-arc	All 3/	4/
MIL-120S-1 MIL-100S-1	MIL-E-23765/2	Gas metal-arc spray transfer arc, semi-automatic or automatic	Flat or Horizontal	All fillet welded joints between HY-130 and HY-130
		Gas metal-arc pulsed spray arc semi-automatic or automatic	All	
MIL-12018	MIL-E-22200/10	Shielded metal-arc	All 5/	
MIL-11018 MIL-9018	MIL-E-22200/1			

1/ For welding HY-130 3/4 inch and greater in thickness only; may be used for thinner material, where approved, where the reduced tensile yield satisfies design requirements.

2/ For welding HY-130 1/2 inch to but not including 3/4 inch in thickness only

3/ 1/8-inch diameter electrode only.

4/ See section 13 for limitations.

5/ Position of welding is limited to flat, and horizontal fillets, for electrode diameters over 5/32 inch.

TABLE VIII - Filler materials HY-130 to other ferritic steels.

Filler material		Process	Position of Welding	Application
Type	Specification			
MIL-120S	MIL-E-23765/2	Gas metal-arc pulsed spray-arc semi-automatic or automatic	All	All welded joints between HY-130 and other ferritic materials such as HY-80/100, HTS or carbon-steel (0.30 C max)
MIL-100S-1	MIL-E-23765/2	Gas metal-arc pulsed spray-arc semi-automatic or automatic	All	All welded joints between HY-130 other ferritic materials such as HY-80, HTS or carbon-steel (0.30 C max)
MIL-B88	MIL-E-19822	Gas metal-arc Spray transfer arc semi-automatic or automatic	Flat or Horizontal	
MIL-70S	MIL-E-23765/1	Gas metal-arc pulsed spray-arc semi-automatic or automatic	All	All welded joints between HY-130 and other ferritic materials, except HY-80, such as HTS or carbon-steel (0.30 C max)
MIL-12018	MIL-E-22200/10	Shielded metal-arc	All 1/	All welded joints between HY-130 and other ferritic materials such as HY-80/100, HTS or carbon-steel (0.30 C max)
MIL-11018	MIL-E-22200/1	Shielded metal-arc	All 1/	All welded joints between HY-130 and other ferritic materials such as HY-80, HTS or carbon-steel (0.30 C max)
MIL-9018	MIL-E-22200/1	Shielded metal-arc	All 1/	All welded joints between HY-130 and HTS or carbon steel (0.30 C max)

1/ Position of welding is limited to flat, and horizontal fillets, for electrode diameters over 5/32 inch.

TABLE IX - Filler materials - HY-130 to non-ferrous and austenitic stainless steel materials.

Filler material		Process	Position of welding	Application
Type	Specification			
MIL-309-15/16 MIL-310-15/16	MIL-E-22200/2	Shielded metal-arc	All 1/	All welded joints between HY-130 and stainless-steel; and for cladding
MIL-309 MIL-310	MIL-E-19933	Semi-automatic or automatic gas metal-arc, spray transfer arc	Flat or horizontal	
MIL-309 MIL-310	MIL-E-19933	Semi-automatic or automatic gas metal-arc, pulsed spray arc or manual or automatic gas tungsten-arc	All	
MIL-4N11 MIL-9N10 MIL-8N12 2/	MIL-E-22200/3	Shielded metal-arc	All 1/	All welded joints between HY-130 and nickel-copper or copper-nickel materials; and for cladding
MIL-EN60 MIL-EN61 MIL-EN62 MIL-EN82 3/	MIL-E-21562	Semi-automatic or automatic gas metal-arc, spray transfer arc	Flat or horizontal	
		Semi-automatic or automatic gas metal-arc, pulsed spray-arc	All	
MIL-RN60 MIL-RN61 MIL-RN62 MIL-RN82 3/	MIL-E-21562	Manual or automatic gas tungsten arc	All	

1/ Position of welding is limited to flat, and horizontal fillets for electrode diameters over 5/32-inch.

2/ Type MIL-8N12 may also be used for joining austenitic stainless steel materials to HY-130.

3/ Type MIL-EN82 or MIL-RN82 may also be used for joining austentic stainless steel materials to HY-130.

TABLE X - Pressure hull structure weld joint efficiencies.

Column 1	Column 2	Column 3	Column 4	Column 5
Item	Connection	Min. req. joint Eff. percent	Design Group	Notes
Bulkheads, structural (Transverse and Longitudinal)	(1) Butt welds	100	I	
	(2) Periphery to pressure Envelope	100	II	
	(3) Primary stiffeners			
	(a) End joint connections	100	II-III	1
	(b) Web to face plate and to bulkhead	75	II-III-IV	
	(4) Secondary stiffeners and panel stiffeners			
	(a) End connections	100	II-III	1
	(b) Web to face plate and to bulkhead			
	(1) For 1/8 length from ends	75	II-III-IV	
	(2) Remainder	50	III-IV	
Bulkheads, non-structural	(1) Butt welds	90	I	
	(2) Plating periphery	75	III-IV	
	(3) Stiffeners			
	(a) End connections	90	II-III	
	(b) Web to plating or flange	75	III-IV	
Decks and platforms	(1) Butt welds	90		
	(2) Periphery to other structure	75	II-III-IV	
	(3) Stiffeners			
	(a) End connections	90	II-III	
	(b) Web to deck or flange	75	II-III-IV	
Floors	(1) To Pressure hull envelope	100	II	
	(2) Butt welds	100	I	
	(3) To structure other than pressure hull envelope	75	II-III	
Foundations	(1) Main connection of primary member	100	I-II-III-IV	
	(2) Connections to pressure hull envelope and frames	100	I-II-III-IV	1
	(3) Tilting brackets	50	II-III	

TABLE X - Pressure hull structure weld joint efficiencies (con.).

Column 1	Column 2	Column 3	Column 4	Column 5
Item	Connection	Min. req. joint Eff. percent	Design group	Notes
Framing, pressure hull	(1) Butt welds	100	I	2
	(2) Web to flange	100	II-III	3
	(3) To pressure hull envelope	100	II	
	(4) Ends of frame web and flange to tank top	100	I-II	
	(5) Where frame is interrupted (a) Web and flange to interruption	100	I-II	
Non-pressure hull envelope	(1) Butt welds	100	I	4
	(2) Intersection or pressure hull envelope to non-pressure hull	90	I-II	
Masts	(1) All joints and attachments	100	I-II-III	
Penetrations in pressure hull envelope	(1) Compensating	100	II-III-IV	3
	(2) Non-compensating	100	II-III-IV	
Penetrations in supporting structure, bulkheads, decks and floors, structural tanks other than hard tanks	(1) Water-tight or oil-tight	75	II-III-IV	
	(2) Non-tight	50	II-III-IV	
Pressure hull envelope	(1) Butt welds	100	I	
Stanchions	(1) Butt welds	100	I	4
	(2) Head and heel connections	100	II-III-IV	
Structural tanks other than hard or intermediate pressure tanks	(1) Butt welds	90	I-III	
	(2) Periphery	100	II-IV	
	(3) Stiffeners (a) End connections	90	II-III	
	(b) Web to flange and tank tops	75	II-III-IV	

TABLE X - Pressure hull structure weld joint efficiencies (con.).

Column 1	Column 2	Column 3	Column 4	Column 5
Item	Connection	Min. req. joint Eff. percent	Design group	Notes
Superstructure and fair-water	(1) Butt welds	100	I	4
	(2) Plating to pressure hull envelope	100	II-III	4
	(3) Frames and panel stiffeners (a) End connections (b) Web to plating or flange	100 75	II-III II-III-IV	4
Hard tanks and intermediate pressure tanks	(1) Butt welds	100	I	
	(2) Periphery	100	II	5
	(3) Stiffeners (a) End connections (b) Web to face plate (c) Web to tank plating when stiffener is not on pressure side (d) Web to tank plating when stiffener is on pressure side	100 75 75 100	II II-III-IV II-III II	
	(4) Tank plating to frame transition blocks	100	I-II	
Tilting brackets	(1) All	50	II-III	
Vertical keel	(1) Butt welds	100	I	
	(2) To pressure hull envelope	100	II	
	(3) To structure other than pressure hull envelope	75	II-III	

NOTES:
(1) Design group III shall not be used for connection to pressure hull envelope except for tubing and round bar connection (see PT-1S.1).
(2) Backing bar may be used to facilitate welding from one side, but must be removed upon completion of welding.
(3) Only joint PT-2V.1 and PT-2J.1 of design group III may be used.
(4) Joint efficiency of 90 percent is acceptable when a backing bar is required due to inaccessibility.
(5) Design group IV may be used for intermediate pressure tanks.

TABLE XI - Pressure hull frame tolerances.

Depth of frame (inches)	Frame depth A (inches)	Web tilt max (degrees)	Flange tilt max (degrees)	Flange width B (inches)	Flange unbalance C-D (inches)
Up to 9	+ 3/16 - 1/8	+2 -2	+2 -2	+ 1/8 - 1/8	+ 3/16 - 3/16
9 to 12	+ 3/16 - 1/8	+2 -2	+2 -2	+ 1/8 - 1/8	+ 3/16 - 3/16
12 to 15	+ 1/4 - 1/8	±2 But 7/16 max	-2 -2	+ 1/8 - 1/8	+ 3/16 - 3/16
15 to 24	+ 5/16 - 1/8	7/16 max	±2 But 17/32 max	+ 1/8 - 1/8	+ 3/16 - 3/16
Over 24	+ 3/8 - 1/8	7/16 max	17/32 max	+ 1/8 - 1/8	+ 3/16 - 3/16

Note: Overdepth (A) and overwidth (B) tolerances may be exceeded provided overweight does not exceed 3 percent of the weight of the specified cross-section.

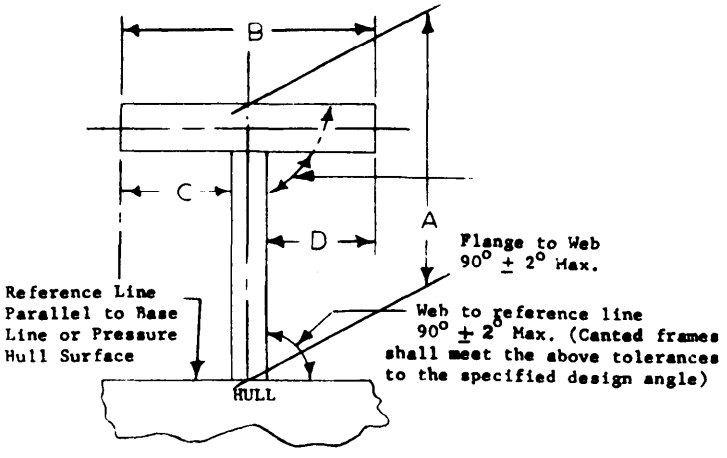


TABLE XII - Plate alignment tolerance.

Plate thickness (inches)	Maximum allowable misalignment (inches)
less than 3/8	1/32
3/8 to 5/8	1/16
over 5/8	1/8

TABLE XIII - Arc-air gouging preheat temperatures.

Thickness (inches)	Minimum preheat temperature °F	Maximum preheat temperature °F
Greater than 1-1/8	150	300
1-1/8 and less	60	300

TABLE XIV - Heat input limitations (Kj/in).

Material thickness range[1] (inches)	Weld process	
	Shielded metal arc Gas metal arc (pulsed and spray transfer)	
	Heat input[2]	
	Minimum	Maximum
Greater than 1-1/4	30	50
3/4 to and including 1-1/4	30	40
1/2 to but less than 3/4	30	40
Unequal thickness[3]	30	45

[1] Weld energy input for fillet welded attachments may be determined using the thickness of crossing members, i.e., intersected member.

[2] Weld energy input may be changed from that shown above, provided approval is obtained based on weld testing which shows conformance to the applicable electrode specification. Heat inputs below the specified minimums shall require dynamic tear testing; heat inputs above the specified maximum shall require testing for tensile yield.

[3] Applies only when one joint member exceed 1-1/4 inch in thickness.

Table XV - Weld energy input for austenitic stainless-steel or non-ferrous welding of HY-130.

Thickness (inch)	Weld Energy Input (Kj/in)
Less than 1/2	45
1/2 and greater	55

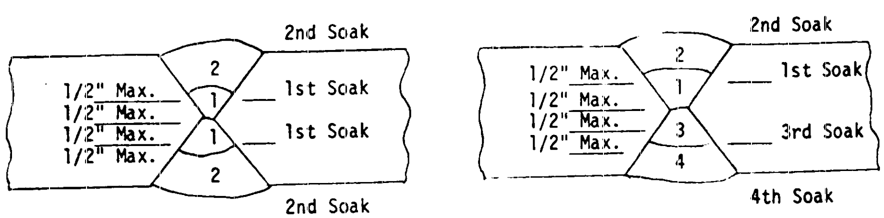
TABLE XVI - MIL-14018 weld metal hydrogen removal requirements.

Category	Weld thickness (see 13.9.1) (in)	Repair depth (in)	Minimum excavation soak		Minimum intra-weld[2/][3/] soak (see figures below)		Minimum post weld soak[2/]	
			Temp (°F)	Time (hr.)	Temp (°F)	Time (hr.)	Temp (°F)	Time (hr.)
Original welds	1/2 and less	NA[1/]	NA	NA	NA	NA	250	4
	Greater than 1/2	NA	NA	NA	250	10	350	12
Weld repairs for cracks only	1/2 and less	All	250	4	NA	NA	250	4
	Greater than 1/2	1/2 & less	250	4	NA	NA	350	8
		Greater than 1/2	350	6	250	10	350	12
Weld repairs for other than cracks	All	1/2 & less	None	None	NA	NA	250	4
		Greater than 1/2	None	None	250	10	350	12
Interruption of preheat (see 13.7.6.3)	1/2 and less	NA	NA	NA	NA	NA	250	4
	Greater than 1/2	NA	NA	NA	NA	NA	350	12

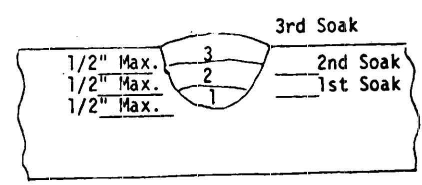
[1/] NA - Not applicable.

[2/] If intra-weld soak is performed, a postweld soak is not required. If any of the intra-weld soaks are not performed a postweld soak is mandatory.

[3/] When intra-weld soaking is employed, a soaking treatment shall be performed on each 1/2 inch or less of weld deposited on any one side of the joint.



Acceptable Intra-Weld Soak
Sequence for Original Weld



Acceptable Intra-Weld Soak
Sequence for Repair Weld

THIS DOCUMENT IS SUBJECT TO SPECIAL EXPORT CONTROLS AND EACH TRANSMITTAL TO FOREIGN GOVERNMENTS OR FOREIGN NATIONALS MAY BE MADE ONLY WITH PRIOR APPROVAL OF THE COMMANDER, NAVAL SHIP ENGINEERING CENTER, CODE 6120D

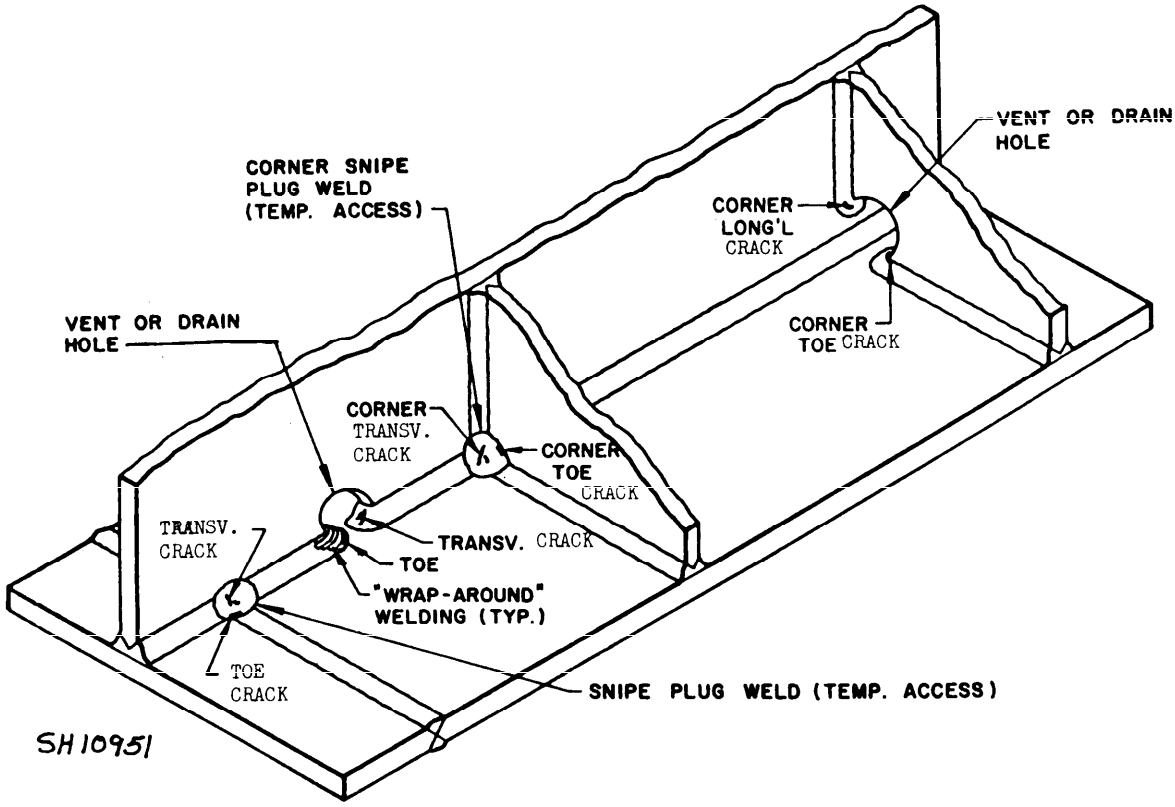
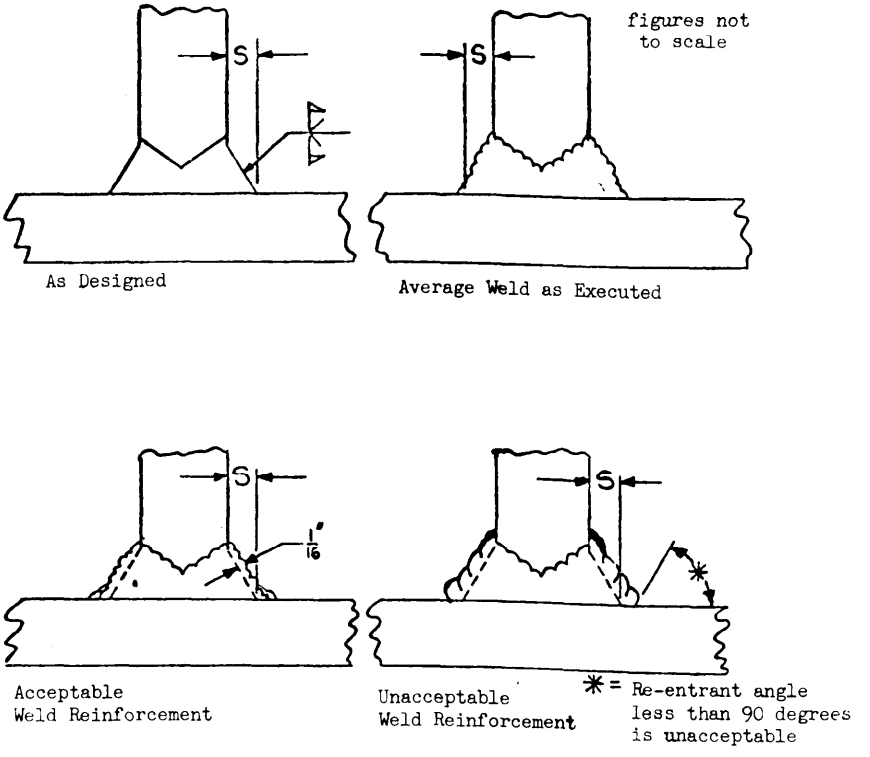


Figure 1 - Corner cracks.



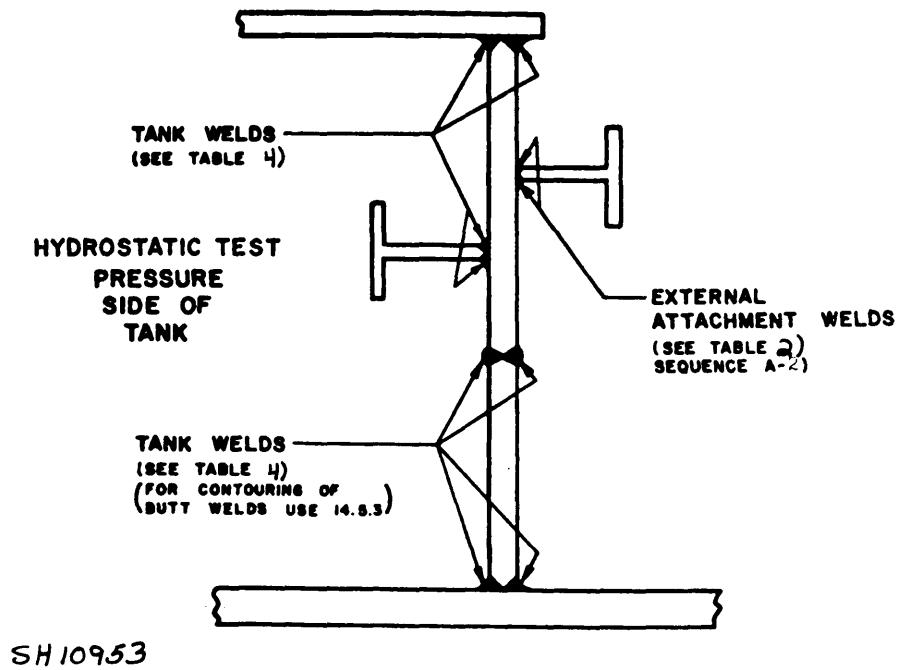
1. Fillet reinforcement size in excess of that required by plan is acceptable provided the contour is in accordance with these figures and convexity is 1/16 inch maximum.

2. Although the fillet contour shown in this figure is for groove tee welds, the same requirements apply for fillet welds.

NOTE: S = required fillet reinforcement.

SH10952

Figure 2 - Recommended reinforcement contour for fillet groove welds for submarine construction.



NOTE: Normally, the hydro test pressure side of the tank and the operational pressure side of the tank are the same. When exceptions exist, welds in or to both sides of the tank plating shall be considered tanks welds.

Figure 3 - Tank welds.

CERTIFICATION OF ELECTRODE CONFORMANCE TEST ACCOMPLISHED

SPECIFICATION		MANUFACTURE		NUMBER
TYPE	DIAMETER	HEAT	LOT	BATCH
WELDER'S NAME & N°		WELDING MACHINE MAKE & N°		DATE

VISUAL INSPECTION OF CONTAINER PRIOR TO WELDING

LBS/CONTAINER: TYPE OF CONTAINER: ☐ CARDBOARD TUBE ☐ METAL CAN ☐ CARDBOARD BOX

CONDITION OF CONTAINER: ☐ ENDS BULGED ☐ TORN ☐ CORNERS BENT ☐ SATISFACTORY

LEAK TEST (METAL CANS, COVERED ELECTRODE ONLY) ☐ LEAKS ☐ SATISFACTORY

VISUAL INSPECTION OF CONDITIONS OF COATING

COLOR CODE IDENT: ☐ SAT ☐ UNSAT PRINTED IDENT ☐ SAT ☐ UNSAT

☐ SATISFACTORY	☐ CRACKS	☐ CONCENTRICITY VARIATION %
☐ CHIPPED ENDS	☐ POCKMARKS	
☐ BOND TO ROD CORE	☐ ENDS COVERED WITH FLUX	N° OF DEFECTIVE ELECTRODE

VISUAL INSPECTION OF CONDITIONS OF BARE STEEL ELECTRODE

☐ CLEAN	☐ SMOOTH	☐ BRIGHT FINISH

FREE OF: KINKS ☐ BENDS ☐ BREAKS ☐ NICKS ☐ SEAMS ☐ LAPS ☐ BURRS ☐ OTHER OBJECTABLE DEFECTS ☐

IDENTIFICATION OF BARE ELECTRODE: ☐ SAT ☐ UNSAT

ELECTRODE LENGTH (INCHES): LAYER AND LEVEL WOUND SAT UNSAT

TEST ACCOMPLISHED

MANUFACTURE

YIELD STRENGTH ☐ SAT ☐ UNSAT
ULTIMATE TENSILE ☐ SAT ☐ UNSAT
ELONGATION ☐ SAT ☐ UNSAT
REDUCTION IN AREA ☐ SAT ☐ UNSAT

D.T. Test (Ft. lbs.)	+30° F
1	
2	

AVERAGE ☐ SAT ☐ UNSAT
R.T. ☐ SAT ☐ UNSAT UNSAT POSITION: F-H-V-O
BENDS: ☐ SAT ☐ UNSAT UNSAT POSITION:
CHEMICAL ANALYSIS: ☐ SAT ☐ UNSAT
IF UNSAT, STATE REASON:

BARE ELECTRODE HYDROGEN CONTENT: ☐ SAT ☐ UNSAT

FABRICATOR

D.T. Test (Foot-lbs.)	+30° F
1	
2	

AVERAGE ☐ SAT ☐ UNSAT
R.T. ☐ SAT ☐ UNSAT UNSAT POSITION F-H-V-O
CHEMICAL ANALYSIS: ☐ SAT ☐ UNSAT
IF UNSAT, STATE REASON:

BARE ELECTRODE HYDROGEN CONTENT: ☐ SAT ☐ UNSAT
COATED ELECTRODE MOISTURE CONTENT: ☐ SAT ☐ UNSAT
MANUFACTURE'S CERTIFICATION OF CHEMICAL, PHYSICAL AND NON-DESTRUCTIVE TEST ATTACHED ☐ YES ☐ NO

USABILITY CHARACTERISTICS OF ELECTRODE

INDICATE IN BOXES— O FOR FILLETS, X FOR GROOVES

CHARACTERISTIC	F	H	V	O	CHARACTERISTIC	F	H	V	O	CHARACTERISTIC	F	H	V	O
EXCESSIVE BUILD UP					EXCESSIVE UNDERCUTTING					EXCESSIVE SPATTER				
POROSITY IN STARTS					DIFFICULT SLAG REMOVAL					CRATER CRACKING				
POROSITY IN STOPS					DIFFICULT SLAG CONTROL					ARC STABILITY POOR				
COATING BURN-OFF UNEVEN					ARC STARTING DIFFICULT					INCOMPLETE FUSION				
MOLTEN ELECTRODE COATING EASY TO CONTROL					MOLTEN WELD METAL EXCESSIVELY FLUID					DIFFICULT FUSION				

REMARKS:

FABRICATOR

SH 10962

Figure 4 - Sample of certification of electrode conformance test accomplished.

IN-PROCESS WELDED JOINT INSPECTION RECORD

STRUCTURE Nº	SECTION Nº	
JOINT Nº	WELD IDENTIFICATION PLAN Nº	
LOCATION, DESCRIPTION OF JOINT		
WELDER Nº	WELDER QUALIFIED ☐ YES ☐ NO	
PROCEDURE QUALIFIED ☐ YES ☐ NO	TYPE OF PASS ☐ ROOT ☐ INTERMEDIATE ☐ FINAL	INITIAL WELD ☐ REPAIR ☐
WELD PROCESS	ELECTRODE TYPE - LOT - HEAT NO	SIZE
LAB. Nº	ELAPSED TIME SINCE ISSUE	MATERIALS
MATERIAL THICKNESS	PREHEAT TEMP. / INTERPASS TEMP.	PREHEAT METHOD
TYPE OF JOINT	LENGTH OF WELD INSPECTED	BEAD WIDTH
AMPS / VOLTS	TRAVEL RATE - INCHES/MINUTE	HEAT INPUT - JOULES/INCH
WELD DEPOSIT CLEANED PRIOR TO NEXT PASS ☐ YES ☐ NO	TEMPERING BEAD TECHNIQUE EMPLOYED ☐ YES ☐ NO	
WELDING TECHNIQUE	POSITION	

HEAT SOAK ☐ YES ☐ NO

INTERLAYER INTRAWELD ☐ POSTWELD ☐

TEMPERATURE/TIME SAT. ☐ UNSAT. ☐

LOSS OF PREHEAT

MT ACC ☐ REJ. ☐

DATE _____ SIG _____

REMARKS:

INSPECTOR	SHIFT	DATE

SH 10963

Figure 5 - Sample of in-process welded joint inspection record.

PLATE HISTORY RECORD

STRUCTURE Nº	STUB Nº	MILL MARK	WEIGHT
DATE INSPECTED	O.K. FOR ISSUE ☐	HEAT Nº	SLAB
MILL ORDER SHEET	DATE ISSUED	GRADE	SIZE

CHEM, PHYS. AND U.T. CERT. ☐ ATTACHED IN FILE Nº

SURFACE CONDITION: TOP ☐ SAT ☐ UNSAT BOTTOM ☐ SAT ☐ UNSAT

BRINELL HARDNESS READINGS

COLOR CODE IDENTIFICATION ☐ SAT ☐ UNSAT

THICKNESS REQUIREMENTS

ULTRASONIC TEST	SPECIFICATION REQUIREMENTS	VENDOR U.T. READINGS	FABRICATOR U.T. READINGS	FABRICATOR MICROMETER GAUGING
AVG.				
MAX.				
MIN.				

U.T. SOUNDNESS ☐ SAT ☐ UNSAT VENDOR'S MAP OF DEFECT LOCATIONS ATTACHED ☐ YES ☐ NO

CHECK OFF LIST TO BE FILLED OUT BY FABRICATOR

	SAT	UNSAT	NAME
CHEM.			
PHYS.			
N.D.T.			
THICK.			
SOUND.			
B.H.N.			
SURFACE COND.			
IDENT.			

REMARKS:

SH 10955

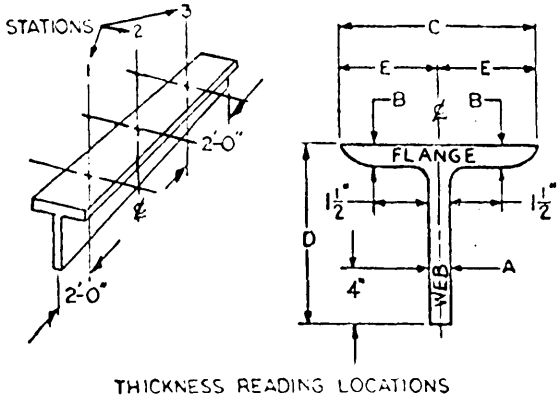
Figure 6 - Sample of plate history record.

	SHAPE HISTORY RECORD		
STRUCTURE NO.	STUB NO.	MILL MARK	WEIGHT
DATE INSPECTED	O.K. FOR ISSUE ☐	HEAT NO.	SLAB
MILL ORDER SHEET	DATE ISSUED	GRADE	SIZE
CHEM. PHYS. AND U.T. CERT. ☐ ATTACHED		IN FILE NO.	
SURFACE CONDITION: FLANGE ☐ SAT ☐ UNSAT WEB ☐ SAT ☐ UNSAT			BRINELL HARDNESS READING
COLOR CODE IDENTIFICATION ☐ SAT ☐ UNSAT			

READING LOCATIONS

STATION	VENDOR D DEPTH	FAB. D DEPTH	VENDOR A WEB THICK.	FAB. A WEB THICK.	FLANGE THICK. VENDOR B	FLANGE THICK. FAB B	FLANGE WIDTH VENDOR C	FLANGE WIDTH FAB C	FLANGE UNBAL. VENDOR E	FLANGE UNBAL. FAB E
1										
2										
3										

U.T. SOUNDNESS ☐ SAT ☐ UNSAT VENDOR'S MAP OF DEFECT LOCATIONS ATTACHED ☐ YES ☐ NO



THICKNESS READING LOCATIONS

CHECK OFF LIST TO BE FILLED OUT BY FABRICATOR

	SAT	UNSAT	NAME
CHEM.			
PHYS.			
N.D.T.			
THICK.			
SOUND.			
B.H.N.			
SURFACE COND.			
IDENT.			

REMARKS:

SHAPE LOCATION(S) IN SHIP:

SH 10956

Figure 7 - Sample of shape history record.

FORGING HISTORY RECORD

STRUCTURE Nº	STUB Nº	SERIAL Nº	WEIGHT
DATE INSPECTED	O.K. FOR ISSUE ☐	HEAT Nº	SIZE
PLAN Nº	DATE ISSUED	GRADE	

CHEM, PHYS. AND N.D.T. CERT. ☐ ATTACHED IN FILE Nº

SURFACE CONDITION ☐SAT ☐UNSAT	THICKNESS REQ.	BRINELL HARDNESS READINGS
IDENTIFICATION Nº ☐SAT ☐UNSAT		

THICKNESS REQUIREMENTS

VENDOR U.T. READINGS	FABRICATOR U.T. READINGS	VENDOR MICROMETER GAUGING	FABRICATOR MICROMETER GAUGING
☐SAT ☐UNSAT REASON:	☐SAT ☐UNSAT REASON:	☐SAT ☐UNSAT REASON:	☐SAT ☐UNSAT REASON:

U.T. SOUNDNESS ☐SAT ☐UNSAT	VENDOR'S MAP OF DEFECT LOCATIONS ATTACHED ☐YES ☐NO
R.T. SOUNDNESS ☐SAT ☐UNSAT	M.T. SOUNDNESS ☐SAT ☐UNSAT

FORGING LOCATION(S) IN STRUCTURE:

CHECK OFF LIST TO BE FILLED OUT BY FABRICATOR

	SAT	UNSAT	NAME
CHEM.			
PHYS.			
N.D.T.			
THICK.			
SOUND.			
B.H.N.			
SURFACE COND.			
IDENT.			

REMARKS:

SH 10957

Figure 8 - Sample of forging history record.

NAME OF PERSON CERTIFIED		DATE
EXPERIENCE		
EMPLOYER	YEARS	TYPE OF WORK
TECHNICAL TRAINING		
ACADEMIC ACHIEVEMENT		

PROCEDURE TO WHICH CERTIFIED	TEST RESULTS		EXAMINER'S SIGNATURE	DATE
	WRITTEN	PRACTICAL		
VISUAL TEST (EYE)	☐ SAT	☐ UNSAT		

REMARKS

EMPLOYEE'S SIGNATURE

SH 10954

Figure 9 - Personnel certification - nondestructive test record.

OPTICAL SQUARE CIRCULARITY MEASUREMENT RECORD*1

STRUCTURE N* | FRAME STATION * | DESIGN RADIUS | DATE

PRELIMINARY** ☐ FINAL*** ☐ SHOP / DEPT. _____ INSPECTOR _____

STBD OFFSETS							BOTTOM HEIGHTS																		
37-39	40	41	42	43	44	45	46-48	49	50	51	52	53	54	55-57	58	59	60	61	62	63	64-66	67	68	69	70	71	72
DEG.	FT.		IN.		32NDS		DEG.	FT.		IN.		32NDS		DEG.	FT.		IN		32NDS		DEG.	FT.		IN.		32NDS	
360							180							180							180						
005							175							175							185						
010							170							170							190						
015							165							165							195						
020							160							160							200						
025							155							155							205						
030							150							150							210						
035							145							145							215						
040							140							140							220						
045							135							135							225						
050							130							130							230						
055							125							125							235						
060							120							120							240						
065							115							115							245						
070							110							110							250						
075							105							105							255						
080							100							100							260						
085							095							095							265						
090							090							090							270						
37-39	40	41	42	43	44	45	46-48	49	50	51	52	53	54	55-57	58	59	60	61	62	63	64-66	67	68	69	70	71	72

NOTES: * GIVE EXACT LOCATION.
** STATE REASON FOR PRELIMINARY OR FOR LOCATIONS NOT READ.
*** ALL MAJOR WELDING COMPLETE.

REMARKS:

SH 10958

Figure 10 - Sample of optical square circularity measurement record.

OPTICAL SQUARE CIRCULARITY MEASUREMENT RECORD # 1

STRUCTURE N# | FRAME STATION # | DESIGN RADIUS | DATE

PRELIMINARY** [ ] FINAL*** [ ] SHOP/DEPT. _____ INSPECTOR _____

PORT OFFSETS					TOP HEIGHTS				
1–3	4	5	6	7	8	9	10–12	13	14	15	16	17	18	19–21	22	23	24	25	26	27	28–30	31	32	33	34	35	36
DEG.	FT.		IN.		32NDS		DEG.	FT.		IN.		32NDS		DEG.	FT.		IN.		32NDS		DEG.	FT.		IN.		32NDS	
180							360							360							360						
185							355							355							005						
190							350							350							010						
195							345							345							015						
200							340							340							020						
205							335							335							025						
210							330							330							030						
215							325							325							035						
220							320							320							040						
225							315							315							045						
230							310							310							050						
235							305							305							055						
240							300							300							060						
245							295							295							065						
250							290							290							070						
255							285							285							075						
260							280							280							080						
265							275							275							085						
270							270							270							090						
1–3	4	5	6	7	8	9	10–12	13	14	15	16	17	18	19–21	22	23	24	25	26	27	28–30	31	32	33	34	35	36

NOTES: *GIVE EXACT LOCATION.
**STATE REASON FOR PRELIMINARY OR FOR LOCATIONS NOT READ.
***ALL MAJOR WELDING COMPLETE.

REMARKS:

SH 10958

Figure 10 - Sample of optical square circularity measurement record (con.).

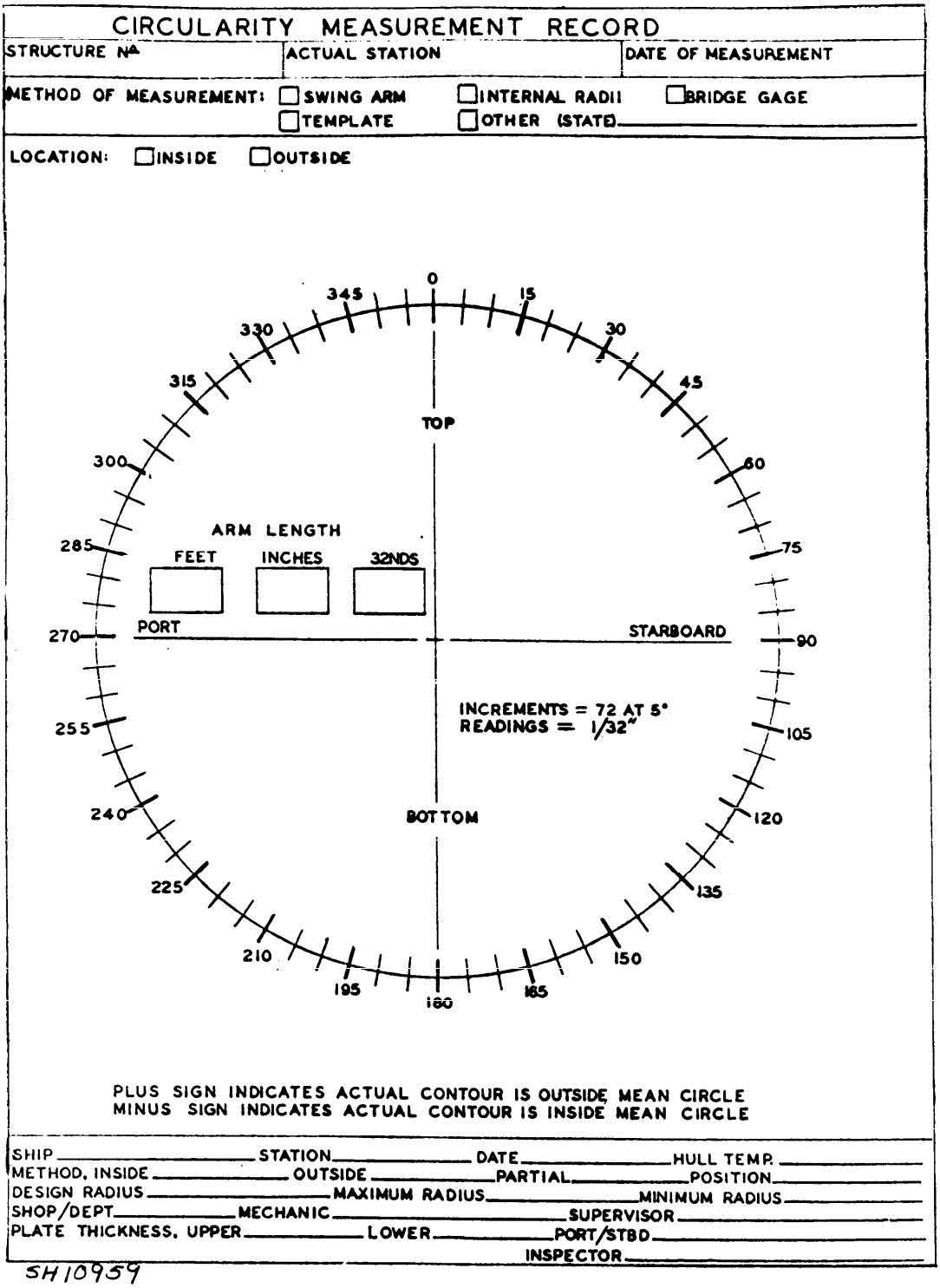


Figure 11 - Sample of circularity measurement record.

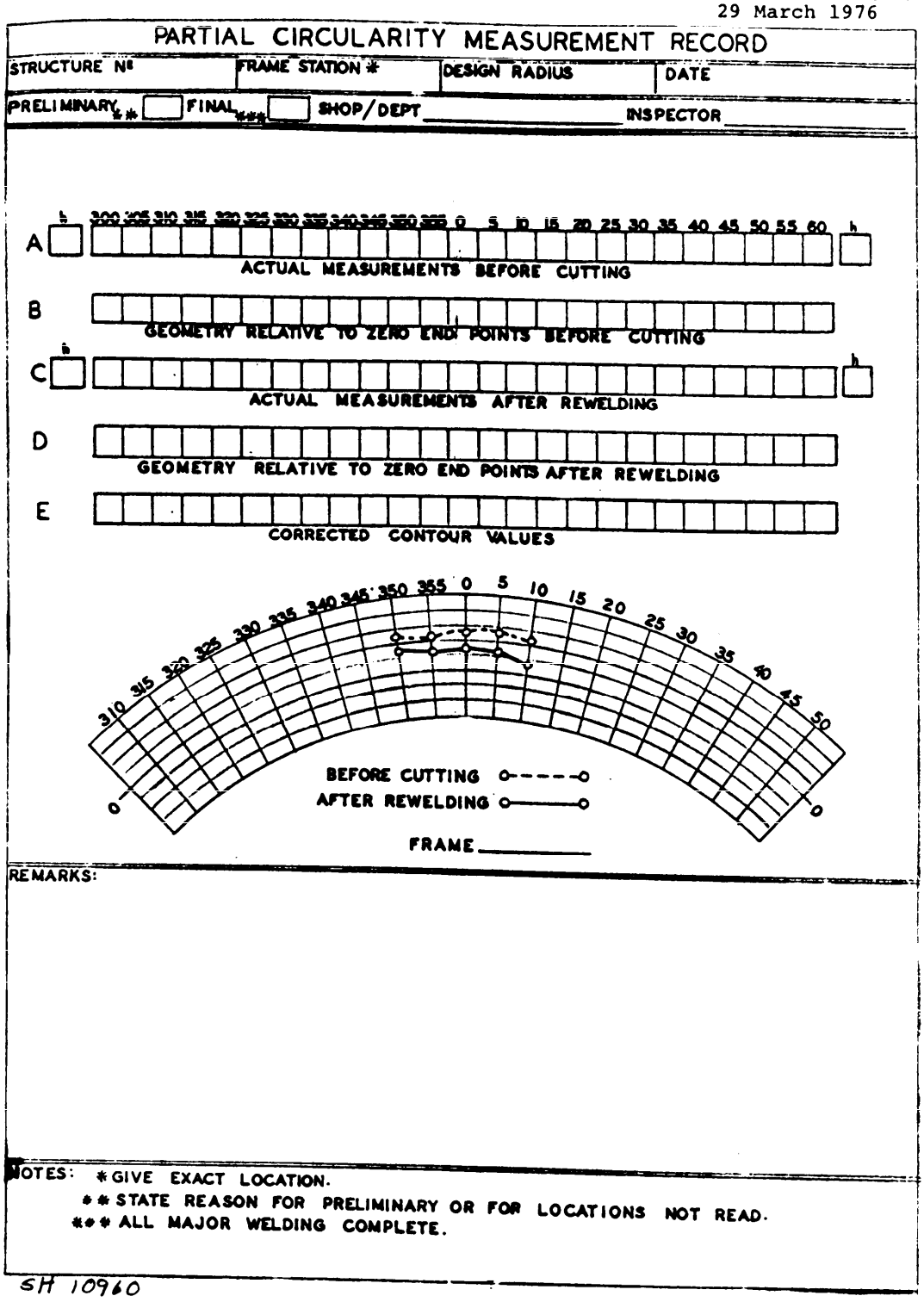


Figure 12 - Sample partial circularity measurement record.

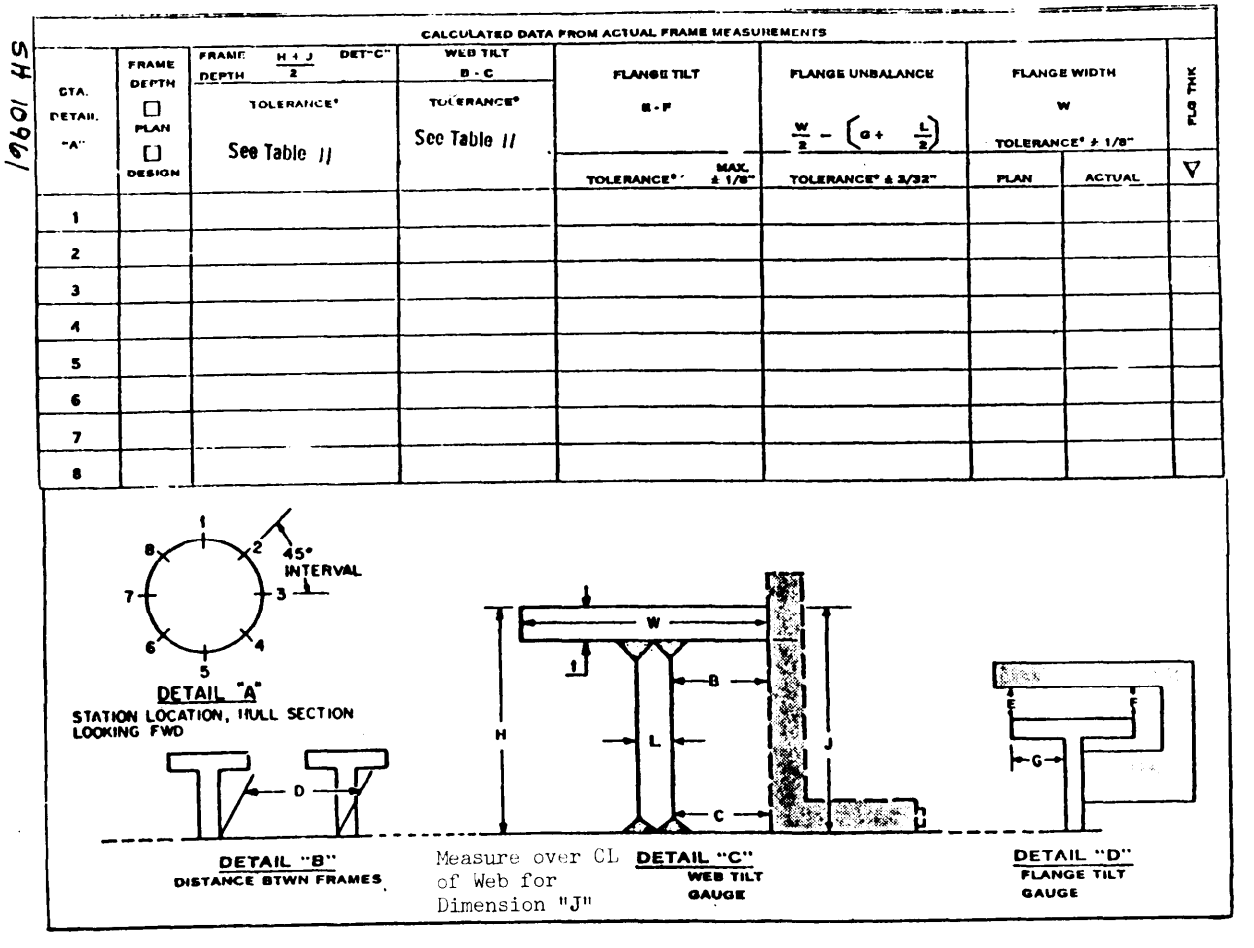


Figure 13 - Record of frame dimensions.

SH1681

BOAT	PLAN	REV	FRAME NO.	INTERNAL ☐ EXTERNAL ☐	FABRICATED ☐ EXTRUDED ☐	SHIP ☐ EBG ☐	BLOCKS ☐ EBG ☐ VENDOR ☐

DATA TAKEN FROM FRAME: MEASUREMENTS IN TENTHS OF 1 INCH

STA. DETAIL "A"	ACTUAL DIST. BETWEEN FRAMES DET "B"	GAGE LOCATION: AFTSIDE OF FRAME ☐ FWD SIDE OF FRAME ☐							
		SYMBOLS DET. "C"				SYMBOL DET. "D"			
		H	J	B	C	E	F	G	L
1									
2									
3									
4									
5									
6									
7									
8									

Data and calculations exceeding tolerances to be marked thus *

D & D NO.

CALCULATED BY:

DATE

INSPECTOR NOT TO WRITE BELOW THIS DOUBLE LINE

INSPECTOR DATE

Figure 13 - Record of frame dimensions (con.).

QUALITY CONTROL MAGNETIC PARTICLE INSPECTION REPORT

STRUCTURE NO.	PLAN NO.
JOINT NO.	WELD COMPLETION DATE

PART TESTED:

FRAME NO._____ ASSEMBLY NO._____

INSIDE HULL_____ OUTSIDE HULL_____ FWD. OF FRAME_____ AFT. OF FRAME_____

A. VERTICAL BUTT_____ E. FLANGE BUTT_____ J. SCARS (NO.)_____

B. HORIZ. BUTT_____ F. WEB BUTT_____ K. TIE-IN BLOCKS_____

C. CIRCUM BUTT_____ G. WEB TO SHELL_____ L. BLOCK ENDS_____

D. FRAME BUTT_____ H. WEB TO FLANGE_____ M. X-RAY REPAIR_____

MISC. PARTS_____
(WRITE OUT)

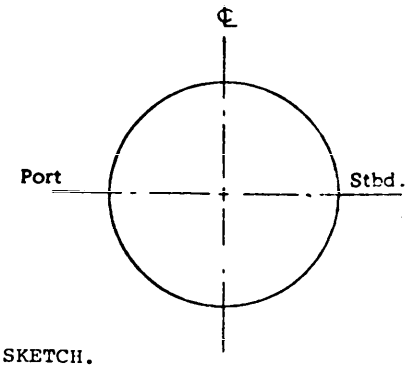
TYPE OF CHECK: ROOT PASS_____ FINISH WELD_____ RECHECK_____ PLATE EDGE_____

TAC WELD_____ LOSS OF PREHEAT_____ SURFACE_____

PROCEDURE: d.c. PROD_____ OTHER_____

NO. OF BLOCKS_____ LENGTH OF BLOCKS_____

	LONG'L	TRANSV.
1. MAGNETIC PARTICLE INDICATIONS	_____	_____
2. ACTUAL CRACKS LEFT AFTER GRINDING 1/16 INCH	_____	_____
3. CRACKS REPAIRED BY WELDING	_____	_____
4. TOTAL INCHES OF CRACKS PER SECTIONS 14 AND 15	_____	_____
5. TOTAL DISTANCE MAGNETIC PARTICLE INSPECTED	Ft____	In____



NOTE: INDICATE CRACKS BY CODE LETTERS (A, B, C, ETC.) ON SKETCH.

REMARKS_____

REQUESTED BY:

WELDING DEPT._____ NAVY_____ NPD_____ OTHER_____
(WRITE OUT)

NDT INSPECTORS SIGNATURE_____ DATE INSPECTED_____

DEFICIENCY NO. FOR REPAIRS_____ FINAL VISUAL_____
INSPECTORS SIGNATURE DATE

SH 10964

Figure 14 - Sample of quality control magnetic particle inspection report.

LIQUID PENETRANT INSPECTION REPORT

TYPE OF PENETRANT USED

WELD OR MATERIAL LOCATION

SHIP _____ DRAWING NO. _____ JOINT NO. _____

OTHER _____

TYPE OF WELD (e.g., butt, tee, fillet, etc.)

SURFACE CONDITION (e.g., as welded, ground, machined, etc.)

TEST RESULTS ☐ SAT. ☐ UNSAT. (If unsat, list cause for rejection)

DATE OF REPAIRS AND REINSPECTION (If required) AND RESULTS.

REPAIR NO.	DATE	REINSPECTION RESULTS AND INSPECTOR SIGNATURE
		☐ SAT. ☐ UNSAT. (IF UNSAT. LIST CAUSE FOR REJECTION)

SIGNATURE OF INSPECTOR _____ DATE _____

SH 10965

Figure 15 - Sample of liquid penetrant inspection report.

RADIOGRAPHY REPORT

STRUCTURE NO.	CONTRACT NO.	PLAN NO. PATT. NO.	WELD COMPLETION DATE	
PIECE MARK- HEAT NO.	JOINT NO. CONTROL NO.	SIZE	WALL	REP'R NO. / SUPP. NO.

MATERIAL	WELD PROCESS	JOINT DESIGN	WELD SURFACE
HY-130 ☐ Carbon-Steel ☐ Stainless-Steel ☐ Nickel-Copper ☐ Copper-Nickel ☐ HY-80 ☐ HTS ☐ Other (Spec.) ☐	Filler Wire ☐ Manual ☐ Automatic ☐ Semi-Auto. ☐ Composite ☐ Other (Spec.) ☐	Double Bevel ☐ Single Bevel ☐ J. Bevel ☐ Other (Spec.) ☐	Ground Smooth ☐ Flush ☐ As Welded ☐

SOURCE	X-RAY	IR-192	CO 60	INSIDE	OUTSIDE	TECHNIQUE NO.	FILM TYPE
	☐	☐	☐	☐	☐		

ACCEPTANCE STANDARD	STRUCTURAL		OTHER (STATE)
	0900-LP-006-9010 ☐ 0900-LP-003-9000 ☐ MIL-STD- ☐		☐

FILM NO.	RATING	NAME OF PART AND REMARKS (DESCRIBE FLAWS)

RATING MARKED "A" ACCEPTABLE
RATING MARKED "R" REJECTED

CC-FILM PACK
RADIOGRAPHY RECORDS
RADIOGRAPHY SUPERVISOR
CUSTOMER'S INSPECTOR

RADIOGRAPHY SUPERVISOR _____ Date

FILM REVIEWER _____ Date

CUSTOMER INSPECTOR _____ Date

SH 10966

Figure 16 - Sample of radiography report.

RADIOGRAPHIC WORK RECORD

STRUCTURE NO.			WELD COMPLETION DATE
PLAN NO.	FILE NO.	JOINT NO./ITEM	MATERIAL
LOCATION/DESCRIPTION OF JOINT:			
REQUIREMENTS: ☐			OTHER ☐
WELD SURFACE: ☐ AS WELDED ☐ SMOOTH ☐ ROUGH		JOINT TYPE ☐ BUTT ☐ CORNER	☐ OTHER

EXPOSURE DATA

X-RAY (MFG-MODEL)		KVP RATE	FOC. SIZE	KV USED
		MA	TIME	DISTANCE
ISOTOPE ☐ IRID. ☐ COBOLT	CURIES	SIZE (PHYS)	MR RATING	
		ISODOSE LOG	PAGE NO.	MONTR.
FILM TYPE	SIZE	NO. OF EXP.	LOADED ☐ SING. ☐ DBL. ☐ MULT.	
		SCREENS ☐ .005 FRONT ☐ .010 FRONT ☐ .005 CENTER ☐ .010 BACK		
PENETRAMETER (MAT'L)	SIZE	LOCATION ☐ FILMSIDE	SOURCE SIDE ☐	RADIATION THROUGH ☐ ONE WALL ☐ TWO WALLS
SHIM MATERIAL	THICKNESS	TECH NO.		

PROCESSING

☐ X-OMAT ☐ MANUAL ☐ 68° ☐ 8 MIN ☐ 6 MIN ☐ OTHER

PENETRAMETER HOLE VISIBLE	FILMSIDE ☐ 1T ☐ 2T ☐ 4T	SOURCE SIDE ☐ 1T ☐ 2T ☐ 4T
FILM DENSITY	(AREA INTEREST)	(SHIM) (PENETRAMETER)

REASON FOR REJECTION

☐ TECHNIQUE ☐ PROCESSING ☐ WELD DEFECT ☐ OTHER

ACCEPTANCE STANDARD

☐ ☐ WITH MODIFICATIONS ☐ OTHER

SH 10967

Figure 17 - Sample of radiographic work records.

WELD ULTRASONIC INSPECTION REPORT

STRUCTURE NO.	INSPECTOR(S) (INSP NO.)	PROCEDURE NO.	SHIFT & DATE OF INSPECTION D S G / /

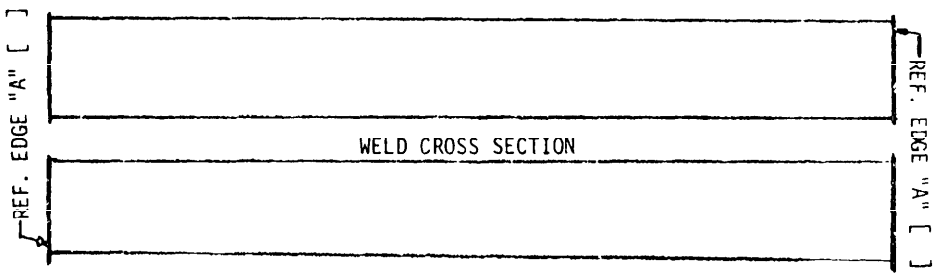
JOINT NO.	PLAN NO.	WELD JOINT TYPE/ DESCRIPTION	FRAME NO.	PORT / STBD	CLOCK POSITION

MATERIAL	STRUCTURE THICKNESS	WEB THICKNESS	WELD WIDTH	COVERAGE FROM TO	BENCHMARK & DIRECTION

INSTRUMENT	MODEL	NUMBER	SEARCH UNITS DATA 1/2" X 1"	CALIBRATION STANDARD (MATERIAL, SIZE/NO.)
			2.25MHz_____° _____, _____, MHz_____°	

LOCATION FROM	LOCATION TO	LENGTH	DEPTH(S) MIN	DEPTH(S) MAX	VERTICAL HEIGHT	"S" * VALUE	SCAN DIRECTION	POSITION FROM REFERENCE	SAT	UNSAT

WELD PLAN VIEW



*Signal Strength

COMMENT REVIEWED BY DATE

SH 10968

Figure 18 - Sample of weld ultrasonic inspection report.

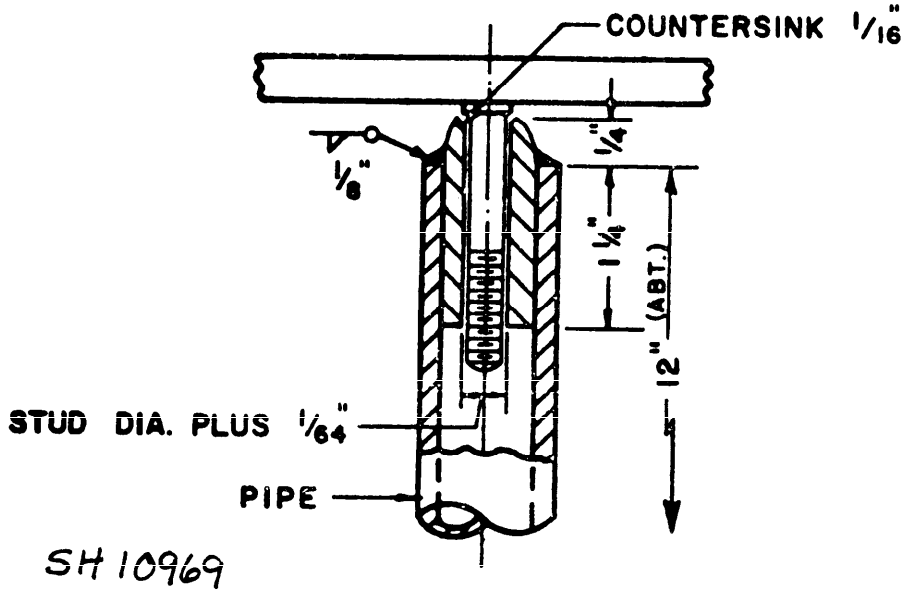
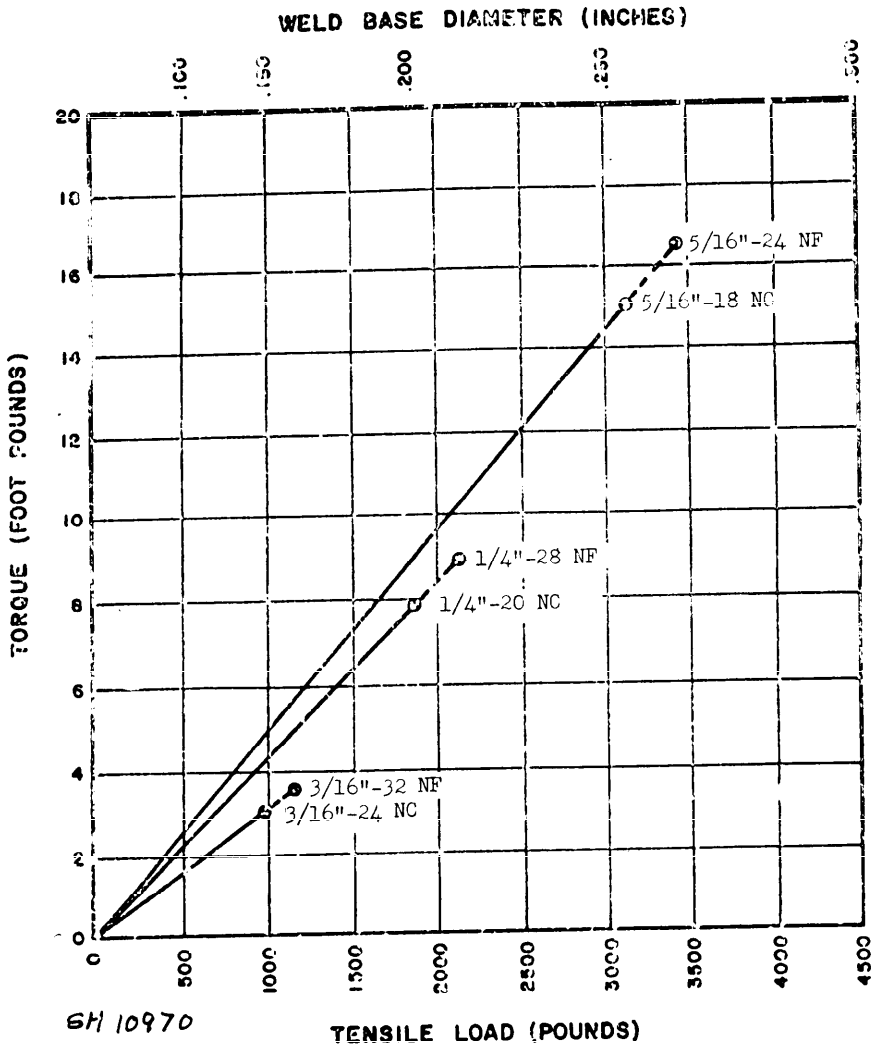


Figure 19 - Device for testing welded studs.



YIELD POINT BASED ON 60,000 lb/in^2 STEEL

Figure 20 - 3/16, 1/4, and 5/16 inch diameter studs.

NF - NATIONAL FINE
NC - NATIONAL COARSE

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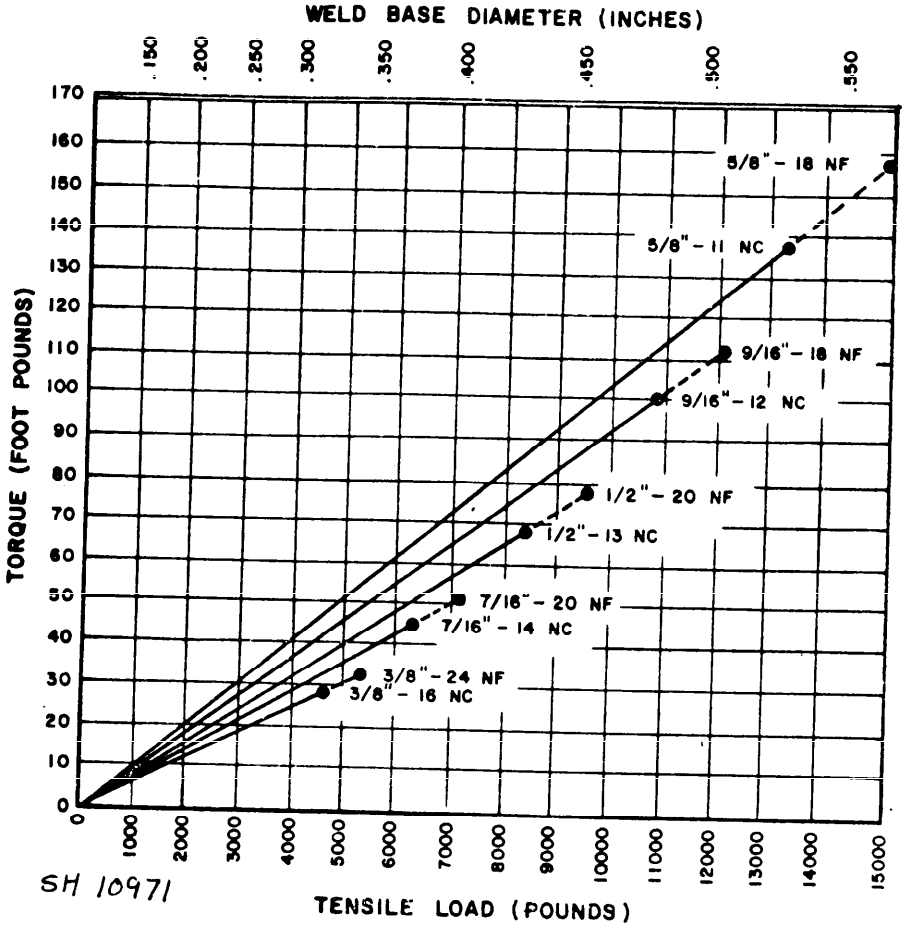

YIELD POINT BASED ON 60,000 lb/in^2 STEEL

Figure 21 - 3/8, 7/16, 1/2, 9/16, and 5/8 inch diameter studs.

NF - NATIONAL FINE
NC - NATIONAL COARSE

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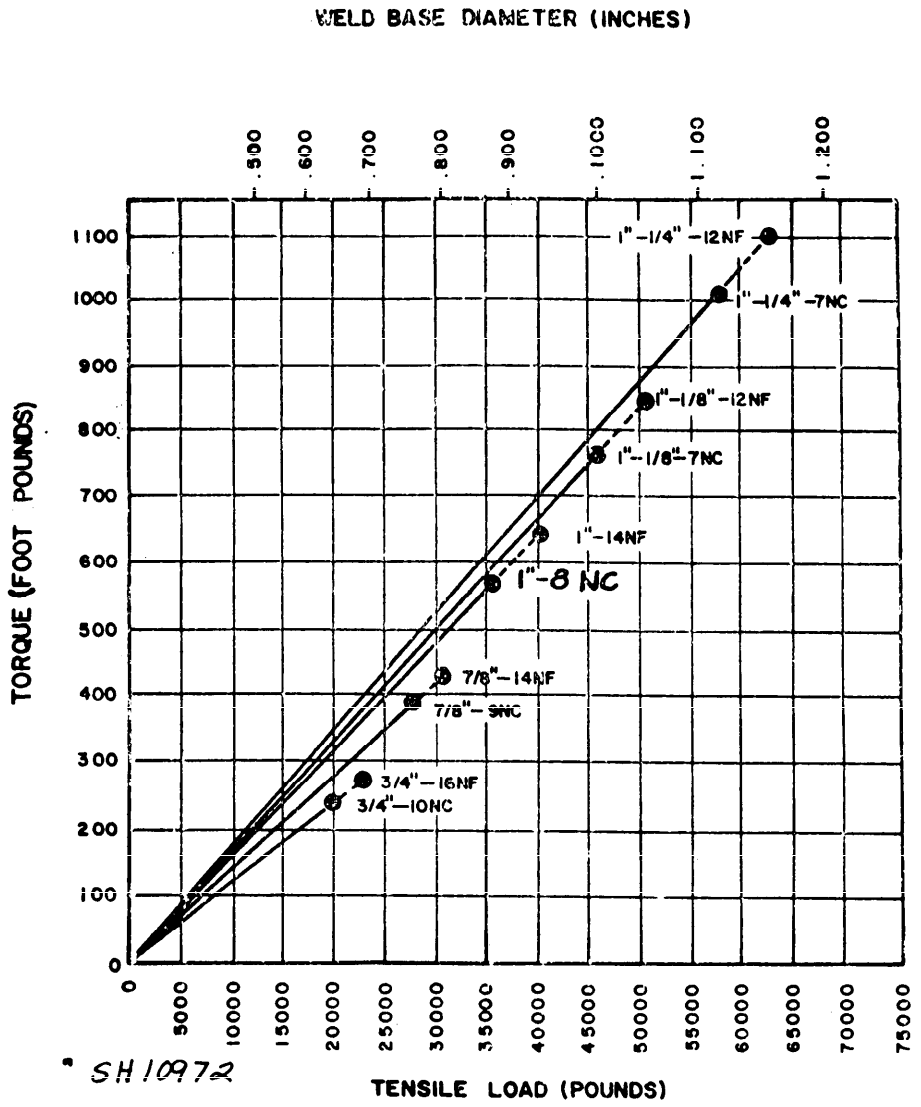

YIELD POINT BASED ON 60,000 lb/in^2 STEEL

Figure 22 - 3/4, 7/8, 1, 1-1/8, and 1-1/4 inch diameter studs.

NF-NATIONAL FINE
NC-NATIONAL COARSE

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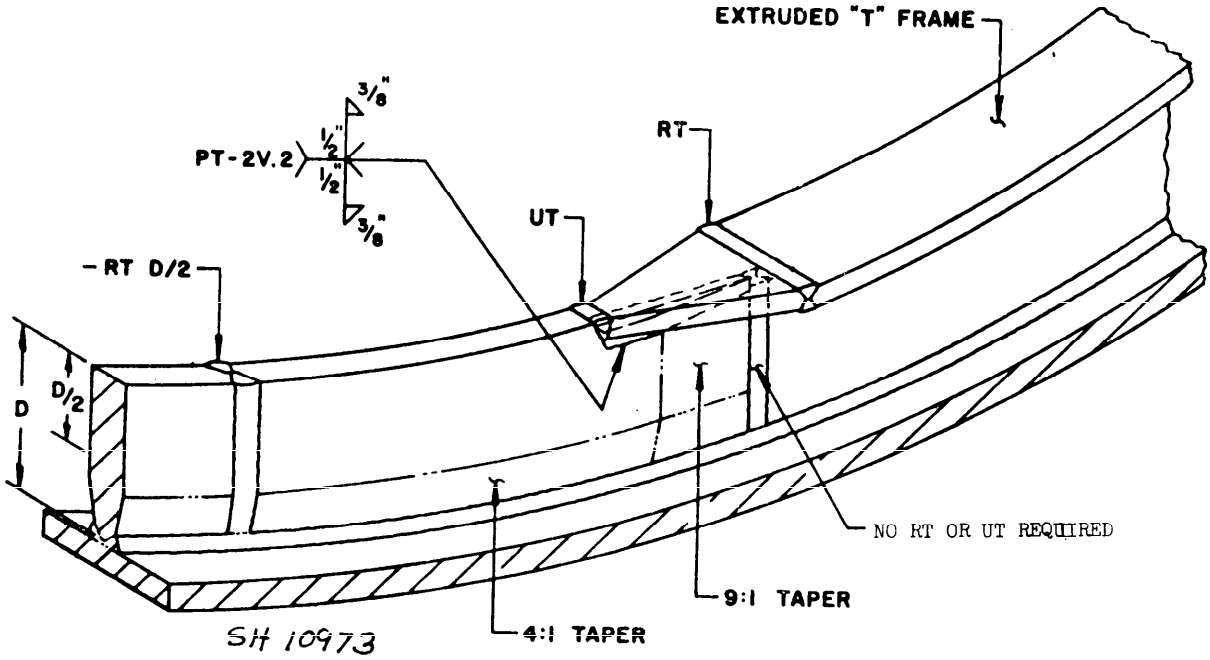
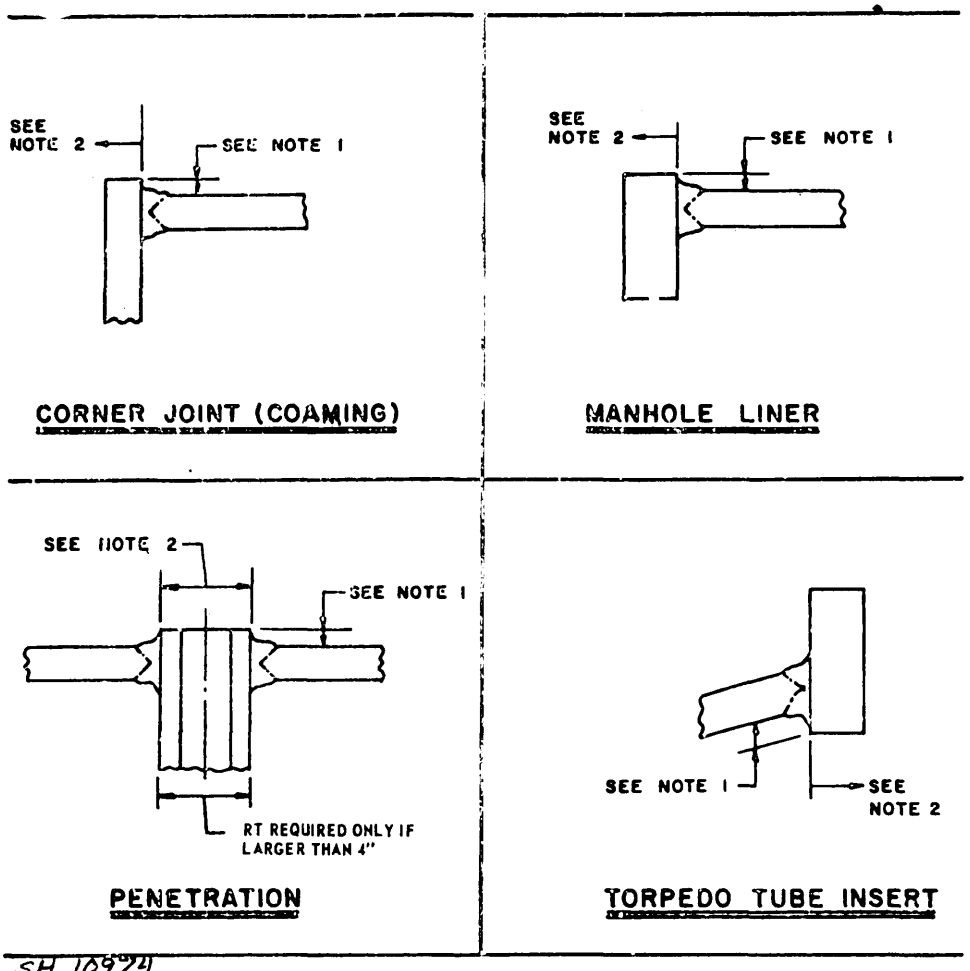


Figure 23 - NDT requirements for flanged to unflanged frame transitions



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Notes: 1. Radiography is required when designed projection is less than one inch for the entire circumference.
2. Film evaluation not required for this area.

Figure 24 - Application examples of table V (category 7).

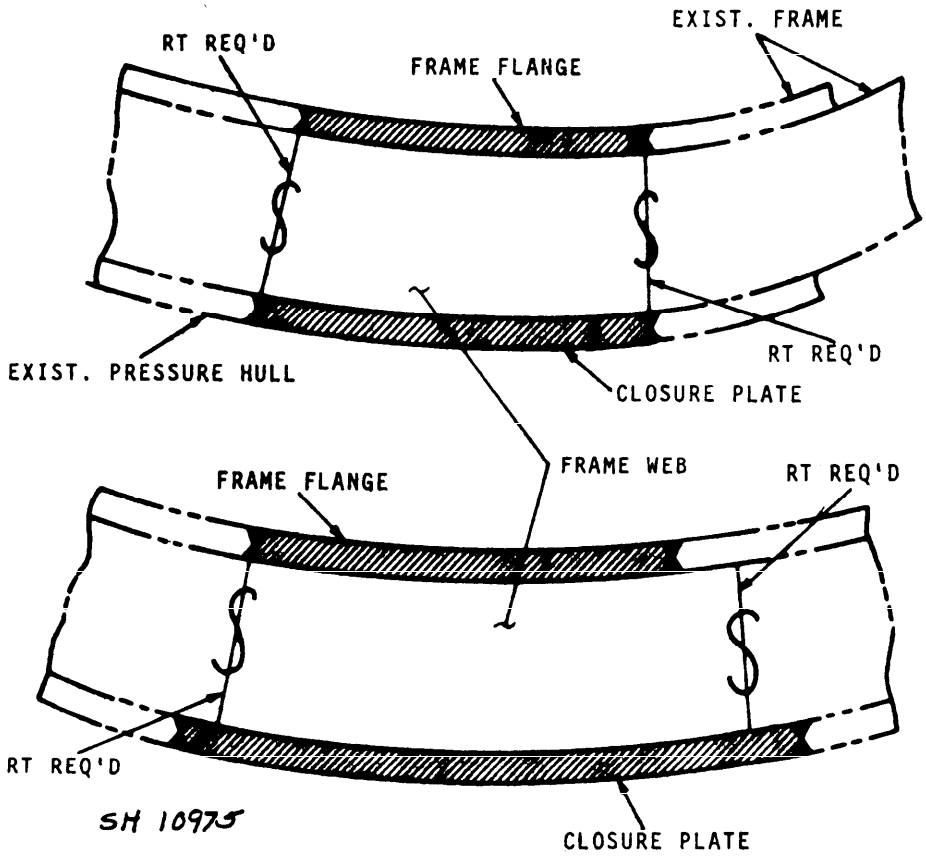
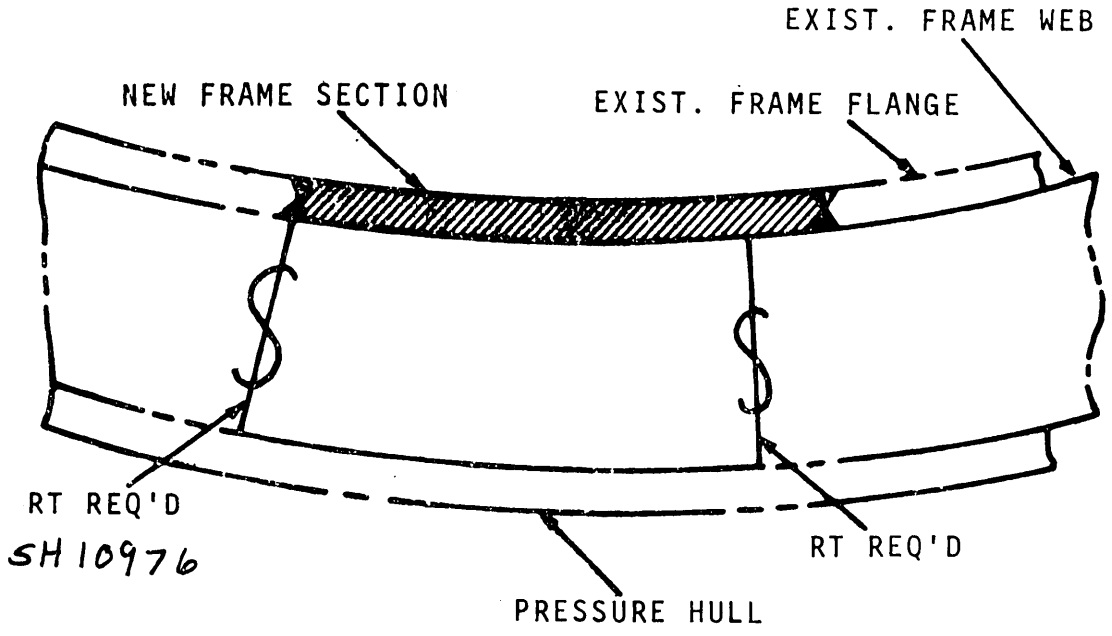


Figure 25 - Frame web butt welds, requiring RT, which are part of access and closure assemblies.



NOTE: OPTION OF OFFSETING WEB BUTT WELD FROM FLANGE BUTT WELDS SHOULD BE EXERCISED ONLY WHERE FLANGE HEIGHT ALLOWS ACCESSIBILITY FOR WELDING.

Figure 26 - Frame web butt welds, requiring RT, which are part of inserted frame sections.

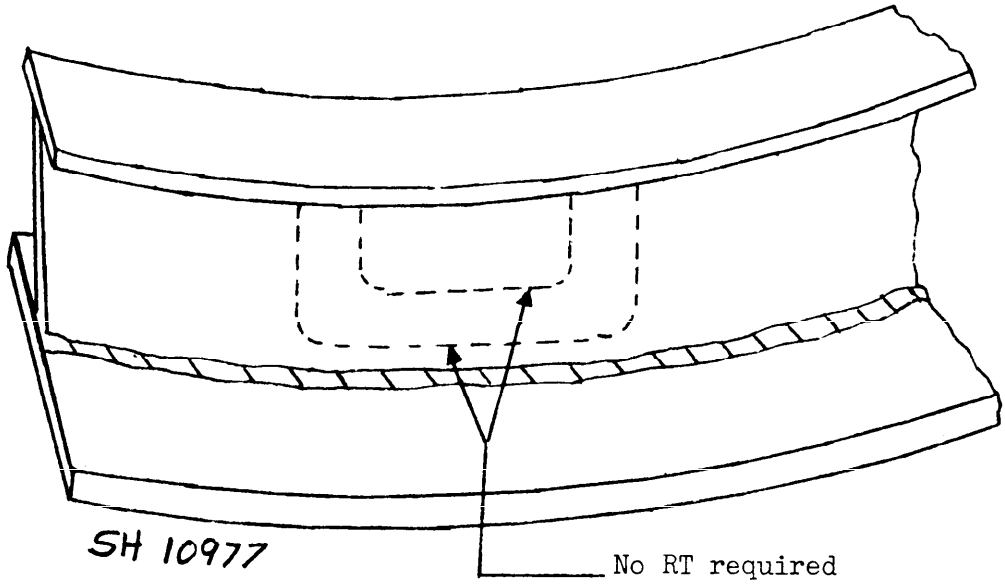


Figure 27 - Frame sections inserted into completed structure.

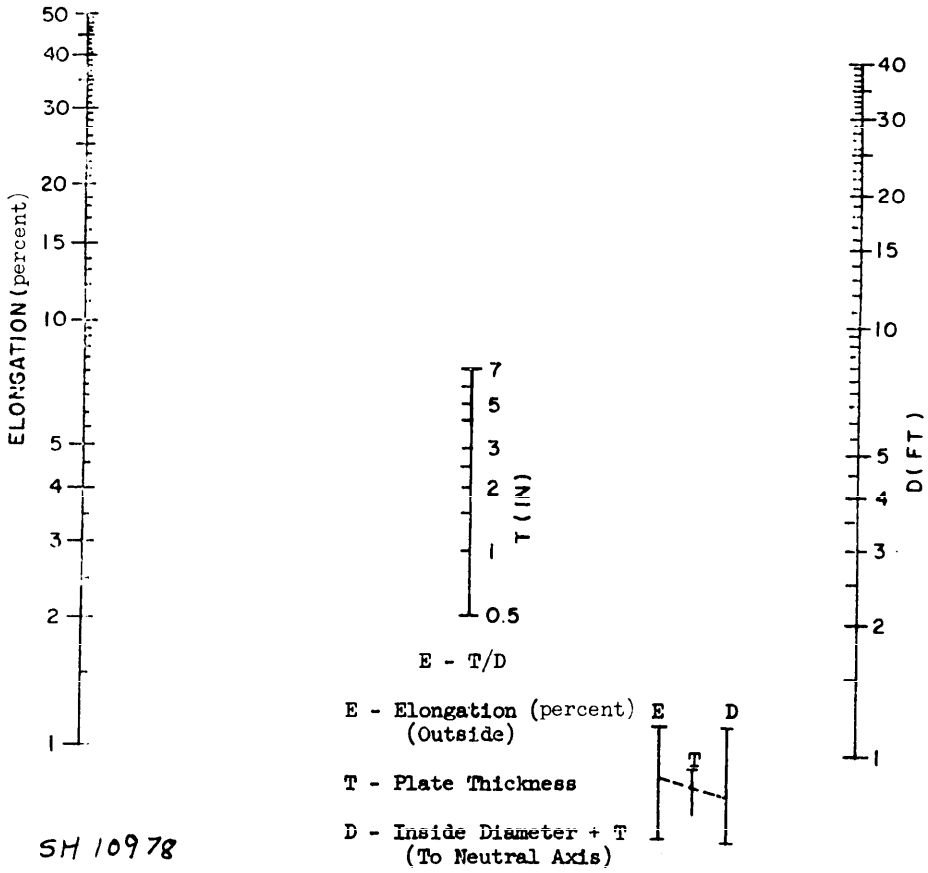


Figure 28 - Nomograph of outside surface elongation after bending or rolling.

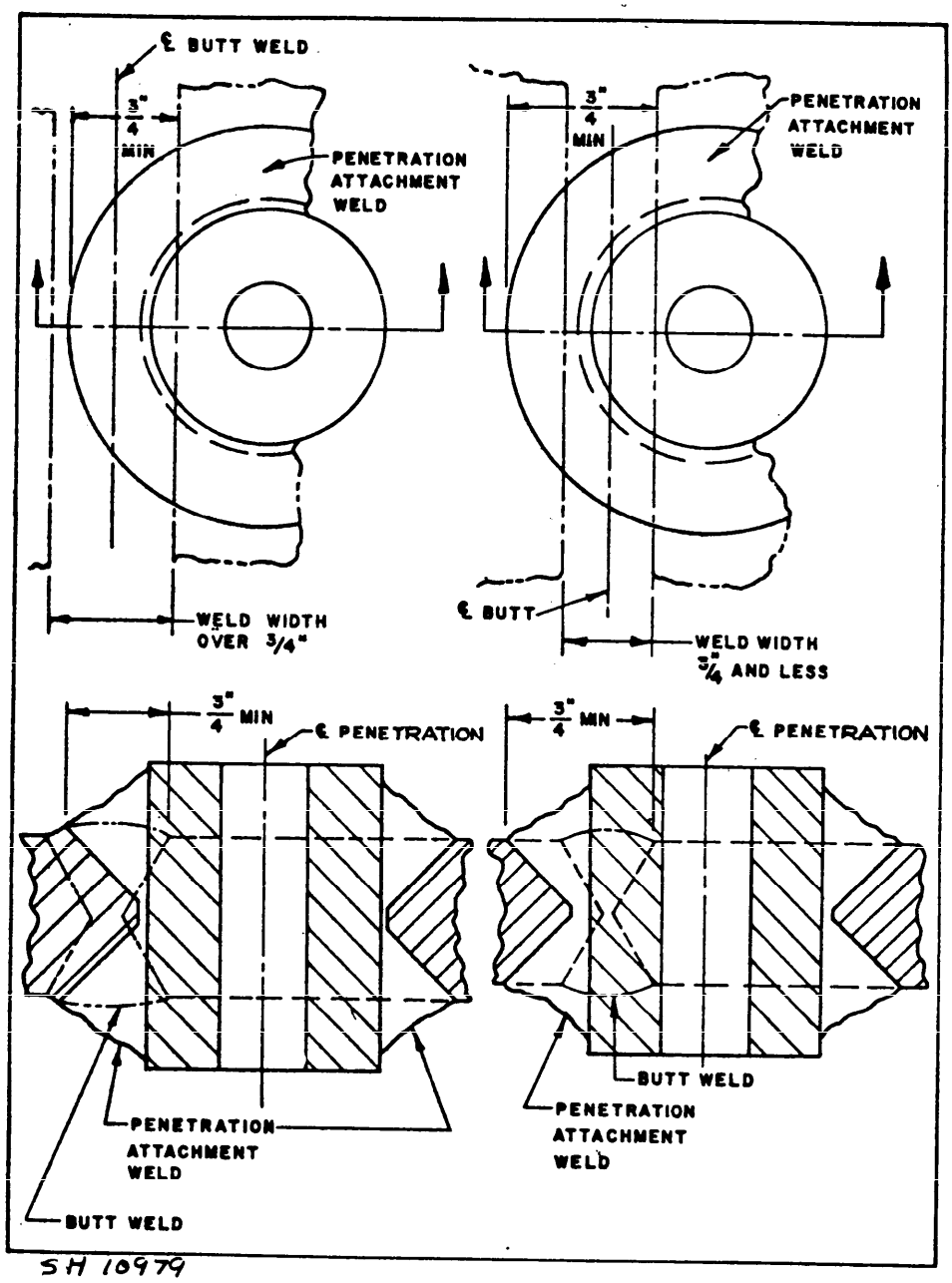


Figure 29 - Location of penetration attachment welds in relation to butts and seams.

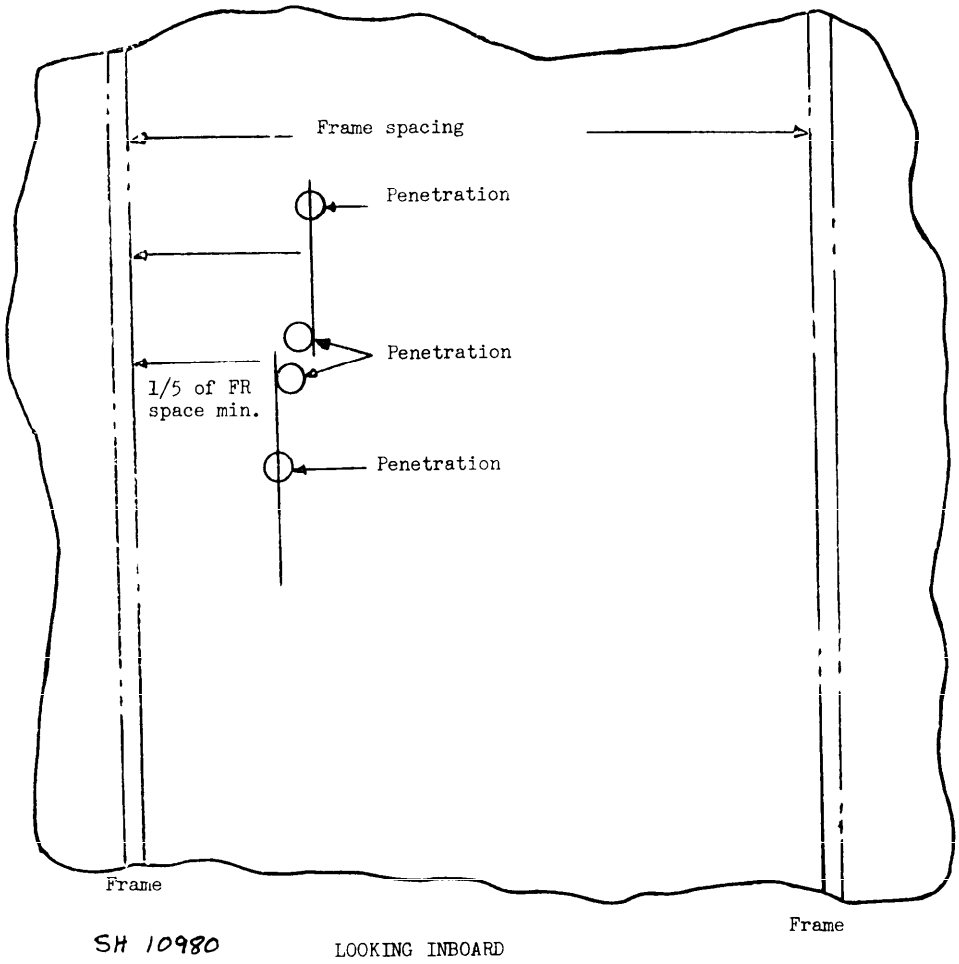
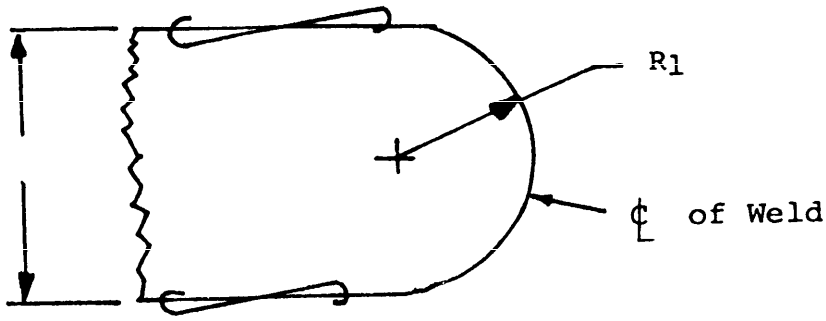
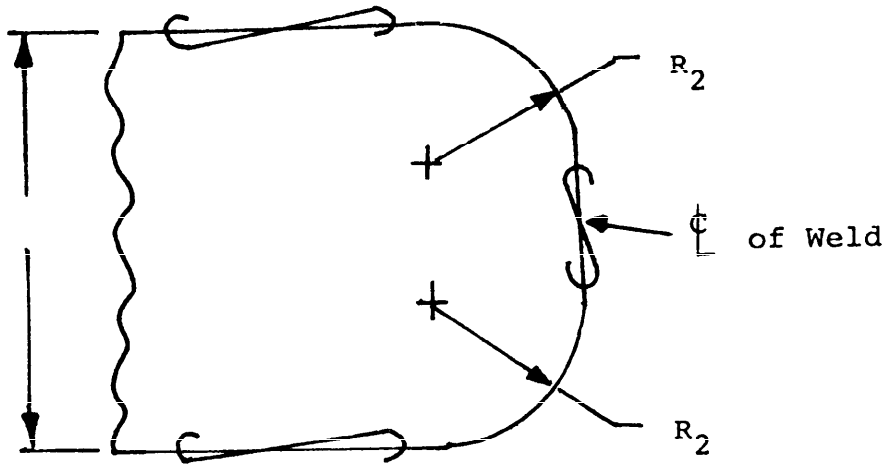


Figure 30 - Locations of penetrations in relation to frames.



When "W" = 6" Min, 12" Max

Then $R_1 = \frac{W}{2}$



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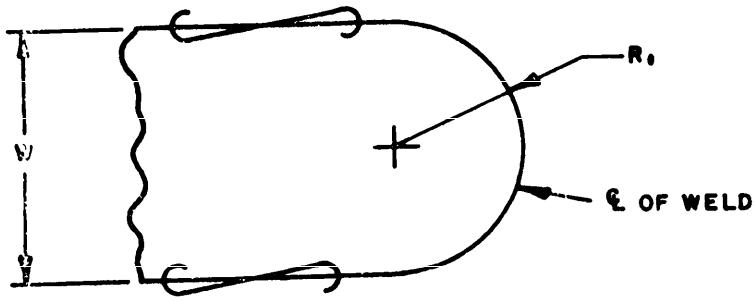
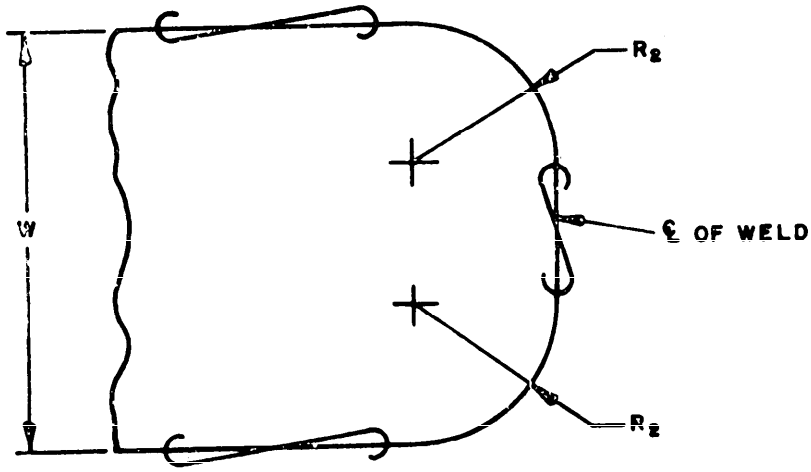
When "W" = 12" Min

Then R_2 = 6" or 2T whichever is larger

Figure 31 - Inserts, patches, and small access plates in pressure hull envelope.



WHEN "W" = 3" MIN, 6" MAX
THEN $R_1 = \frac{W}{2}$



WHEN "W" = 6" MIN
THEN R_2 = 3" OR 2T WHICHEVER IS LARGER

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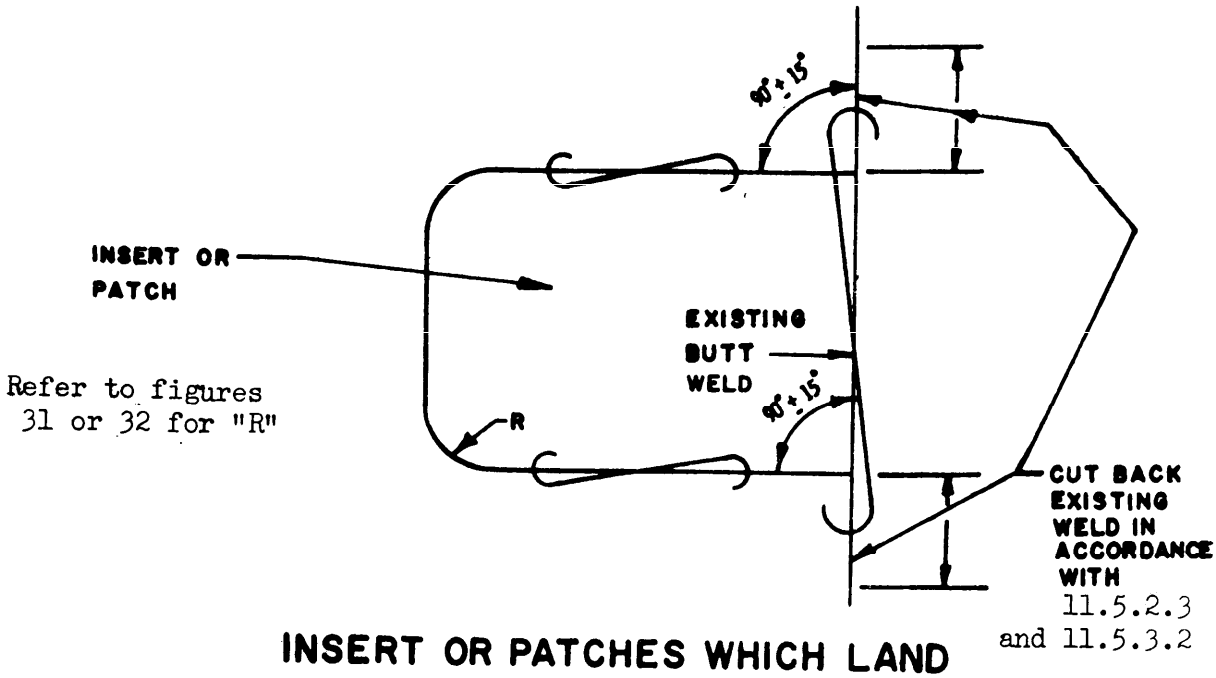
Figure 32 - Inserts, patches, and small access plates in plating and structure other than pressure hull envelope.



INSERT OR PATCHES WHICH LAND ON EXISTING BUTT WELDS

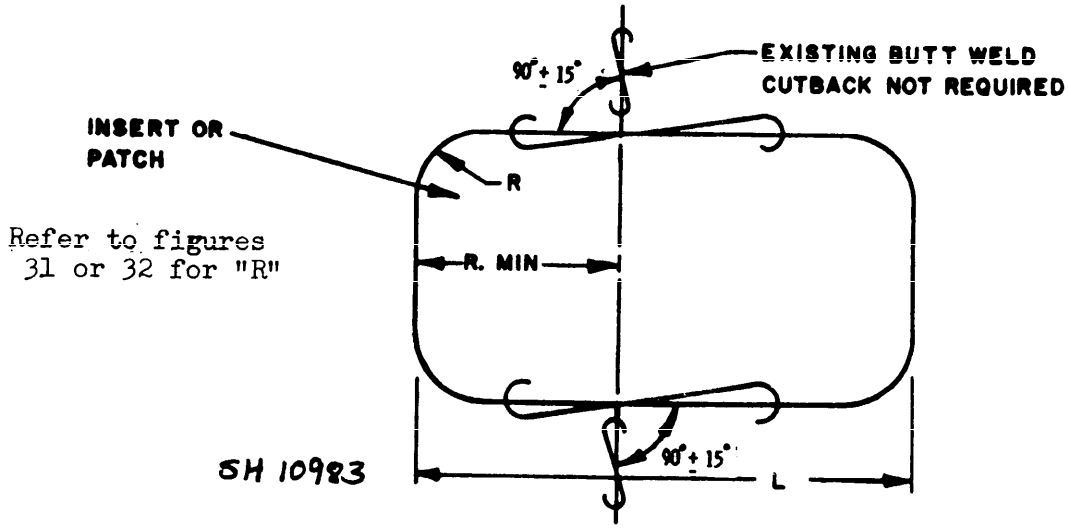
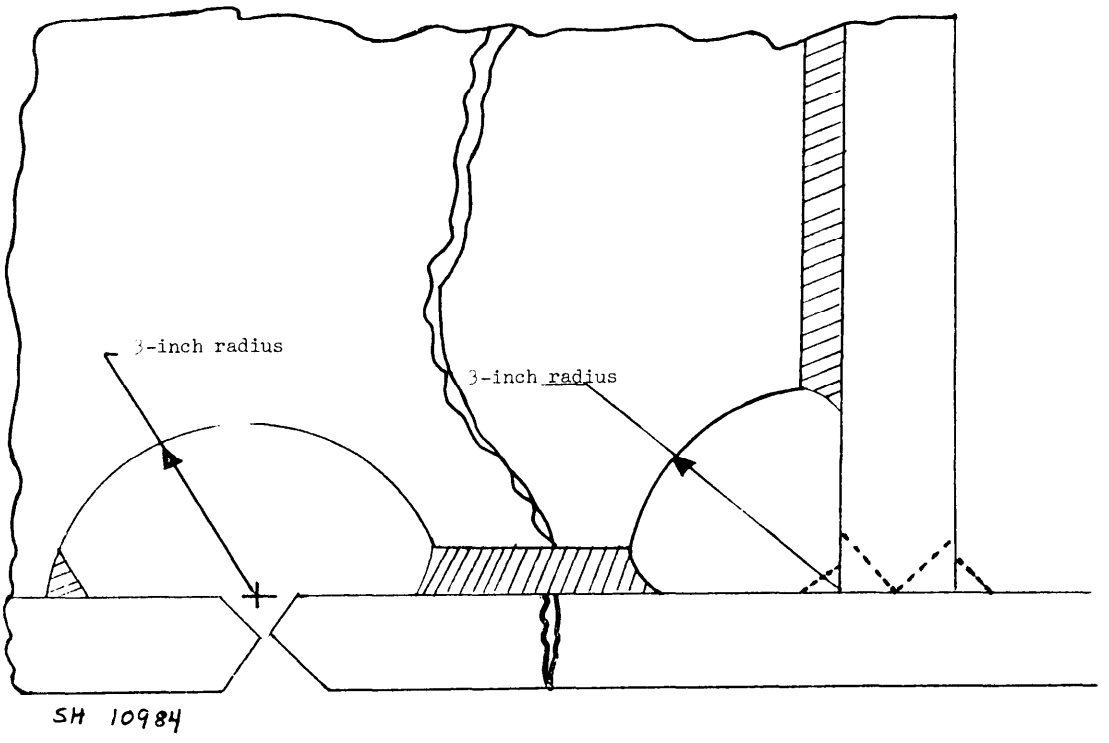


Figure 33 - Insert patches and small access plates which cross existing butt welds.



NOTE: Close off end of opening with a 3/8" fillet weld

Figure 34 - Drain; vent or permanent snipe opening.

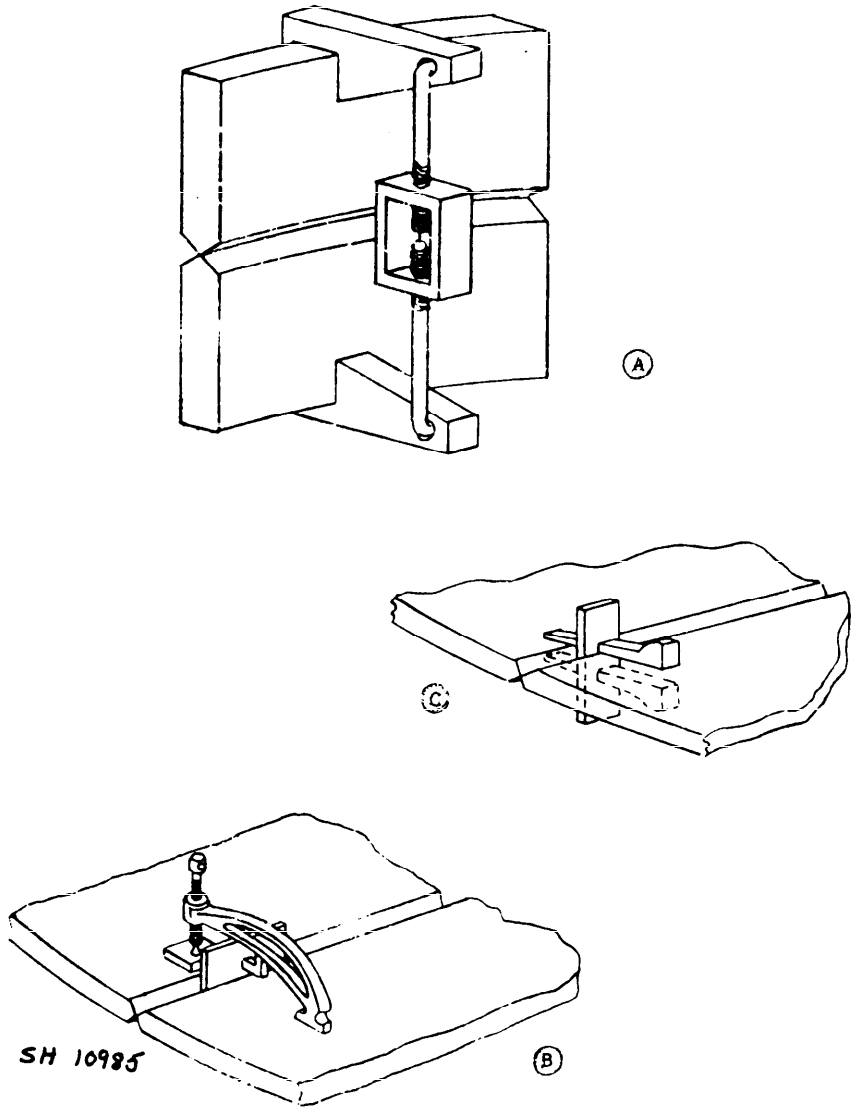
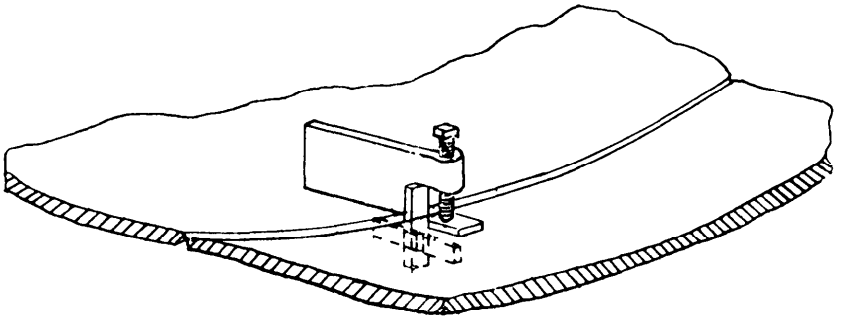
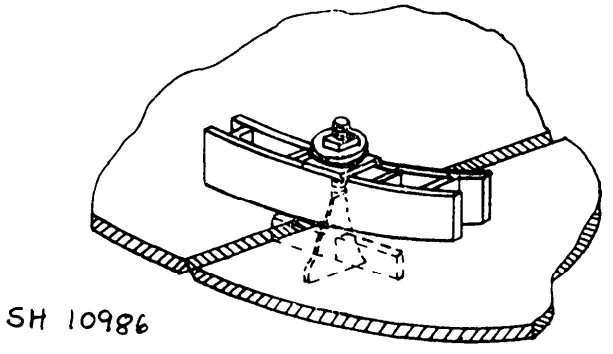


Figure 35 - Typical plate alignment and fitting devices.



SKETCH "A"



SKETCH "B"

Figure 36 - Typical plate alignment and fitting devices.

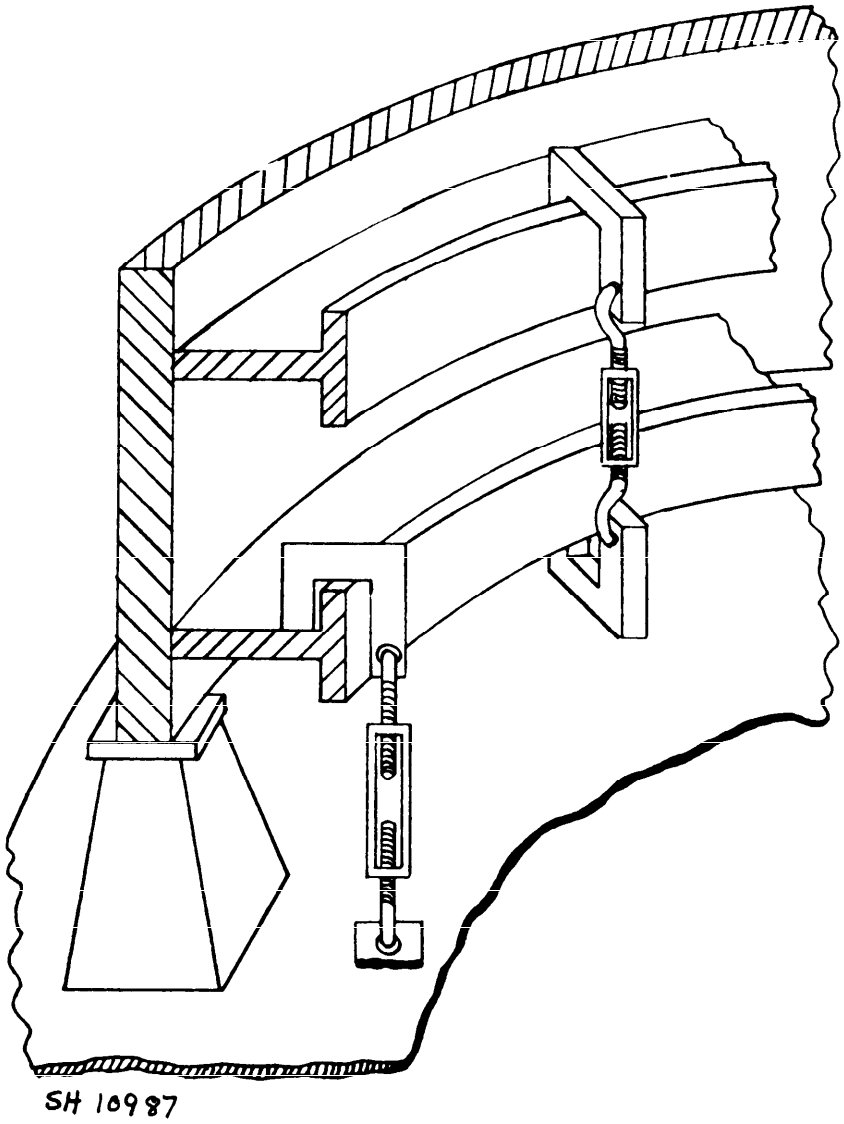


Figure 37 - Restraining device to hold frame tilt.

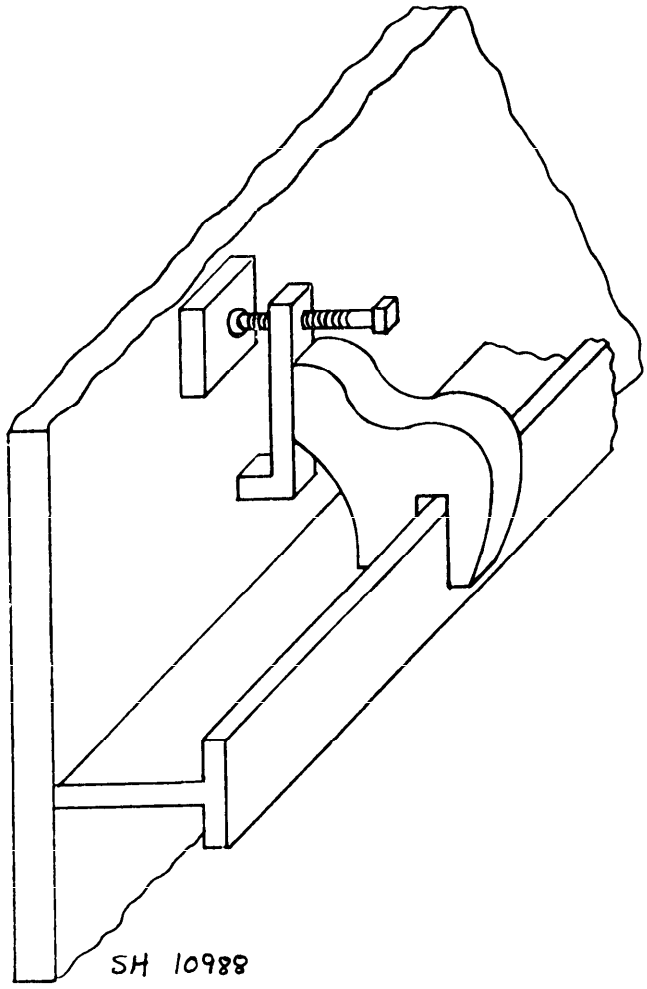


Figure 38 - Restraining device to hold frame tilt.

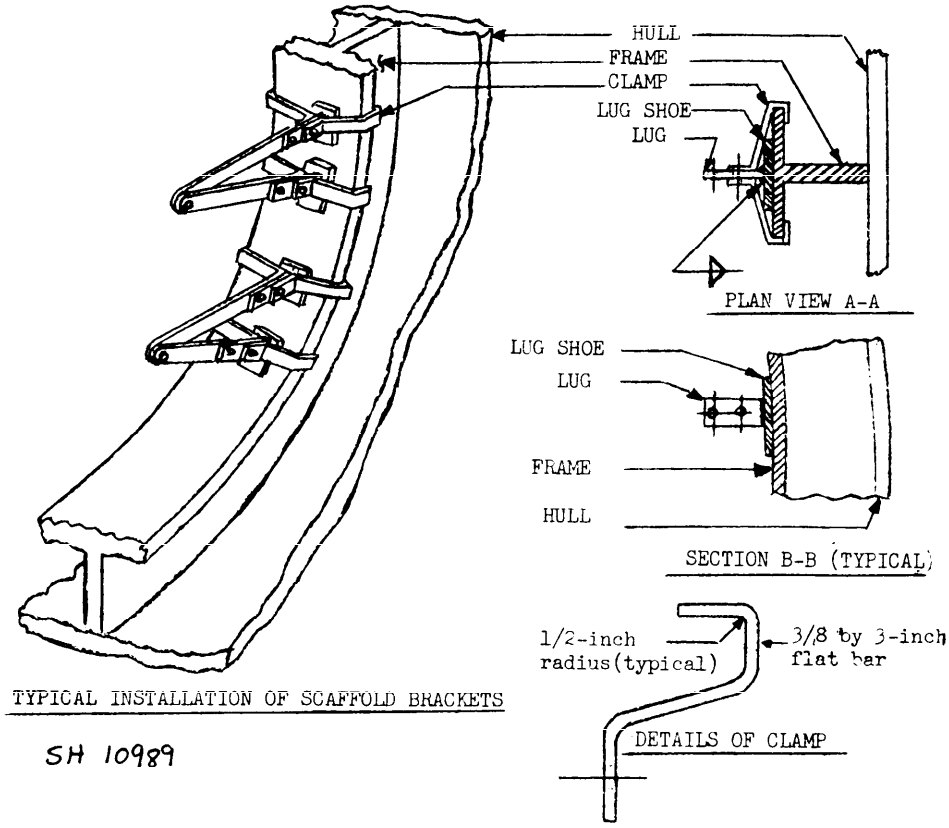


Figure 39 - Non-welded type scaffold or staging attachment arrangement.

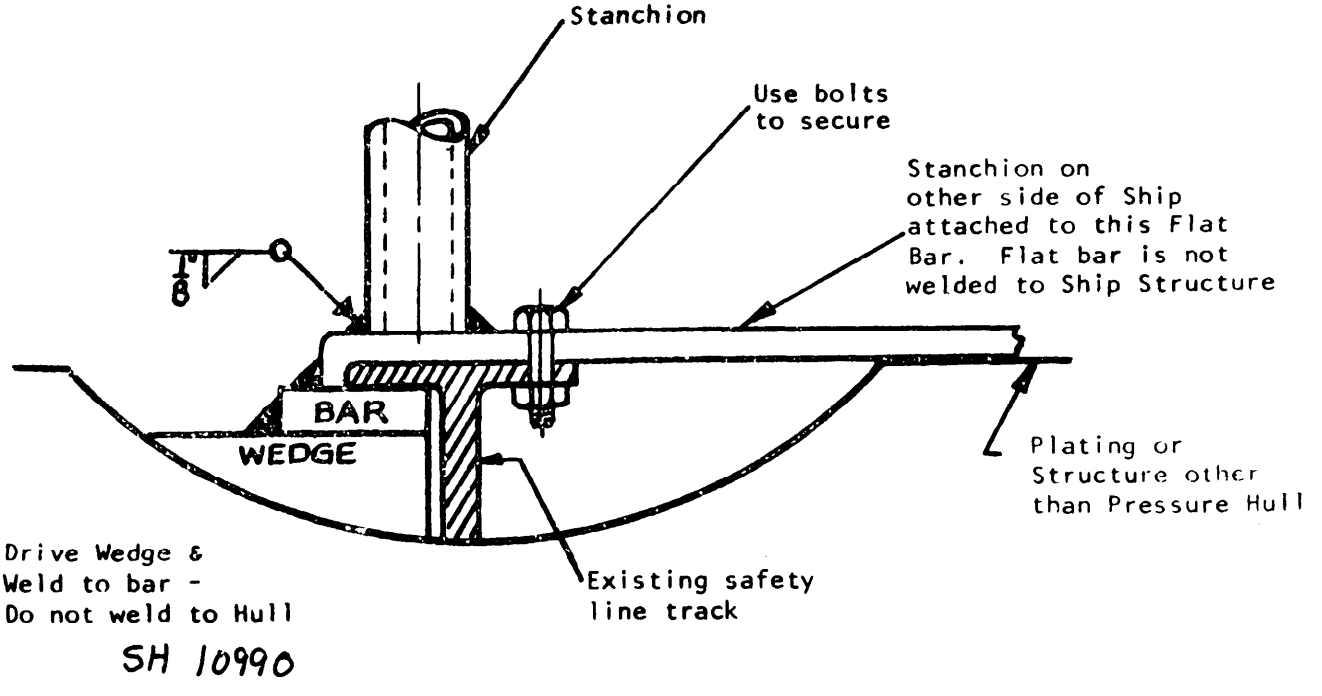


Figure 40 - Temporary stanchion attachment when safety line track is flush with deck or walking surface.

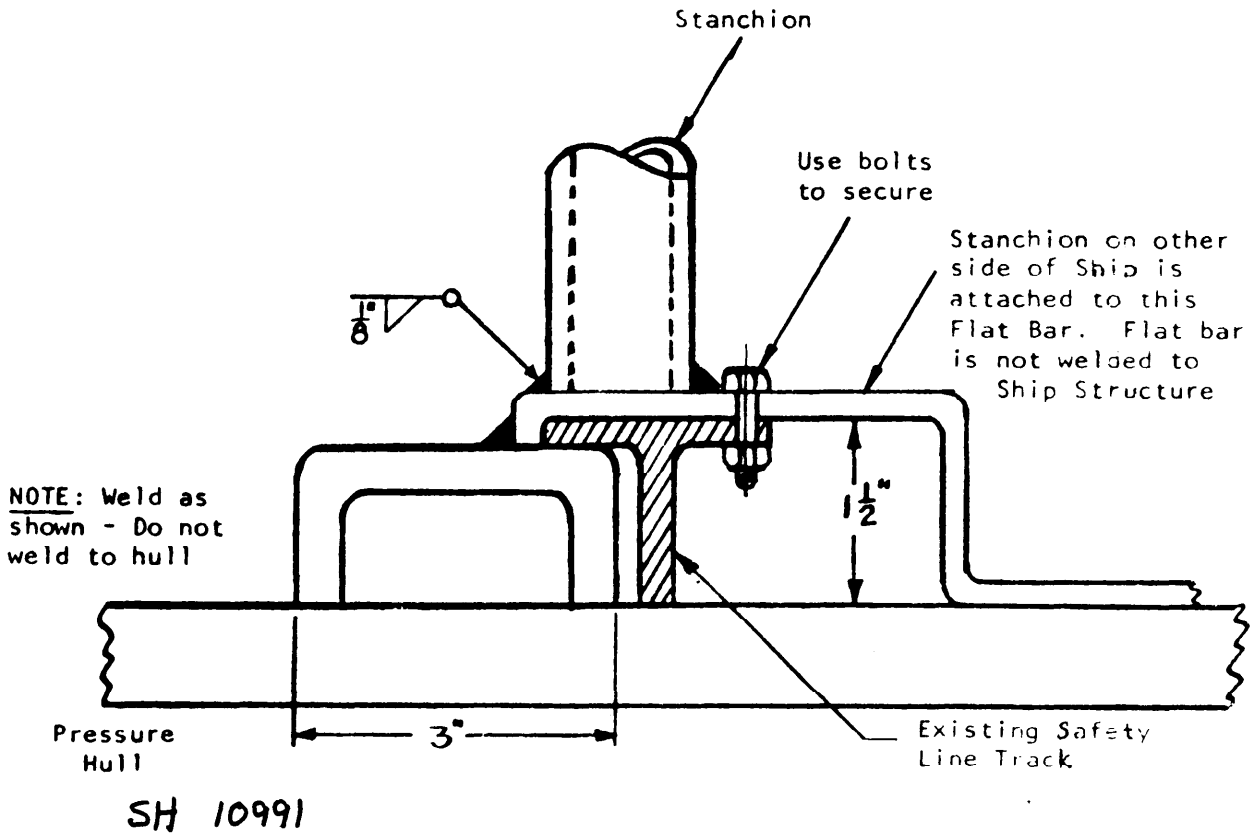


Figure 41 - Temporary stanchion attachment when safety line track attaches to pressure hull where hull is outer most plating

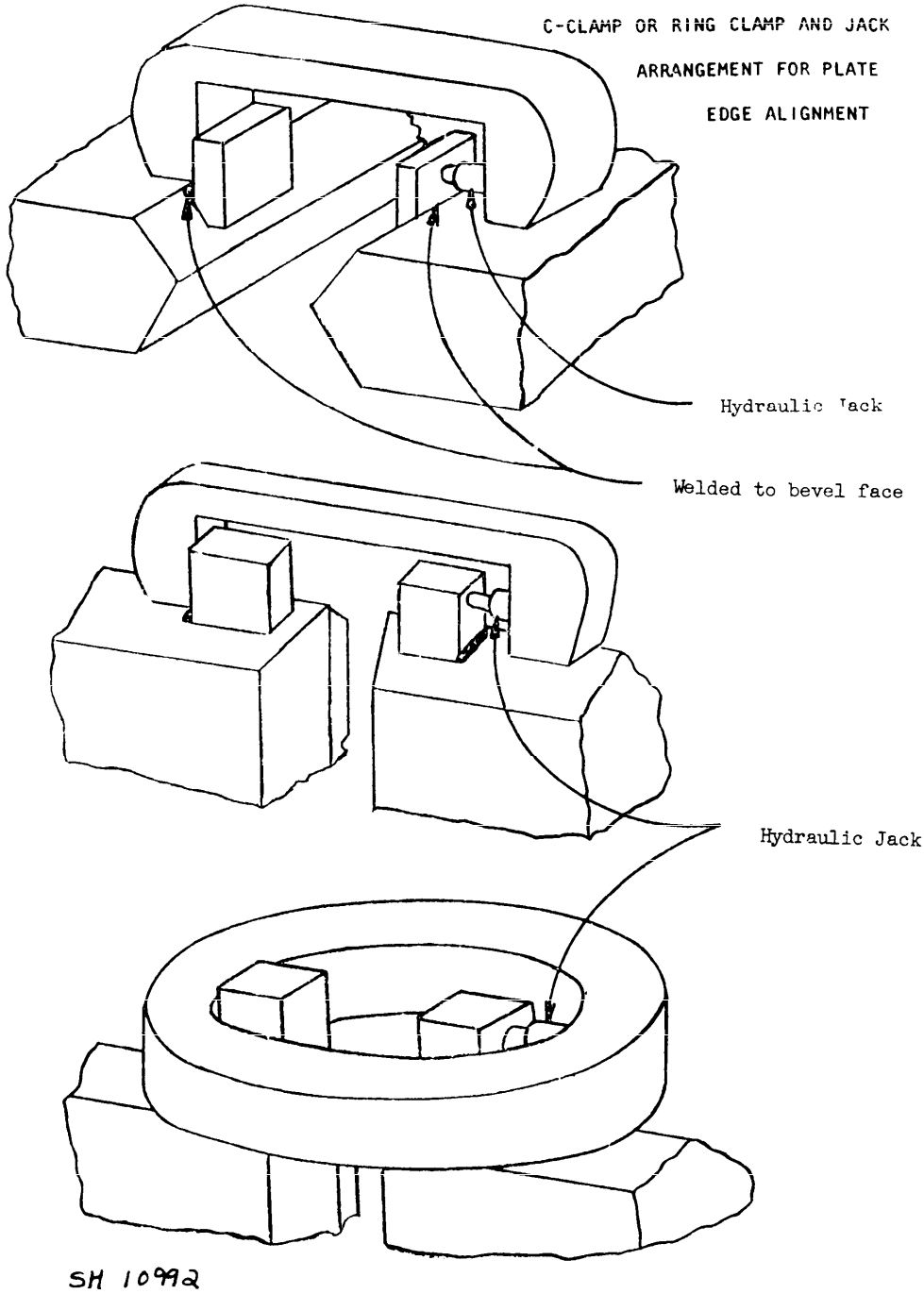
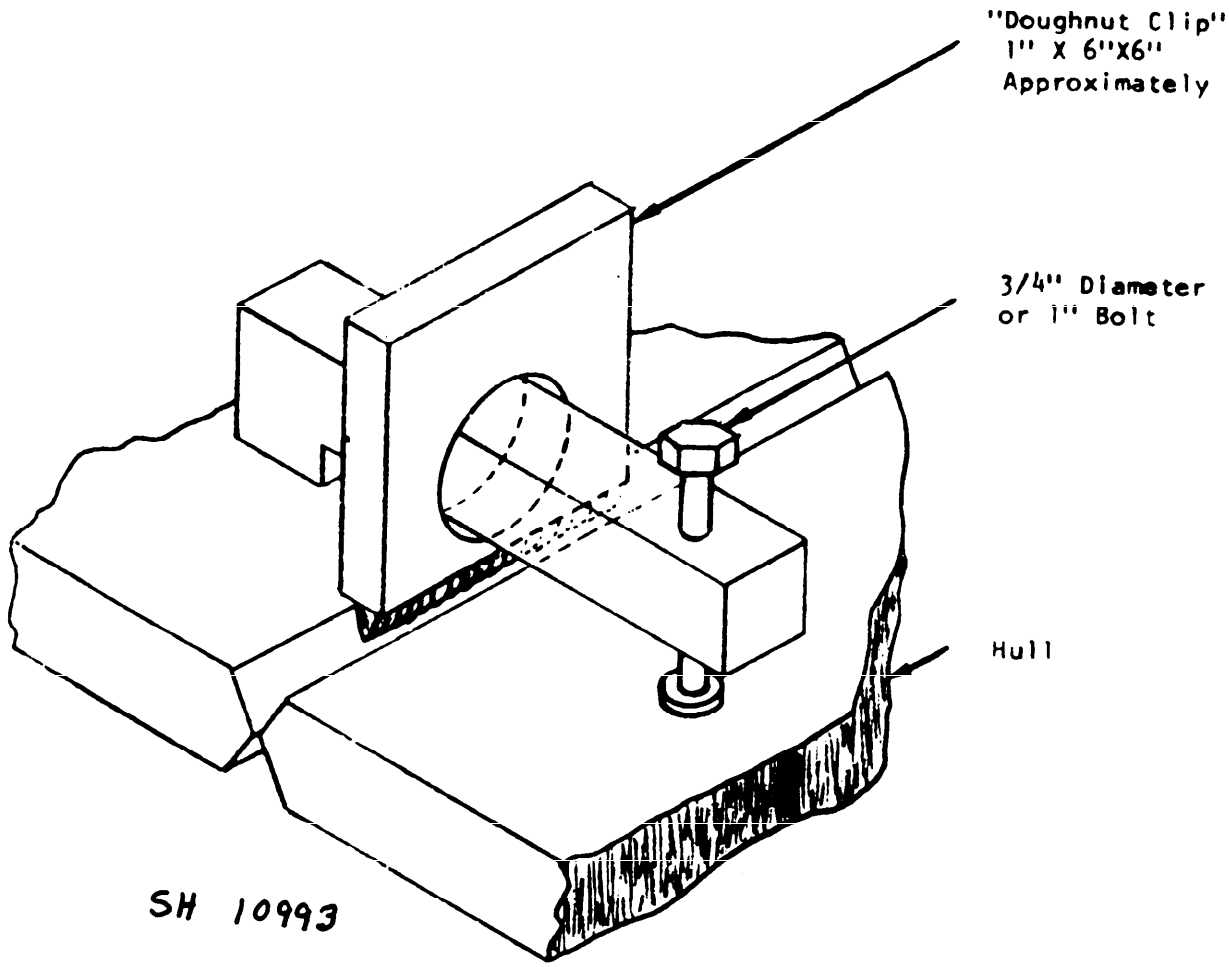


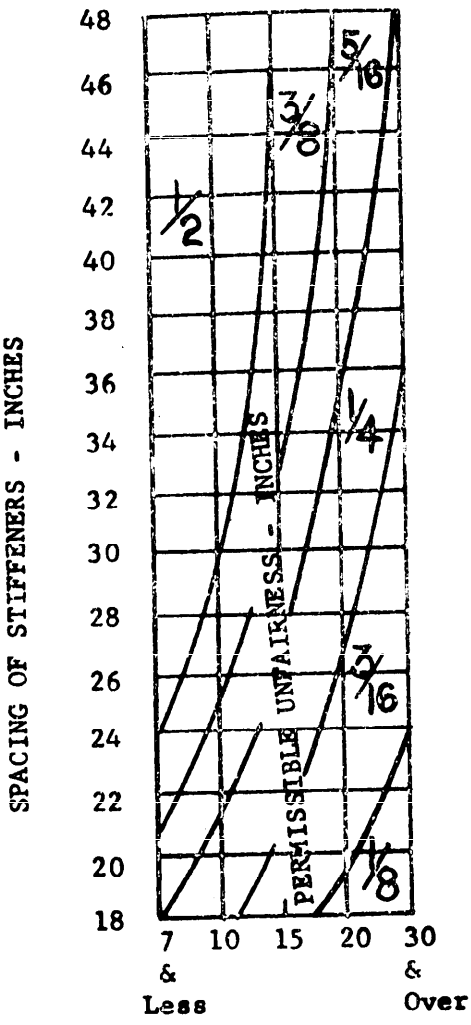
Figure 42 - C-clamp or ring clamp and jack arrangement for plate edge alignment.



1. Normally attached to second side to be welded and removed during backgouging.

2. Spacing as required and alternated from side to side on bevels.

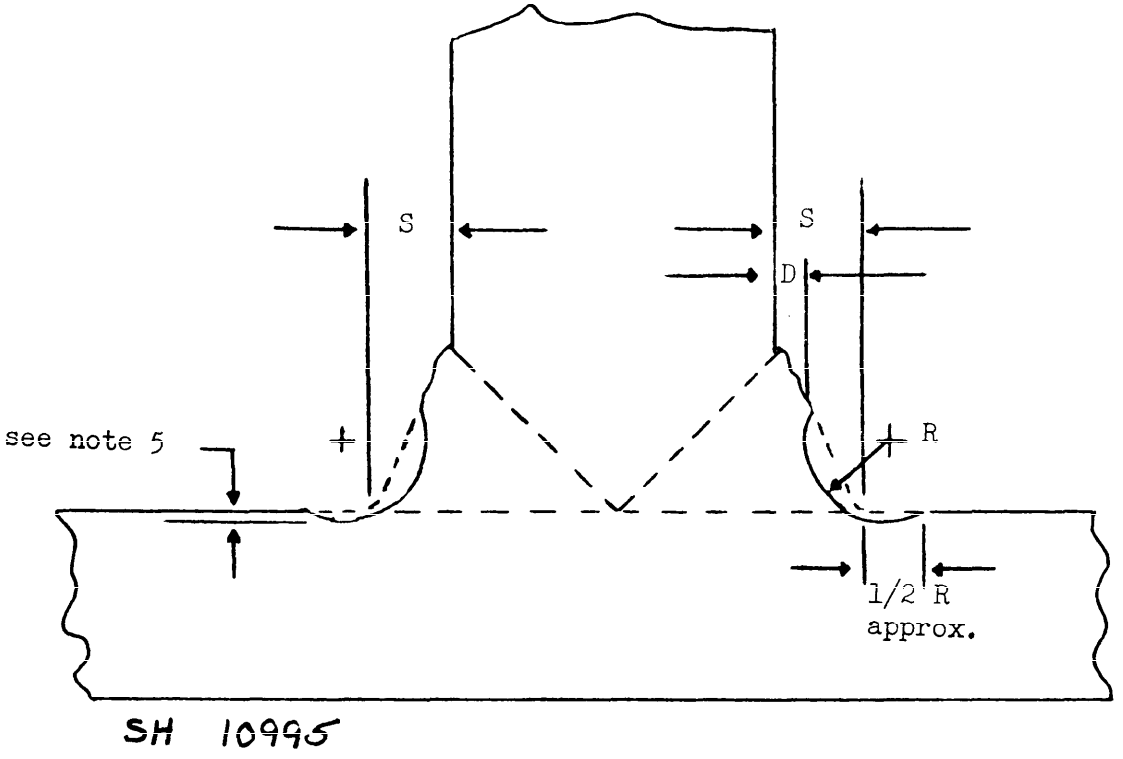
Figure 43 - Doughnut clip and jacking screw.



SH 10994

NOTE: IN APPLYING THE ABOVE TOLERANCES, THE UNFAIRNESS OF the PLATING SHALL BE MEASURED ACROSS THE MINOR DIMENSION OF THE PANEL.

Figure 44 - Tolerance for unfairness of welded plate panels.

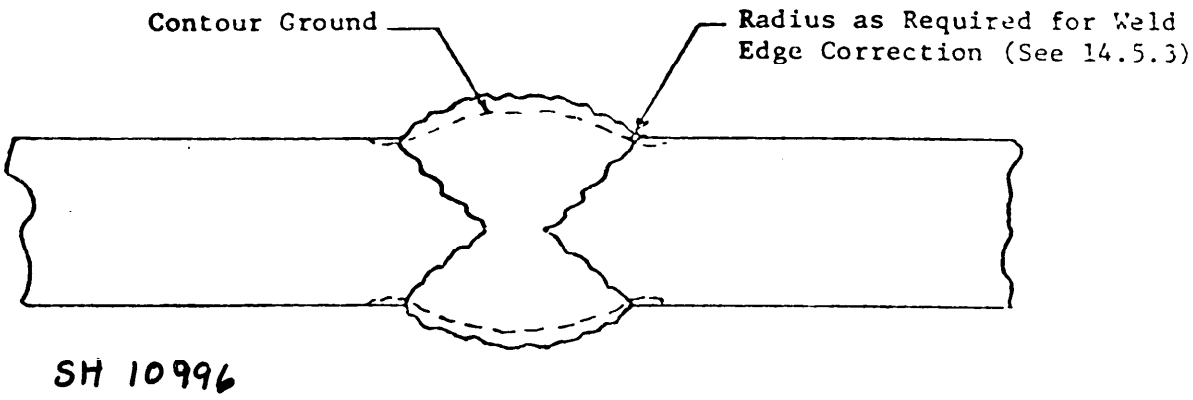


GROOVED TEE WELD

NOTES:

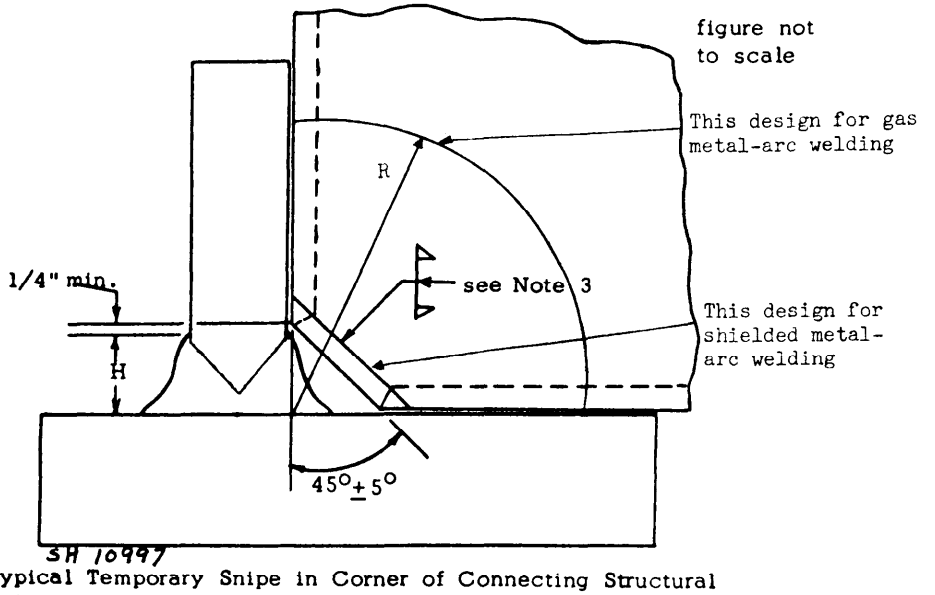
1. S = Required fillet reinforcement.
2. D = 1/3 S minimum
3. R = Approximately S or 3/8-inch whichever is less.
4. Finished contour of the grooves shall be lightly ground or burred sufficiently to remove indications of peening prior to magnetic particle inspection. The groove shall taper gradually into the weld and plate surface.
5. Nominal finished depth of indications below plate surfaces shall be 1/32", or 1/6" provided the length does not exceed 12" in any 36" length of peened and ground length

Figure 45 - Finished contour of ground, or peened and ground welds.



BUTT WELD

Figure 46 - Finished contour of ground, or peened and ground welds.



Typical Temporary Snipe in Corner of Connecting Structural Member which Intersects Two or More Other Members

NOTES:

1. Height of the snipe (H) shall be such that the corners of the snipe clear the intersecting weld preparation at least 1/4" as shown above.

2. Regardless of whether design of the sniped member specifies beveled or square edge preparation, the snipe shall be beveled as shown to insure maximum accessibility for welding.

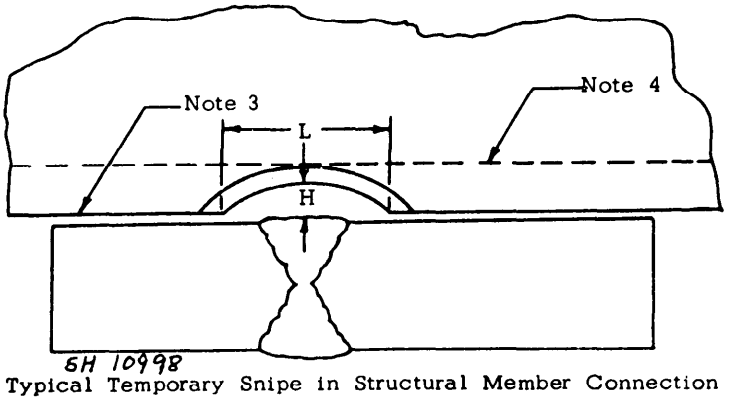
3. The snipe shall be closed during welding of the periphery of the members in which they occur.

Gas Metal-Arc Welding

4. The radius of the temporary snipe shall be 2 inch minimum in non-pressure hull structure and 3 inch minimum in pressure hull structure.

Figure 47 - Temporary access snipes.

figure not to scale



Typical Temporary Snipe in Structural Member Connection Crossing a Butt Weld

NOTES:

1. Length of snipe opening (L) to be 1/2" longer than width of butt weld which it crosses.

2. Height of snipe opening (H) to be 3/16" minimum, 3/4" maximum.

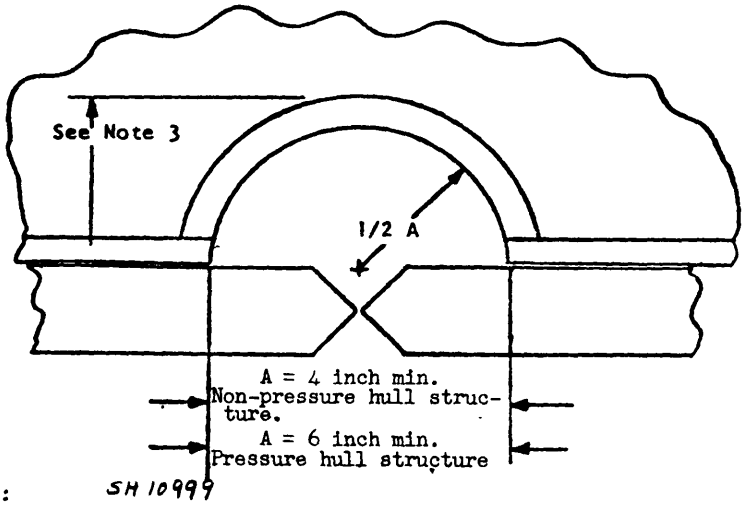
3. When design of the crossing member calls for snipe edge joint preparation, the edges of the snipe shall be beveled on each side to provide maximum accessibility to the butt.

4. When design of the crossing member calls for single or double bevel edge preparation, the edges of the snipe shall be beveled to "fair in" with the plate edge preparation bevel.

5. All snipes are to be closed during welding of the joints in which they occur.

Figure 48 - Temporary access snipes for shielded metal-arc welding.

Figure not to scale



SH 10999

NOTES:

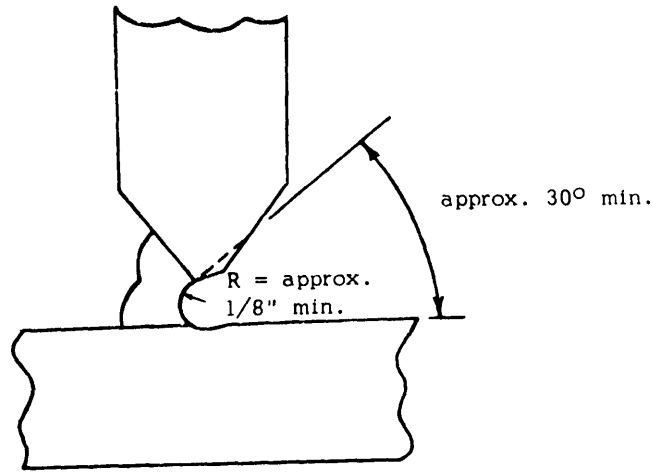
1. Temporary access hole shall be used for access for welding equipment where required to permit depositing sound welds in way of intersections.

2. Temporary access holes shall be closed by installation of a patch plate. Full penetration welds shall be employed and all welding shall be in accordance with the requirements of Section 13.

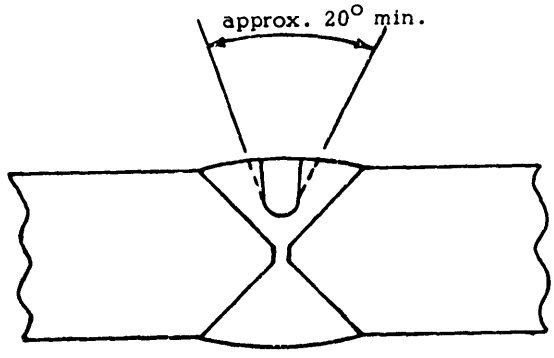
3. Where added height is required to provide access for the welding process being employed, the hole may be elongated by maintaining the specified minimum width and the 3-inch minimum radius at the upper end of the hole.

4. Nondestructive testing for the hole patch weld shall be as specified in Section 6 as applicable for the member involved.

Figure 49 - Temporary access hole for gas metal-arc or shielded metal-arc welding.



"Keyholing" resulting from grinding or carbon arc gouging. Additional metal should be removed as shown by dotted line to permit proper electrode accessibility and manipulation.



Excavation of weld metal for repair. Side walls of groove should be opened as shown by dotted lines before rewelding Radius at bottom contour = approximately 1/8" min.

SH 11000

Figure 50 - Gouged or ground excavation contours.

WELD PREPARATION FOR REPAIR OF PARTIAL PENETRATION HOLE

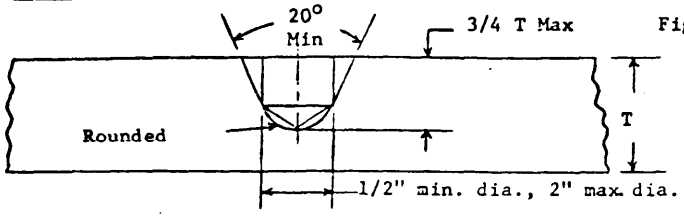
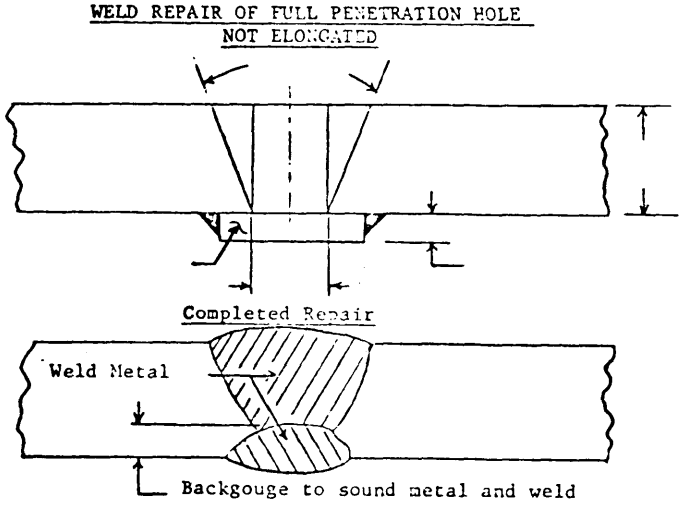


Figure not to scale

NOTES: 1. Multiple passes shall be used when making repair welds. Repair of original hole diameters over 2" diameter requires replacement by patch in accordance with 14.11.1 a or b.

2. The hole may be left round or preferably be elongated to accomodate welding. The ends of the elongated hole should taper gradually to the surface of the plate. The elongation should be in the radial direction (port and starboard) rather than fore and aft.

WELD REPAIR OF FULL PENETRATION HOLE
NOT ELONGATED



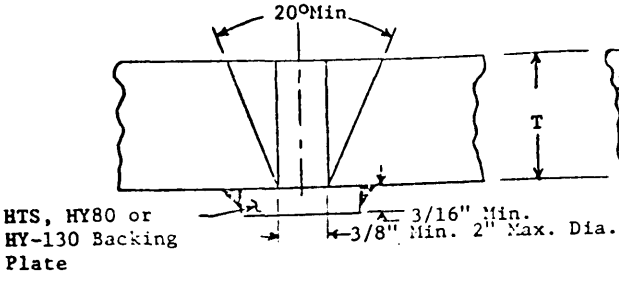
NOTE: 1. Multiple passes shall be used when making repair welds. Repair of original hole diameters over 2" diameter required replacement by patch in accordance with 14.11.1 a or b.

SH 11001

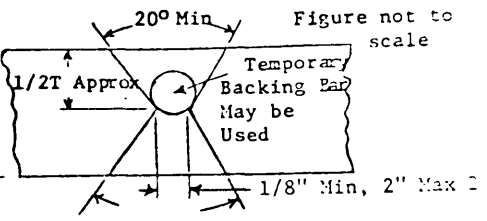
Figure 51 - Weld repair of holes.

WELD REPAIR OF FULL PENETRATION HOLE WHICH ARE ELONGATED

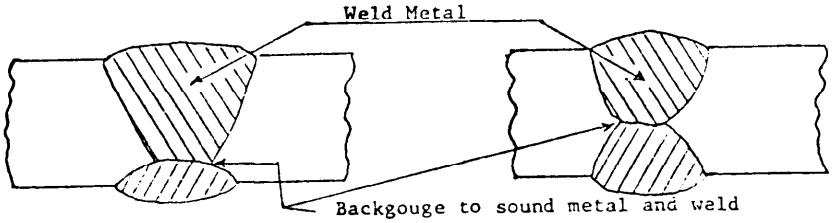
SINGLE VEE WELD REPAIR



DOUBLE VEE WELD REPAIR



COMPLETED REPAIRS

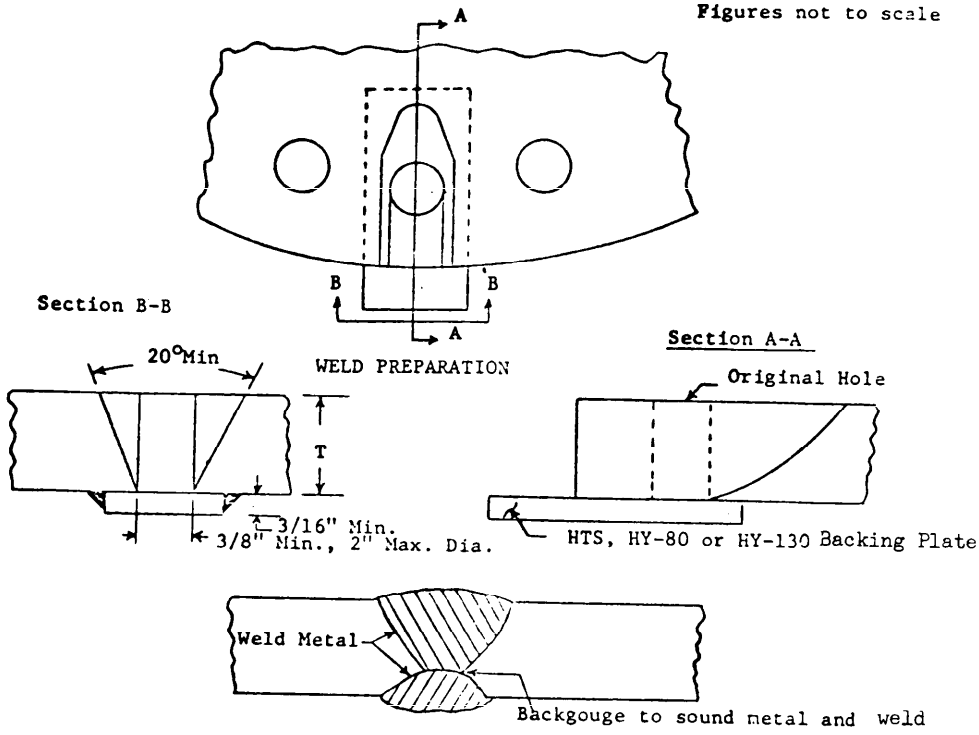


NOTES:
1. Welding shall be in accordance with Section 13. Repair of original hole diameters over 2" diameter requires replacement by patch in accordance with 14.11.1 a or b.
2. Elongation of the hole is the preferred method for repairing full penetration holes using either a single vee or double vee weld repair method. The ends of the elongated hole should taper gradually to the surface(s) of the plate. The elongation should be in the radial direction (port and starboard) rather than fore and aft.

SH 11001

Figure 51 - Weld repair of holes (con.).

WELD REPAIR OF FULL PENETRATION HOLES IN FLANGES



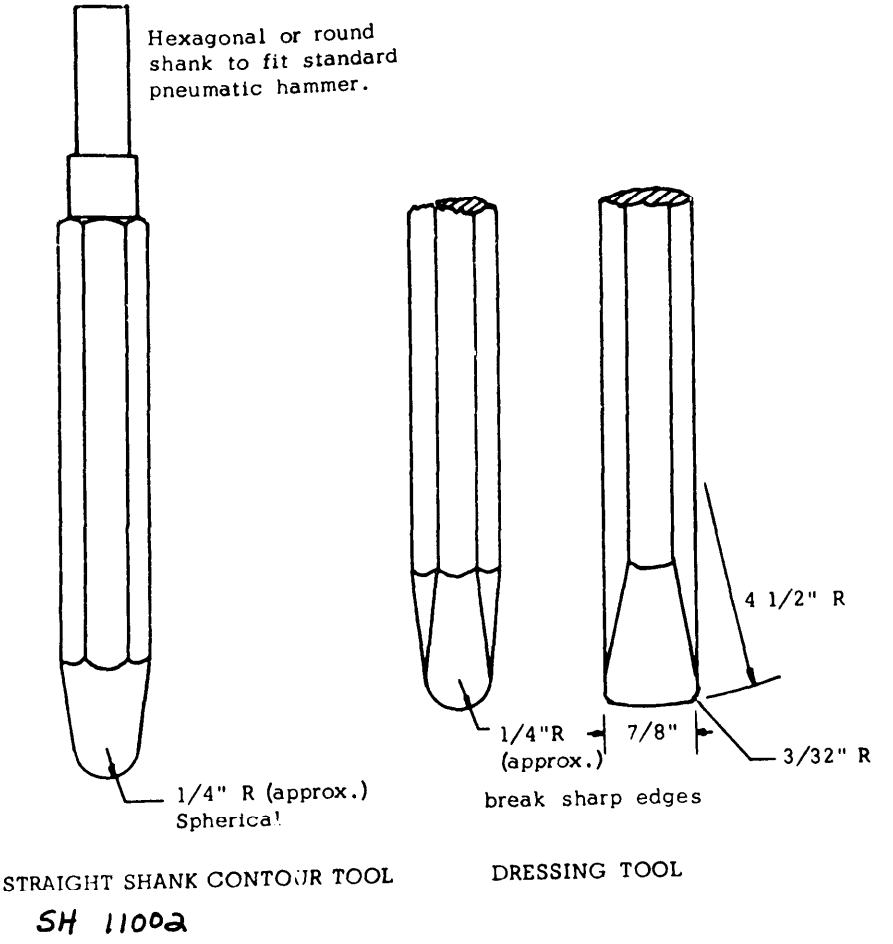
NOTES: 1. Welding shall be in accordance with Section 13.

2. The end of the hole shall be elongated as shown with a gradual taper from the backing plate to the surface of the flange.

SH 11001

Figure 51 - Weld repair of holes (con.).

figures not to scale



SH 11002

Figure 52 - Suggested mechanical peening tools.

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U.S.MAIL

COMMANDER
NAVAL SHIP ENGINEERING CENTER
CENTER BUILDING - SEC 6124
PRINCE GEORGES CENTER
HYATTSVILLE, MARYLAND 20782

FOLD

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

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