

# COMMON WELDING PROCEDURES

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# PQR and WPS

- Procedure Qualification Record
- Welding Procedure Specification

PQR: industry standard way to determine if a given set of welding parameters produces the desired mechanical properties. Contains data such as: base & filler metal specs; welding position & geometry; preheat, interpass, PWHT temperatures and durations; shielding gas; polarity, current, voltage, wire feed speed. Description of each pass with heat input recorded. Contains test results.

WPS: formal document that the manufacturer must possess. WPS is written only after PQR testing is done and it is satisfactory. Contains essential welding parameters and material/joint specifications. Does not contain test results.



# The Procedure Handbook of Arc Welding

- It is an excellent start for welding procedures for many processes and materials
- Procedures (even from this book) must be qualified according to code to be used in practice.

# Example

- Butt joint of 3/8" structural steel
  - consider different processes
    - different joint preparation
      - welding symbol
    - calculate nominal heat input

# SMAW

## SHIELDED METAL-ARC (MANUAL)

Position: Flat  
 Weld Quality Level: Code  
 Steel Weldability: Good  
 Welded From: One side

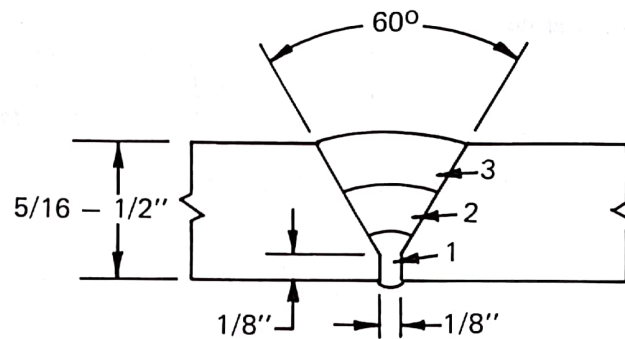


Plate Thickness (in.)	5/16		3/8		1/2		
	1	2	1	2 & 3	1	2	3
Pass	1	2	1	2 & 3	1	2	3
Electrode Class	E6011	E6027	E6011	E6027	E6011	E6011	E6027
Size	5/32	5/32	5/32	5/32	5/32	1/4	1/4
Current (amp) AC	135	240	135	240	135	275	400
Arc Speed (in./min)	5.5-6.5	12.0-14.0	5.5-6.5	12.0-14.0	5.5-6.5	8.0-10.0	10.0-12.0
Electrode Req'd (lb/ft)	0.168	0.142	0.168	0.284	0.168	0.228	0.354
Total Time (hr/ft of weld)	0.0487		0.0641		0.0717		

A5.1	A5.1M	Type of Covering	Welding Position <sup>a</sup>	Type of Current <sup>b</sup>
E6010	E4310	High cellulose sodium	F, V, OH, H	dcep
E6011	E4311	High cellulose potassium	F, V, OH, H	ac or dcep
E6012	E4312	High titania sodium	F, V, OH, H	ac or dcen
E6013	E4313	High titania potassium	F, V, OH, H	ac, dcep, or dcen
E6018 <sup>c</sup>	E4318 <sup>c</sup>	Low-hydrogen potassium, iron powder	F, V, OH, H	ac or dcep
E6019	E4319	Iron oxide titania potassium	F, V, OH, H	ac, dcep, or dcen
E6020	E4320	High iron oxide	H-fillet F	ac or dcen ac, dcep, or dcen
E6022 <sup>d</sup>	E4322 <sup>d</sup>	High iron oxide	F, H-fillet	ac or dcen
E6027	E4327	High iron oxide, iron powder	H-fillet F	ac or dcen ac, dcep, or dcen
E7014	E4914	Iron powder, titania	F, V, OH, H	ac, dcep, or dcen
E7015	E4915	Low-hydrogen sodium	F, V, OH, H	dcep
E7016 <sup>c</sup>	E4916 <sup>c</sup>	Low-hydrogen potassium	F, V, OH, H	ac or dcep
E7018 <sup>c</sup>	E4918 <sup>c</sup>	Low-hydrogen potassium, iron powder	F, V, OH, H	ac or dcep
E7018M	E4918M	Low-hydrogen iron powder	F, V, OH, H	dcep
E7024 <sup>c</sup>	E4924 <sup>c</sup>	Iron powder, titania	H-fillet, F	ac, dcep, or dcen
E7027	E4927	High iron oxide, iron powder	H-fillet F	ac or dcen ac, dcep, or dcen
E7028 <sup>c</sup>	E4928 <sup>c</sup>	Low-hydrogen potassium, iron powder	H-fillet, F	ac or dcep
E7048	E4948	Low-hydrogen potassium, iron powder	F, OH, H, V-down	ac or dcep

## Notes:

- a. The abbreviations, F, H, H-fillet, V, V-down, and OH indicate the welding positions as follows: F = Flat, H = Horizontal, H-fillet = Horizontal fillet, V = Vertical, progression upwards (for electrodes 3/16 in [5.0 mm] and under, except 5/32 in [4.0 mm] and under for classifications E6018 [E4318], E7014 [E4914], E7015 [E4915], E7016 [E4916], E7018 [E4918], E7018M [E4918M], E7048 [E4948]). V-down = Vertical, progression downwards (for electrodes 3/16 in [5.0 mm] and under, except 5/32 in [4.0 mm] and under for classifications E6018 [E4318], E7014 [E4914], E7015 [E4915], E7016 [E4916], E7018 [E4918], E7018M [E4918M], E7048 [E4948]), OH = Overhead (for electrodes 3/16 in [5.0 mm] and under, except 5/32 in [4.0 mm] and under for classifications E6018 [E4318], E7014 [E4914], E7015 [E4915], E7016 [E4916], E7018 [E4918], E7018M [E4918M], E7048 [E4948]).
- b. The term "dcep" refers to direct current electrode positive (dc, reverse polarity). The term "dcen" refers to direct current electrode negative (dc, straight polarity).
- c. Electrodes with supplemental elongation, notch toughness, absorbed moisture, and diffusible hydrogen requirements may be further identified as shown in Tables 2, 3, 10, and 11.
- d. Electrodes of the E6022 [E4322] classification are intended for single-pass welds only.

# SMAW

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Electrode Class	E6011	E6027	E6011	E6027	E6011	E6011	E6027
Electrode Size	5/32	5/32	5/32	5/32	5/32	1/4	1/4
Current (amp) AC	135	240	135	240	135	275	400
Arc Speed (in./min)	5.5-6.5	12.0-14.0	5.5-6.5	12.0-14.0	5.5-6.5	8.0-10.0	10.0-12.0
Electrode Req'd (lb/ft)	0.168	0.142	0.168	0.284	0.168	0.228	0.354
Total Time (hr/ft of weld)	0.0487		0.0641		0.0717		

Pass	Electrode	Size	I	V	U	Q'n
		in	A	V	ipm	kJ/cm
1	E6011	5/32	135	28	6	14.88
2	E6027	5/32	240	36	13	15.70
3	E6027	5/32	240	36	13	15.70

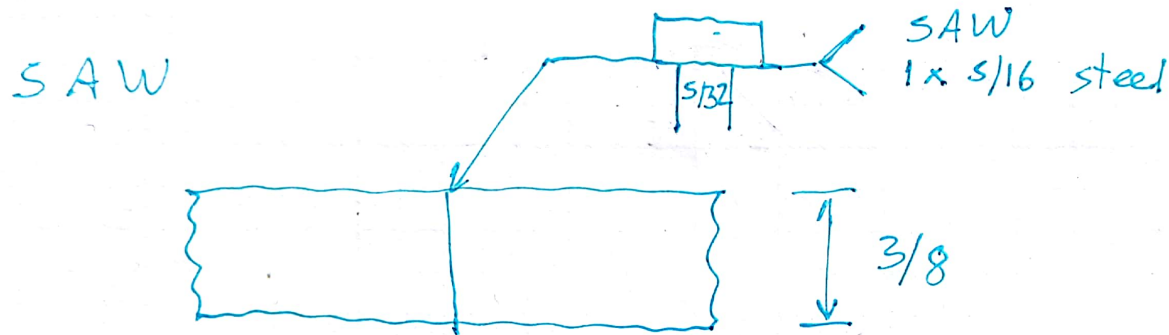
# SAW

## SUBMERGED-ARC (FULL AUTOMATIC) SINGLE ELECTRODE

<p>Welding Position: Flat  Weld Quality Level: Commercial  Steel Weldability: Good  Welded from: One side</p>				
Plate Thickness (in.)	3/16	1/4	3/8	1/2
Pass	1	1	1	1
Electrode Size	3/16	3/16	3/16	3/16
Current (amp) DC(+)	800	850	900	1000
Volts	32	33	34	35
Arc Speed (in./min)	50	33	24	17
Electrode Req'd (lb/ft)	0.087	0.14	0.23	0.35
Flux Req'd (lb/ft)	0.076 – 0.094	0.11 – 0.15	0.18 – 0.24	0.27 – 0.37
Total Time (hr/ft of weld)	0.00400	0.00606	0.00833	0.0118
Backing, minimum size (in.)	3/16 x 3/4	1/4 x 1	5/16 x 1	3/8 x 1
Gap (in.)	3/32	1/8	5/32	3/16
W, min (in.)	3/4	1	1	1
t, min (in.)	3/16	1/4	5/16	3/8



# SAW



1 Pass:  $\phi$  3/16 (9.8 mm)

900 A

34 V

24 ipm

$$q'_n = \frac{IV}{v} = \frac{900 \text{ A} \cdot 34 \text{ V}}{24 \frac{\text{in}}{\text{min}} \cdot \frac{1 \text{ min}}{60 \text{ s}} \cdot 0.0254 \frac{\text{m}}{\text{in}}} = 31 \frac{\text{kJ}}{\text{cm}}$$