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AWS-NAVSEA B2.1-8-320:2020
An American National Standard

Standard Welding Procedure Specification for Naval Applications (SWPS-N) for Gas Tungsten Arc Welding Followed by Shielded Metal Arc Welding of Austenitic Stainless Steel (S-8), 1/8 inch [3 mm] through 1-1/2 inch [38 mm] Thick, MIL-3XX and MIL-3XX-XX, in the As-Welded Condition, Primarily Pipe for Naval Applications

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American Welding Society®

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Approved by the
American National Standards Institute
March 16, 2020

Standard Welding Procedure Specification for Naval Applications (SWPS-N) for Gas Tungsten Arc Welding Followed by Shielded Metal Arc Welding of Austenitic Stainless Steel (S-8), 1/8 inch [3 mm] through 1-1/2 inch [38 mm] Thick, MIL-3XX and MIL-3XX-XX, in the As-Welded Condition, Primarily Pipe for Naval Applications

1st Edition

Prepared by the
American Welding Society (AWS) B2 Committee on Procedure and Performance Qualification

Under the Direction of the
AWS Technical Activities Committee

Approved by the
AWS Board of Directors

Abstract

This standard contains the essential welding variables for austenitic stainless steel in the thickness range of 1/8 inch [3 mm] through 1-1/2 inch [38 mm], using manual gas tungsten arc welding followed by shielded metal arc welding. It cites the base metals and operating conditions necessary to make the weldment, the filler metal specifications, and joint designs for groove and fillet welds. This SWPS-N was developed primarily for naval applications that require performance to NAVSEA Technical Publication S9074-AQ-GIB-010/248*, Requirements for Welding and Brazing Procedure and Performance Qualification*.

American Welding Society®

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Foreword

This foreword is not part of this standard but is included for informational purposes only.

The American Welding Society generates Standard Welding Procedure Specifications (SWPSs) for industry through the cooperative efforts of the AWS B2 Committee on Procedure and Performance Qualification, the AWS B2D Subcommittee on Standard Welding Procedure Specifications, and the AWS B2G Subcommittee on Procedure Qualification Records. The Welding Procedures Committee (WPC) of the Welding Research Council (WRC) originally managed the procedure qualification records in support of AWS Standard Welding Procedure Specifications and was formally transitioned to the AWS B2G Subcommittee on Procedure Qualification Records in 2019.

The need for pretested welding procedures that are supported by adequate test data and that satisfy the technical requirements for the commonly used construction codes and specifications has been expressed by many individuals and organizations. The purpose of a welding procedure qualification is to provide test data for assessing the properties of a weld joint.

This Standard Welding Procedure Specification for Naval Applications is an outgrowth of the coordinated work of the AWS B2G Subcommittee on Procedure Qualification Records, the AWS B2 Committee on Procedure and Performance Qualification, and a Task Group of this committee that included the Naval Sea Systems Command (NAVSEA) and representatives of the shipbuilding industry. The AWS B2G Subcommittee on Procedure Qualification Records provided the test data documented by a Summary of Procedure Qualification Records. This SWPS-N was prepared by adapting AWS B2.1-8-214 to include requirements from NAVSEA Technical Publication S9074-AQ-GIB-010/248, *Requirements for Welding and Brazing Procedure and Performance Qualification*, and other relevant fabrication documents.

The welding terms used in this specification shall be interpreted in accordance with the definitions given in the latest edition of AWS A3.0M/A3.0, *Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying.* Welding symbols shall be those shown in the latest edition of AWS A2.4, *Standard Symbols for Welding, Brazing, and Nondestructive Examination.* The AWS designations for welding gases should be those shown in the latest edition of AWS A5.32M/A5.32 (ISO 14175 MOD), *Welding Consumables—Gases and Gas Mixtures for Fusion Welding and Allied Processes.*

The AWS B2 Committee on Procedure and Performance Qualification was formed in 1979 to provide welding standards concerning the subject of qualification. The primary document developed by this committee is AWS B2.1/B2.1M, *Specification for Welding Procedure and Performance Qualification*. This document established the foundation and framework for Standard Welding Procedure Specifications (SWPSs). The Task Group on Standard Welding Procedure Specifications for Naval Applications was formed in 2009 to address the need for SWPS-N documents that support the requirements of NAVSEA Technical Publication S9074-AQ-GIB-010/248 and fabrication requirements for naval applications.

Comments and suggestions for the improvement of this standard are welcome. They should be sent to the Secretary of the AWS B2 Committee on Welding Procedure and Performance Qualification, American Welding Society, 8669 NW 36 St., #130, Miami, Florida, 33166.

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Standard Welding Procedure Specification for Naval Applications (SWPS-N)

Gas Tungsten Arc Welding Followed by Shielded Metal Arc Welding of Austenitic Stainless Steel (S-8), 1/8 inch [3 mm] through 1-1/2 inch [38 mm] Thick, MIL-3XX and MIL-3XX-XX, in the As-Welded Condition, Primarily Pipe for Naval Applications

Supporting PQR Numbers: 001027, 001031, 001032, 003049, 007018 007019, 103023, 103024, 107018, 200005, 200159, 200160, 200161, 200162, 200163, 200164, 200165, 200166, 200167, 200168, 200169, 200170, 200172, 200175, 200199, 200200, 200201, 200204, 200524, 200525, 200623, 200720, 200721, 200724, 200749, 200750, 200751, 500095, 500096, 500097, 500098, 500099, 500100, 500223, 500224, 500225, 500226, 500227, 500228, 500229, 500230, 500231, 500253, 500254, 500255, 500256, 500257, 500258, 500263, 500264, 500265, 500266

Requirements for Application of SWPS-Ns

Scope. The data to support this Standard Welding Procedure Specification for Naval Applications (SWPS-N) have been derived from the above listed Procedure Qualification Records (PQRs), which were reviewed and validated under the auspices of the AWS B2G Subcommittee on Procedure Qualification Records. This SWPS-N is not valid using conditions and variables outside the ranges listed. The American Welding Society and Naval Sea Systems Command (NAVSEA) consider that this SWPS-N presents information for producing an acceptable weld using the conditions and variables listed. This procedure is intended to be used for groove and fillet welds. The user needs a significant knowledge of welding and accepts full responsibility for the performance of the weld and for providing the engineering capability, qualified personnel, and proper equipment to implement this SWPS-N.

Application. This SWPS-N is to be used only as permitted by AWS B2.1/B2.1M*, Specification for Welding Procedure and Performance Qualification*, and either NAVSEA Technical Publication S9074-AQ-GIB-010/248*, Requirements for Welding and Brazing Procedure and Performance Qualification*, or *American Bureau of Shipping (ABS) Naval Vessel Rules (NVR),* as applicable. Restrictions on the use of SWPS-Ns specified in the following documents, if any, shall also apply.

- NAVSEA Technical Publication S9074-AR-GIB-010/278*, Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels.*
- MIL-STD-1689*, Fabrication, Welding, and Inspection of Ships Structure.*
- NAVSEA Technical Publication T9074-AD-GIB-010/1688*, Requirements for Fabrication, Welding, and Inspection of Submarine Structure.*

The fabrication document(s) should specify the engineering requirements such as design, need for postweld heat treatment, fabricating tolerances, quality control, and examination and tests applicable to the end product.

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Standard Welding Procedure Specification for Naval Applications (SWPS-N)

User's Responsibility. A SWPS-N does not replace or substitute for fabrication codes, specifications, contract requirements, or capability and judgment on the part of the user. A SWPS-N is to be used only as permitted by the applicable fabrication document, specification, or contract document. The ability to produce production welds having properties suitable for the application depends upon supplementing the SWPS-N with appropriate performance qualification tests and sound engineering judgment. The user is responsible for the quality and performance of the final product in accordance with the provisions of the fabrication document(s).

Supplementary Instructions. To adapt this SWPS-N to a specific application, a user may issue supplementary instructions. Such instructions may consist of tighter fit-up tolerances, higher minimum preheat temperature, or any other instructions necessary to produce a weldment that meets the requirements of the fabrication document(s). These instructions shall not be less restrictive than provided in the SWPS-N.

Nomenclature Caution. The base material S numbers appearing in this standard are base material groupings used for qualification purposes in NAVSEA Technical Publication S9074-AQ-GIB-010/248 just as M numbers in AWS B2.1/B2.1M and P numbers in the ASME Boiler and Pressure Vessel Code are material groupings. The S numbers in this standard are different from and not to be confused with the S number nomenclature that has been used in the ASME Boiler and Pressure Vessel Code. The P number joint designations and P piping classifications in this standard have no association with the ASME P number material groupings. The "A" number suffix letter filler metal grouping in this standard is that included in NAVSEA Technical Publication S9074-AQ-GIB-010/248 and should not be confused with the A number weld metal groupings included in AWS B2.1/B2.1M or in the ASME Boiler and Pressure Vessel Code, Section IX*, Welding, Brazing, and Fusing Qualifications.*

Standard Units of Measure. This standard makes use of both US Customary Units and the International System of Units (SI). The latter are shown within brackets ([ ]) or in appropriate columns in tables and figures. The measurements may not be exact equivalents; therefore, each system must be used independently.

Safety. Safety and health issues and concerns are beyond the scope of this standard and therefore are not addressed herein. Safety and health information is available from the following sources:

American Welding Society:

(1) ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*

(2) AWS Safety and Health Fact Sheets

(3) Other safety and health information on the AWS website

Material or Equipment Manufacturers:

(1) Safety Data Sheets supplied by materials manufacturers

(2) Operating Manuals supplied by equipment manufacturers

Applicable Regulatory Agencies:

Work performed in accordance with this standard may involve the use of materials that have been deemed hazardous, and may involve operations or equipment that may cause injury or death. This standard does not purport to address all safety and health risks that may be encountered. The user of this standard should establish an appropriate safety program to address such risks as well as to meet applicable regulatory requirements. ANSI Z49.1 should be considered when developing the safety program.

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Standard Welding Procedure Specification for Naval Applications (SWPS-N)

LIMITATIONS

This procedure is not qualified for Notch Toughness or PWHT applications.

WELDING PROCESSES

Welding Processes:	GTAW (Gas Tungsten Arc Welding) followed by SMAW (Shielded Metal Arc Welding)
Method of Application:	Manual

BASE METALS

Base Metal:[1]	Austenitic Stainless Steel, S-8 to S-8 (See Table 1)
Thickness Range:	1/8 in [3 mm] through 1-1/2 in [38 mm] for groove welds, 3/16 in [5 mm] minimum for fillet welds
Pipe Diameter:	All diameters
Coating:	Uncoated

FILLER METALS

Filler Metal Specification:[2]	MIL-E-19933, *Electrodes and Rods—Welding, Bare, Chromium and Chromium-Nickel Steels;* and MIL-E-22200/2, *Electrodes, Welding, Covered (Austenitic Chromium-Nickel Steel)*
Classification:	See Table 1 for allowable classifications
Filler Metal Grouping:	A-8B for GTAW and A-8A for SMAW in NAVSEA S9074-AQ-GIB-010/248; A Number 8, F Number 6 for GTAW, and F Number 5 for SMAW in AWS B2.1/B2.1M
Deposit Thickness Range:	1/8 in [3 mm] through 1-1/2 in [38 mm] maximum plus reinforcement for groove welds 3/16 in [5 mm] through 1-1/2 in [38 mm] fillet weld size for fillet welds
Consumable Inserts:	Not permitted
Penetration Enhancing Flux:	Not permitted
Supplemental Filler Metal:	Not permitted

JOINT DESIGNS

Joint Design:	See Figure 1
Backing:	When required by Figure 1
Backing Material:[1]	Austenitic Stainless Steel, S-8 or weld metal of similar chemical analysis. Nonmetallic or nonfusing metal retainers are not permitted

POSITIONS

Permitted Positions:	All
Vertical Progression:	Uphill

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[1] S-8 base metals are as detailed in NAVSEA S9074-AQ-GIB-010/248 (or approved by the Navy authorized representative). AWS B2.1/B2.1M includes a list of Navy approved S-8 materials.

[2] Commercial filler metal may be used in place of MIL-E-19933 or MIL-E-22200/2 if purchased to the additional requirements specified in the fabrication document(s).

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Standard Welding Procedure Specification for Naval Applications (SWPS-N)

PREHEAT AND INTERPASS TEMPERATURES

Preheat Temperature:	60°F [15°C] Minimum
Interpass Temperature:	60°F [15°C] Minimum, 350°F [175°C] Maximum
Preheat Control:	Shelter the weldment from wind and inclement weather during welding and until the weld area has cooled to a temperature no more than 50°F [28°C] above ambient temperature. When using a gas flame for low temperature preheating, heat the material until it is dry and warm to the touch.
Preheat Maintenance:	Continuous or special heating not required

GAS

Torch Shielding Gas:	Argon or AWS A5.32M/A5.32 (ISO 14175 MOD)-I1-Ar or MIL-A-18455 Argon
Torch Shielding Gas Flow Rate:	10 ft^3/h [4.7 L/min] to 25 ft^3/h [11.8 L/min]
Root Shielding Gas:	Argon or AWS A5.32M/A5.32 (ISO 14175 MOD)-I1-Ar or MIL-A-18455 Argon is to be used for root shielding (purge) gas. Gas shall remain in place until the joint is completed or at least 3/16 in [5 mm] of weld metal has been deposited. When introducing root shielding gas to initiate the purge, it is necessary to have at least 6 volume changes of atmosphere within the purged zone prior to welding. As an alternative, the oxygen content of the purge zone shall be 1% or less, as measured with an Oxygen Analyzer, prior to welding. It is not necessary to shield the root of fillet welds or groove welds with backing or backgouging.
Root Shielding Gas Flow Rate:	A typical flow rate of 5 ft^3/h [2.4 L/min] to15 ft^3/h [7.1 L/min] may be used depending on component configuration.
Torch Gas Nozzle Size:	1/4 in [6 mm] to 3/4 in [19 mm] inside diameter
Trailing Gas:	None

TUNGSTEN ELECTRODES

Type:	AWS A5.12M/A5.12 (ISO 6848 MOD) EWTh-2, EWCe-2, or EWLa-1.5
Size:	1/16 in [1.6 mm] through 1/8 in [3.2 mm] diameter sharpened to a point

POSTWELD HEAT TREATMENT

Postweld Heat Treatment:	None (Not qualified for PWHT applications).

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Standard Welding Procedure Specification for Naval Applications (SWPS-N)

ELECTRICAL CHARACTERISTICS

GROOVE WELDS AND FILLET WELDS				
	Filler Metal		Current	
Beads or Layers	Classification[a]	Dia. in [mm]	Amperes	Polarity
Tack, Root, and 1 or 2 layers if needed	MIL-3XX	1/16 [1.6]	50–100[b]	DCEN (Straight)
Fill	MIL-3XX	3/32 [2.4]	70–120[b]	DCEN (Straight)
	MIL-3XX	1/8 [3.2]	90–140[b]	DCEN (Straight)
	MIL-3XX-XX	3/32 [2.4]	40–80	DCEP (Reverse)
	MIL-3XX-XX	1/8 [3.2]	65–110	DCEP (Reverse)
	MIL-3XX-XX	5/32 [4.0]	100–150	DCEP (Reverse)

[a] See Table 1 for allowable classifications.
[b] Values not to exceed capacity of tungsten electrodes.

Pulsing Current: Not permitted

TECHNIQUE

Weave or Stringer Bead: Multiple. Width of weave beads is limited to 1/2 in [13 mm] for GTAW and 3 times the diameter of the electrode core wire for SMAW.

Peening: Not required. If used, proceed as permitted by the fabrication document(s).

Initial Cleaning: Chemical or mechanical; joint shall be dry prior to welding. The joint members to be welded, including the base metal surfaces, shall be cleaned to remove foreign material for a minimum of 1 in [25 mm] from the weld edge. Mill scale or metallic oxides shall be removed from surfaces on which weld metal will be deposited.

Interpass Cleaning: Mechanical only. Weld metal and adjacent surfaces shall be cleaned prior to depositing subsequent passes or layers and upon completion of the weld.

Backgouging: Thermal and/or mechanical when used. Before applying weld metal on the reverse side of double-welded joints, the joint shall be (1) prepared for welding by chipping, grinding, machining, or arc gouging to remove all unsound metal, and (2) contoured for access, cleaned per the applicable fabrication document, and inspected per NAVSEA Technical Publication T9074-AS-GIB-010/271*, Requirements for Nondestructive Testing Methods,* to assure a sound weld.

Single or Multiple Passes: Multiple. A minimum of two weld layers are required for (a) all pressure containing weld joints, and (b) each side of tank boundary fillet weld joints.

Maximum Bead Thickness: 1/4 in [6 mm]

Repair: Defects in welds shall be removed by mechanical or arc gouging methods and the excavation inspected per the fabrication document. The repair cavity may differ in contour and dimension from a normal joint preparation and may present different restraint conditions. Repair of base metal defects shall be in accordance with the requirements of the fabrication document(s).

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Standard Welding Procedure Specification for Naval Applications (SWPS-N)

Table 1
Base Metal and Corresponding Filler Metal Classifications

Base Metal Grade or Type	Corresponding MIL-Type or Classification
304, CF8	MIL-308, MIL-308L, MIL-309, ER309L MIL-308-XX, MIL-308L-XX, MIL-309-XX, MIL-309L-XX
304L, CF3	MIL-308L, ER309L MIL-308L-XX, MIL-309L-XX
316, CF8M	MIL-316, MIL-316L MIL-316-XX, MIL-316L-XX
316L, CF3M	MIL-316L, MIL-316L-XX
321	MIL-321, MIL-347-XX
347, CF8C	MIL-347, MIL-347-XX
348	MIL-347, MIL-347-XX

Notes:
1. XX coating types -15 and -16 are acceptable.
2. When two different base metal grades or types listed above are being joined, a filler metal classification permitted for either base metal grade or type may be used.
3. The care and storage of filler metals and electrodes shall be as recommended by the electrode manufacturer and as required by the fabrication document.
4. ER309L classification to AWS A5.9/A5.9M, *Welding Consumables—Wire Electrodes, Strip Electrodes, Wires, and Rods for Arc Welding of Stainless and Heat Resisting Steels—Classification and Rods*. See footnote 2 on page 3 for use of commercial filler metal specifications.
5. Table 1 is based on room temperature strength and may not ensure high temperature or corrosion resistance properties.

COMPANY NAME: _____

In the name of the Company stated above, I accept full responsibility for the application of this SWPS-N for use with:

_____ Dated: _____

Fabrication Document(s): (Such as Code, Specification, or Contract Document)

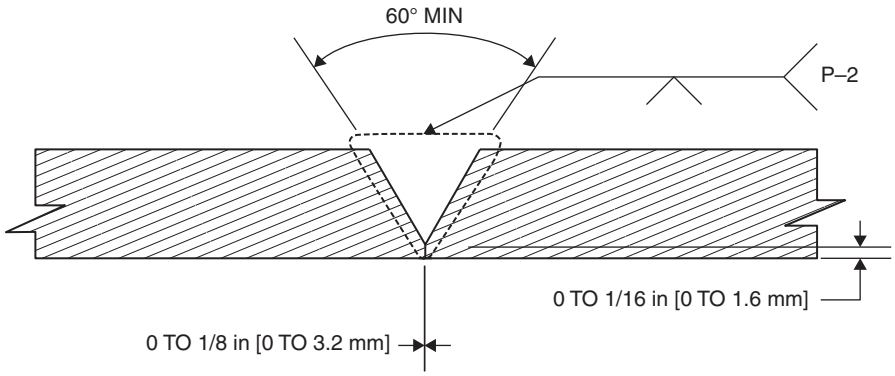
Date: _____ Approved By: _____ Title: _____

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All weld joint designs shall conform to the requirements of MIL-STD-22D, *Welded Joint Design,* and the fabrication document(s) (for example NVR). The P-number joint designations and P-piping classifications are found in these documents.

This procedure is intended to be used for groove and fillet welds. Joints in P-1 and P-LT class piping and welded from one side must use a backing ring. The sketches in Figure 1 show some of the common joint designs for full penetration groove welds and fillet welded sockets and slip-on flanges. Backing ring details are shown in Figure 2.

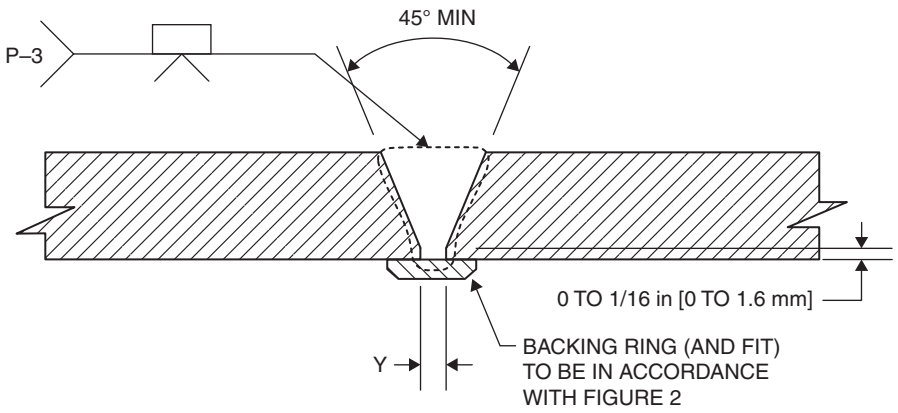


Joint 1
Butt Joint, V-Groove, P-2

Figure 1—Allowable Joint Designs Fillet and Groove Welds

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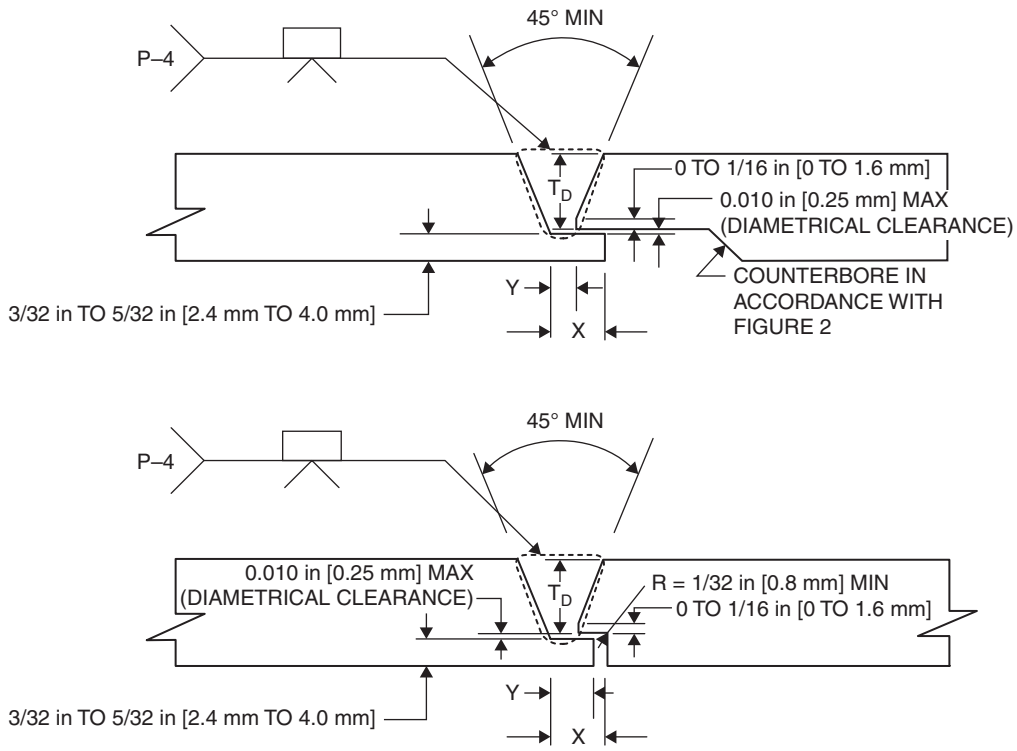
Pipe Size	Y (Root Opening), in [mm]
NPS 3 [DN 80] and under	3/16–7/16 [4.8–11.1]
Over NPS 3 [DN 80]	1/4–1/2 [6.4–12.7]

Joint 2
Butt Joint, Welded on Permanent Backing Ring, V-Groove, P-3

Figure 1 (Continued)—Allowable Joint Designs Groove and Fillet Welds

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T_D SHALL BE EQUAL TO OR GREATER THAN THE MINIMUM REQUIRED WALL THICKNESS

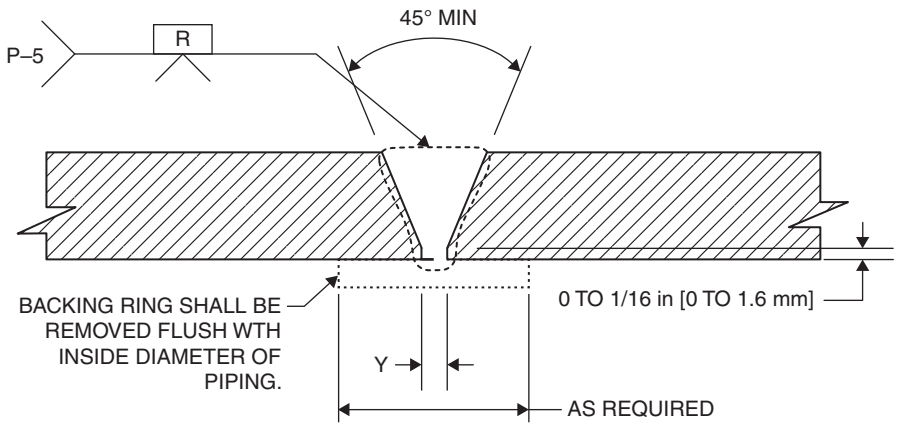
X = 7/16 in TO 9/16 in [11.1 mm TO 14.3 mm]
Y = 3/16 in TO 5/16 in [4.8 mm TO 8.0 mm]

Joint 3
Butt Joint, Welded on Permanent, Integral Backing Ring, V-Groove, P-4

Figure 1 (Continued)—Allowable Joint Designs Fillet and Groove Welds

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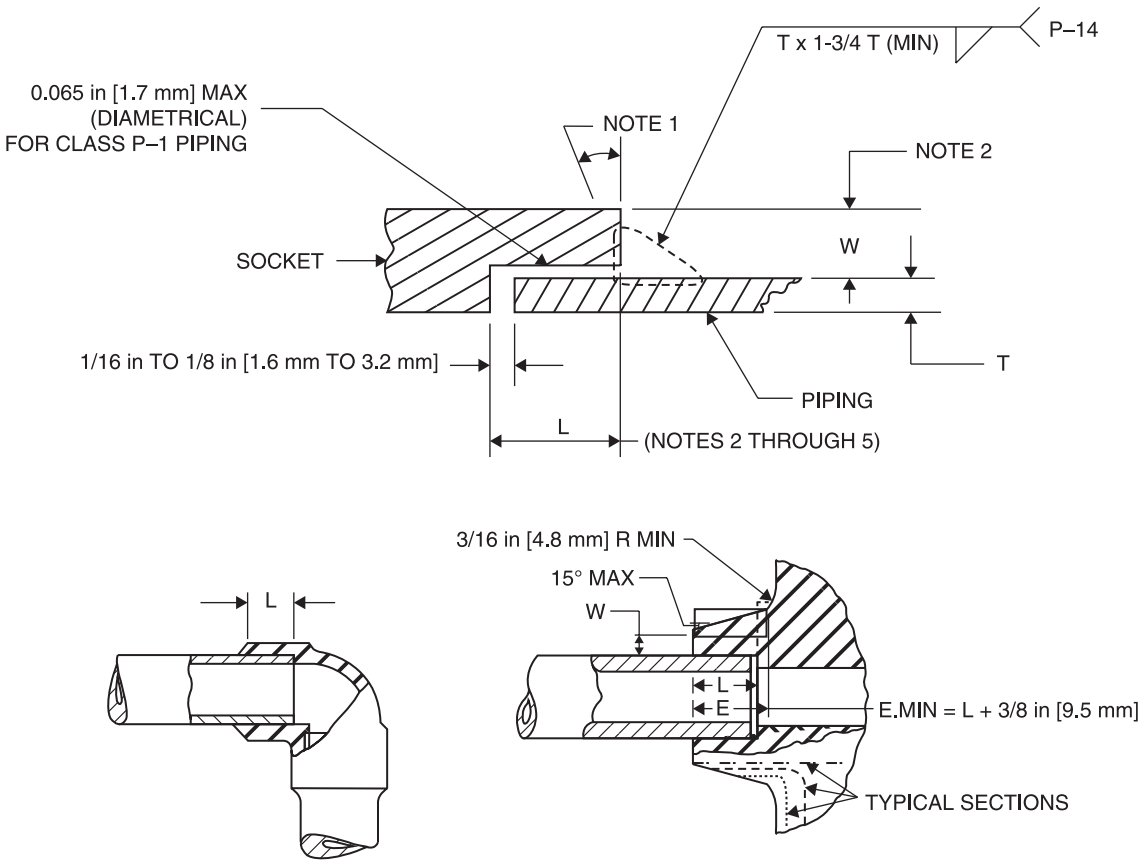
Pipe Size	Y (Root Opening), in [mm]
NPS 3 [DN 80] and under	3/16–7/16 [4.8–11.1]
Over NPS 3 [DN 80]	1/4–1/2 [6.4–12.7]

Joint 4
Butt Joint, Welded on Removable Backing Ring, V-Groove, P-5

Figure 1 (Continued)—Allowable Joint Designs Groove and Fillet Welds

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Notes:

1. Up to 22-degree bevel may be used.
2. Wall thickness (W) and minimum socket depth (L) shall be in accordance with the applicable specification for the fittings.
3. For repairs where the weldment and the pipe must be removed, the existing fitting, with reduced socket depth, may be reused under the following conditions:
   (a) The pipe end gap clearance shall be held to 1/16 in [1.6 mm] maximum.
   (b) If the diametrical clearance between the pipe and the fitting is 0.025 in [0.64 mm] or less, the L-dimension may be reduced by 50 percent of the specified dimension.
   (c) If the diametrical clearance is greater than 0.025 in [0.64 mm] but is within 0.065 in [1.7 mm], the L-dimension may be reduced by 25 percent of the specified dimension.
4. The provisions of note 3 do not apply if the diametrical clearance exceeds 0.065 in [1.7 mm].
5. The provisions of note 3 are not applicable to submarine piping without approval of the Navy authorized representative.

Joint 5
Socket, Fillet Welded, P-14

Figure 1 (Continued)—Allowable Joint Designs Groove and Fillet Welds

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