

# Standard Welding Procedure Specification (WPS)

## Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 through 3/4 inch Thick, E6010 (Vertical Uphill), As-Welded Condition, Primarily Pipe Applications

Welding Research Council<sup>1</sup>—Supporting PQR Numbers:  
001009, 003016, 003017, 103004, 106006, 107020, 200112, 200113,  
200114, 200115, 200519, 200614, 200615, 200617, 200703, 500021,  
500119, 197A, 198A, 199A

### Requirements for Application of Standard WPSs

**Scope.** The data to support this Standard Welding Procedure Specification (WPS) have been derived from the above listed Procedure Qualification Records (PQRs) which were reviewed and validated under the auspices of the Welding Research Council. This Standard WPS is not valid using conditions and variables outside the ranges listed. The American Welding Society considers that this Standard WPS presents information for producing an acceptable weld using the conditions and variables listed. 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 Standard WPS.

**Application.** This Standard WPS is to be used only as permitted by the applicable fabrication document(s) [such as code, specification, or contract document(s)]. The fabrication document(s) should specify the engineering requirements such as design, need for heat treatment, fabricating tolerances, quality control, and examination and tests applicable to the end product.

**User's Responsibility.** A Standard WPS does not replace or substitute for fabrication codes, specifica-

tions, contract requirements, or capability and judgment on the part of the user. A Standard WPS is to be used only as permitted by the applicable fabrication code, specification, or contract document.

The ability to produce production welds having properties suitable for the application depends upon supplementing the Standard WPS 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 Standard WPS 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 Standard WPS.

**Safety.** Safety precautions shall conform to the latest edition of ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, published by the American Welding Society.

This specification may involve hazardous materials, operations, and equipment. The specification does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to establish appropriate safety and health practices. The user should determine the applicability of any regulatory limitations prior to use.

1. Welding Research Council, 345 East 47th Street, New York, NY 10017.

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## LIMITATIONS

This procedure is not qualified for Notch Toughness or Postweld Heat Treatment (PWHT) applications.

## WELDING PROCESSES

**Welding Processes:** SMAW (Shielded Metal Arc Welding)  
**Method of Application:** Manual

## BASE METALS

**Base Metal:<sup>2</sup>** Carbon Steel, M-1, P-1, or S-1, Group 1 or 2 to M-1, P-1, or S-1, Group 1 or 2  
**Thickness Range:** 1/8 in. through 3/4 in. for groove welds,  
 1/8 in. minimum for fillet welds  
**Pipe Diameter:** Groove Welds: 1 in. O.D. minimum  
 Fillet Welds: 3/4 in. O.D. minimum

## FILLER METALS

**Filler Metal Specification:<sup>2</sup>** ANSI/AWS A5.1 or ASME SFA 5.1  
 A Number 1, F Number 3  
**Classification:** E6010  
**Deposit Thickness Range:** 3/4 in. maximum plus reinforcement for groove welds,  
 1/8 in. through 3/4 in. fillet weld size for fillet welds

## JOINT DESIGNS

**Joint Designs:** See Figure 1  
**Backing:** Not required  
**Backing Material:<sup>2</sup>** Carbon Steel, M-1, P-1, or S-1, Group 1, 2, or 3 or weld metal of similar chemical analysis. Nonmetallic or nonfusing metal retainers are not permitted

## POSITIONS

**Permitted Positions:** All, except as noted  
**Vertical Progression:** Uphill

## PREHEAT AND INTERPASS TEMPERATURES

**Preheat Temperature:<sup>3</sup>** 50°F Minimum  
**Interpass Temperature:<sup>3</sup>** 50°F Minimum, 500°F Maximum  
**Preheat Maintenance:** Continuous or special heating is not required

2. M, P, and S numbers for base metal and F and A numbers for filler metal and weld metal respectively, are as detailed in AWS B2.1 and ASME *Boiler and Pressure Vessel Code*, Section IX.

3. Preheat and interpass temperatures must be sufficient to prevent crack formation. Temperatures above the minimum shown may be required for base metals with a specified carbon content greater than 0.25%, for highly restrained welds or to meet the requirements of the fabrication document(s).

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## POSTWELD HEAT TREATMENT (PWHT)

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

## ELECTRICAL CHARACTERISTICS

GROOVE WELDS AND FILLET WELDS				
Layer	Electrodes <sup>1</sup>		Current	
	Classification	Dia. (in.)	Amperes	Polarity
Root or Fill	E6010	3/32	40-80	DCEP (Reverse)
Root or Fill	E6010	1/8	75-125	DCEP (Reverse)
Fill	E6010	5/32	110-170	DCEP (Reverse)
Fill	E6010	3/16 <sup>2</sup>	140-215	DCEP (Reverse)

1. The care and storage of electrodes shall be as recommended by the electrode manufacturer.  
2. Flat and Horizontal positions only.

## TECHNIQUE

**Weave or Stringer Bead:** Either  
**Peening:** Not permitted  
**Initial Cleaning:** Chemical or mechanical; joint shall be dry prior to welding  
**Interpass Cleaning:** Mechanical only  
**Backgouging:** Mechanical or thermal when required by Figure 1  
**Single or Multiple Passes:** Either. All pressure retaining welds shall be a minimum of two passes  
**Maximum Bead Thickness:** 1/4 in.  
**Repair:** Defects in welds shall be removed by mechanical or thermal methods. 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)

COMPANY NAME \_\_\_\_\_

In the name of the Company stated above, I accept full responsibility for the application of this Standard WPS for use with:

\_\_\_\_\_ Dated \_\_\_\_\_  
 Fabrication Document(s): (such as Code, Specification, or Contract Document)

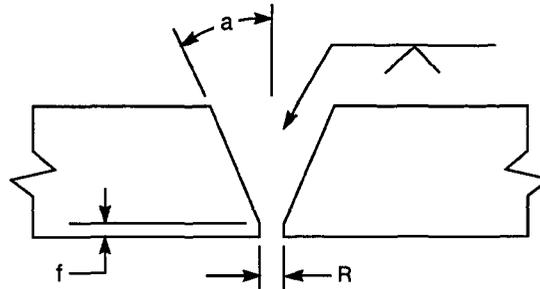
DATE \_\_\_\_\_ APPROVED BY \_\_\_\_\_ TITLE \_\_\_\_\_

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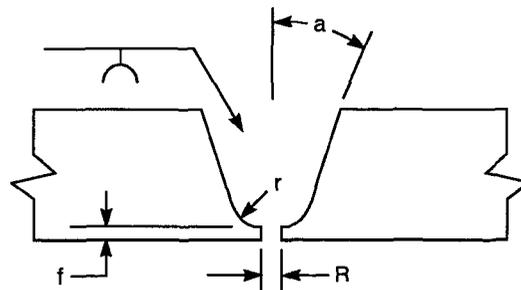
**FILLET WELDS:** All Joints

**GROOVE WELDS:** For pipe and tubular products, see Joints 1 through 4. In addition, joints having groove designs resulting from end preparations conforming with ASME/ANSI B16.25, *Buttwelding Ends*, and prequalified joint details for complete joint penetration groove welded joints permitted by ANSI/AWS D1.1, *Structural Welding Code — Steel*, are also allowable for application with this WPS.



$a = 30^\circ, +10^\circ, -0^\circ$   
 $f = 1/16 \text{ in.} \pm 1/32 \text{ in.}$   
 $R = 1/8 \text{ in.} \pm 1/16 \text{ in.}$   
 I.D. MISMATCH = 1/16 in. MAX.

JOINT 1



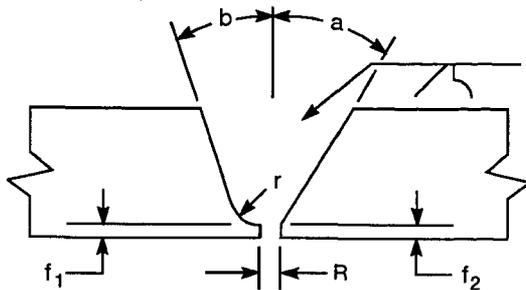
$a = 22-1/2^\circ \pm 2-1/2^\circ$   
 $f = 1/16 \text{ in.} \pm 1/32 \text{ in.}$   
 $r = 1/8 \text{ in. TO } 3/16 \text{ in. RADIUS}$   
 $R = 1/16 \text{ in., } +1/16 \text{ in., } -1/32 \text{ in.}$   
 I.D. MISMATCH = 1/16 in. MAX.

JOINT 2

Figure 1—Allowable Joint Designs

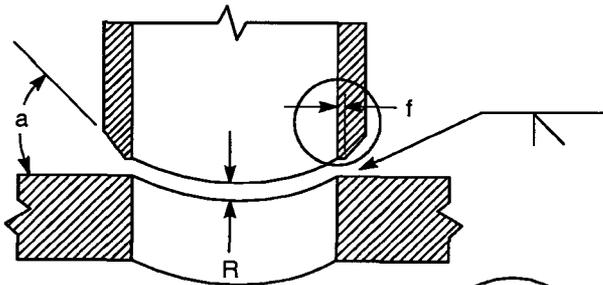
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$a = 30^\circ, + 10^\circ, - 0^\circ$   
 $b = 22-1/2^\circ \pm 2-1/2^\circ$   
 $f_1 = 1/16 \text{ in.}, + 1/16 \text{ in.}, - 1/32 \text{ in.}$   
 $f_2 = 1/16 \text{ in.}, + 1/16 \text{ in.}, - 1/32 \text{ in.}$   
 $r = 1/8 \text{ in. TO } 3/16 \text{ in. RADIUS}$   
 $R = 3/32 \text{ in.} \pm 1/32 \text{ in.}$   
 I.D. MISMATCH = 1/16 in. MAX.

JOINT 3



$a = 45^\circ \pm 5^\circ$   
 $R = 1/8 \text{ in.} \pm 1/32 \text{ in.}$   
 $f = 0 \text{ TO } 1/16 \text{ in.}$   
 I.D. MISMATCH = 1/8 in. MAX.

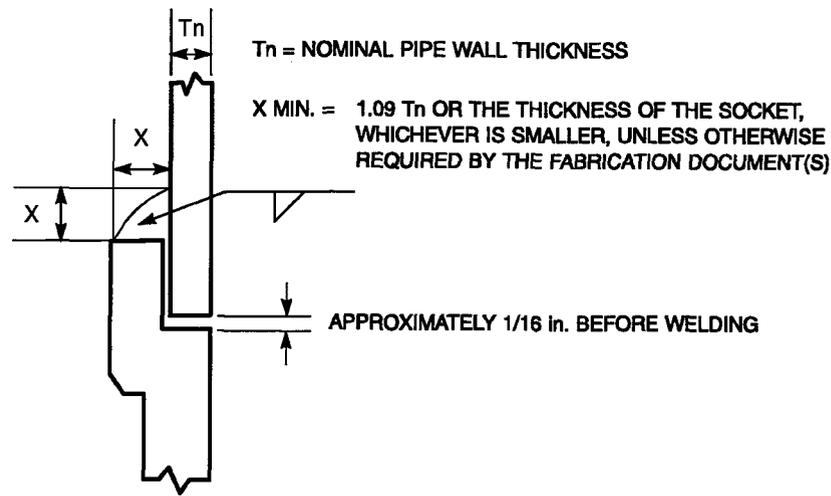
TYPICAL BRANCH CONNECTION

JOINT 4

Figure 1 (continued) — Allowable Joint Designs

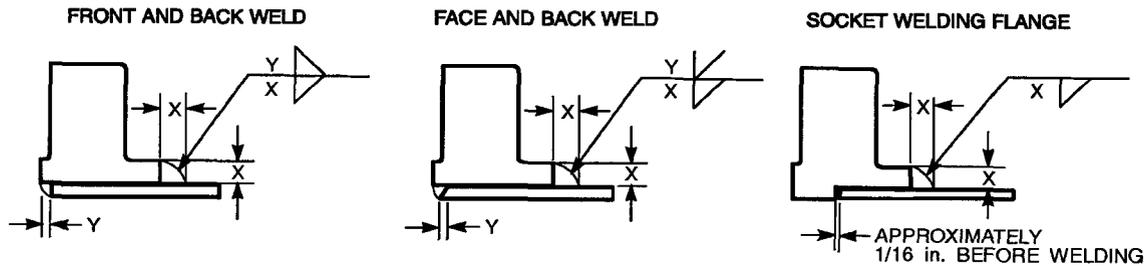
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RECOMMENDED WELDING DIMENSIONS FOR SOCKET WELDING COMPONENTS OTHER THAN FLANGES

## JOINT 5



$X$  MIN. =  $1.4 T_n$  OR THE THICKNESS OF THE HUB, WHICHEVER IS SMALLER, UNLESS OTHERWISE REQUIRED BY THE FABRICATION DOCUMENT(S)

$Y$  MIN. =  $T_n$  OR 1/4 in., WHICHEVER IS SMALLER, UNLESS OTHERWISE REQUIRED BY THE FABRICATION DOCUMENT(S)

$T_n$  = NOMINAL PIPE WALL THICKNESS

RECOMMENDED WELDING DIMENSIONS FOR FLANGES

## JOINT 6

Figure 1 (continued) — Allowable Joint Designs

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**Metric Conversions**

in.	mm	°F	°C
1/32	0.8	50	10
1/16	1.6	500	260
3/32	2.4		
1/8	3.2		
5/32	4.0		
3/16	4.8		
1/4	6.4		
3/4	19.0		
1	25.4		

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