Stick Electrode

Welding Guide

LINCOLN ELECTRIC

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STICK ELECTRODE WELDING GUIDE

Contents

Welding Procedures

Out-Of-Position Welding (Vertical and Overhead)

When welding out-of-position, the molten metal tends to spill out of the joint. To offset this tendency, an electrode with a fast freezing deposit is needed.

Welding made with out-of-position electrodes is slow, relatively expensive and require a high degree of operator skill. Therefore, whenever possible, work should be positioned for downhand welding using High-Deposition electrodes – see pages 8-15.

PROCEDURES

For vertical up and vertical down pipe welding technique, request Lincoln Electric bulletin C2.420, Welding Pressure Pipelines.

ALTERNATE ELECTRODES

Vertical, overhead and horizontal groove welds on plate thicker than 1/2 in. (12.7 mm) are most economically done with low hydrogen electrodes – see pages 24-34.

VERTICAL UP VS. VERTICAL DOWN

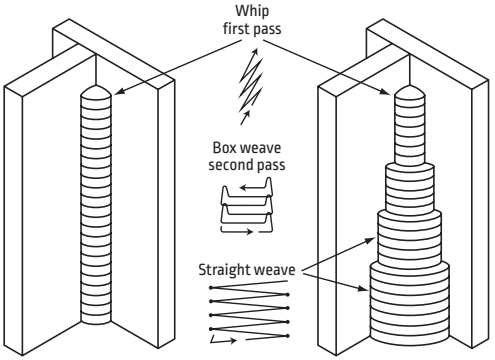
Vertical down is recommended for fastest welding of 18 gauge to 3/16 in. (4.8 mm) thick steel. A description of the recommended drag technique along with sheet metal procedures are given in the section High-Speed Welding on pages 18-23.

Vertical up techniques provide deeper penetration and lower overall welding costs on plate over 3/16 in. (4.8 mm) thick.

ELECTRODE, CURRENT AND POLARITY

The vertical up and overhead procedures in this section recommend 3/16 in. (4.8 mm) and smaller Fleetweld® 5P or 5P+ (E6010) electrode using electrode positive and currents in the lower portion of the electrode's range. When only AC otuput is available, use Fleetweld® 35 or Fleetweld® 180 (E6011) electrode at about 10% higher current.

VERTICAL UP TECHNIQUES FOR FILLET AND GROOVE WELDS



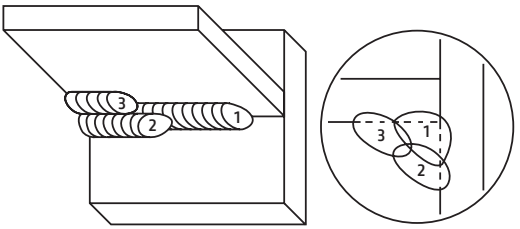
1. Make first pass root beads with a whipping technique. Whip the electrode tip out of the molten crater and up for a short time to let the crater cool before returning the electrode tip to the crater area to add more weld metal.

2. Root pass beads, particularly when made with a whipping technique, tend to be humped in the middle. Therefore, a box weave is often needed for the second pass to assure good fusion along the edge of the first bead. The box weave is similar to the straight weave except a slight upward motion is made at both sides of the weld. Maintain a short arc with no whipping.

3. Employ a straight weave for the final passes. Simply move the electrode tip back and forth across the surface of the weld pausing slightly at both edges to insure penetration and wash-in without undercut.

OVERHEAD TECHNIQUES

Weld overhead as a series of root beads using a slight circulation motion in the crater sometimes accompanied by a whip. Weave beads are too fluid and will spill.



VERTICAL UP TECHNIQUES FOR FILLET AND GROOVE WELDS

Plate Size – T (in) No. of Passes	1/4 1-2	5/16 1-2	3/8 1-2	1/2-1 All
Electrode/AWS Class	Fleetweld® 5P, Fleetweld® 5P+ / E6010			
Diameter – in (mm)	5/32 (4.0)	5/32 (4.0)	3/16 (4.8)	3/16 (4.8)
Current (Amps) Polarity Arc Speed, in/min[1]	110 DC+ 5-1/2	120 DC+ 4	150 DC+ 5	160 DC+ 4
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	11 0.323	8.5 0.440	10 0.586	See Table A

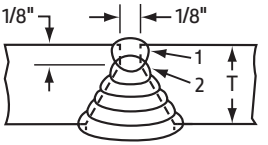


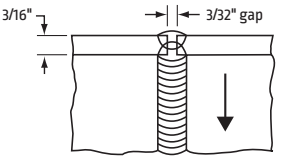
Table A

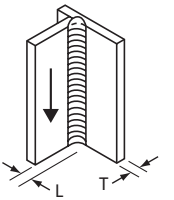
Plate Size – T	1/4	5/16	3/8	1/2-1
No. of Passes	3	4	6	10
Ft of Weld/Hr[2]	6.6	4.4	3.1	1.8
Lbs of Elec/ft	0.990	1.48	2.08	3.56

1/2 in. and thicker plates are more economically welded with low hydrogen electrodes.

VERTICAL DOWN WELDS

Weld thicker plate with vertical up techniques.

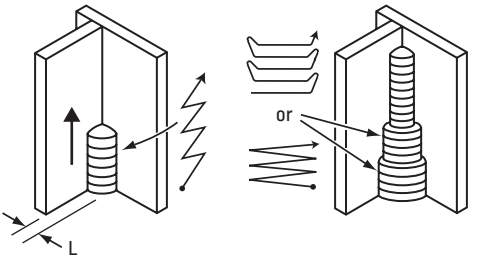




	Groove	Fillet
Plate Size – T (in) Leg Size – L (in) No. of Passes	3/16 – 1-2	– 5/32 1
Electrode/AWS Class	Fleetweld® 5P, Fleetweld® 5P+ / E6010	
Diameter – in (mm)	5/32 (4.0)	
Current (Amps) Polarity Arc Speed, in/min[1]	120 DC+ 10-11	
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	26 0.168	55 0.071

(1) First pass only. On later passes adjust arc speed to obtain proper bead size.
(2) Total for all passes. 100% operating factor.

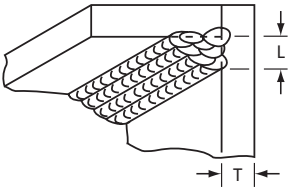
VERTICAL UP FILLET WELDS



No. of Passes Leg Size - L (in.)	1 3/16	1 1/4	1 5/16	1 3/8	1-2 1/2	1-3 5/8	1-4 3/4
Electrode/AWS Class	Fleetweld® 5P, Fleetweld® 5P+[1] / E6010						
Diameter – in (mm)	3/16 (4.8)	3/16 (4.8)	3/16 (4.8)	3/16 (4.8)	3/16 (4.8)	3/16 (4.8)	3/16 (4.8)
Current (Amps) Polarity Arc Speed, in/min[2]	150 DC+ 8	155 DC+ 5	155 DC+ 3	155 DC+ 2	160 DC+ 4-1/2	160 DC+ 4-1/2	160 DC+ 4-1/2
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	40 0.137	25 0.211	15 0.346	10 0.514	6.8 0.850	4.4 1.31	3.0 1.93

OVERHEAD FILLET WELDS

After first bead, the sequence of bead placements starts on vertical plate for each layer.



No. of Passes Leg Size - L (in.)	1 5/32	1 3/16	1 1/4	1-2 5/16	1-3 3/8	1-6 1/2	1-10 5/8	1-15 3/4
Electrode/AWS Class	Fleetweld® 5P, Fleetweld® 5P+ / E6010							
Diameter – in (mm)	5/32 (4.0)	5/32 (4.0)	5/32 (4.0)	5/32 (4.0)	3/16 (4.8)	3/16 (4.8)	3/16 (4.8)	3/16 (4.8)
Current (Amps) Polarity Arc Speed, in/min[2]	130 DC+ 7-1/2	170 DC+ 9	170 DC+ 5	170 DC+ 7	170 DC+ 7	170 DC+ 7	170 DC+ 7	170 DC+ 7
Ft of Weld/Hr[3] Lbs of Elec/ft of Weld	38 0.100	45 0.145	25 0.253	18 0.369	12 0.532	6.9 0.945	4.4 1.48	3.1 2.13

(1) 5/32 in. (4.0 mm) electrode can be used to allow better control. (2) First pass only. On later passes adjust arc speed to obtain proper bead size. (3) Total for all passes. 100% operating factor.

High-Deposition Welding

High deposition applications includes groove, fillet, lap and corner welds in 3/16 in. (4.8 mm) and thicker plate welded with the work level or slightly downhill. These joints are capable of holding a large molten pool of weld metal as it freezes.

These welds are made with Jetweld® electrodes because the high iron powder content in the coating produces high deposit rates to fill joints in the shortest time for economical welding.

PROCEDURES

ALTERNATE ELECTRODES

When desired, the following alternate electrodes can be used with similar procedures:

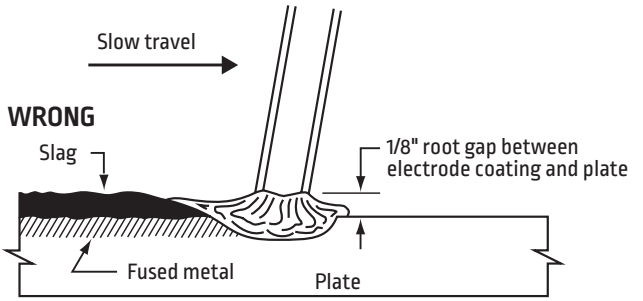
RECOMMENDED	ALTERNATE
Jetweld® 1 (E7024-1)	Jetweld® 3 (E7024)
Jetweld® 1 or 3 (E7024)	Jetweld® LH-3800 (E7028H8)

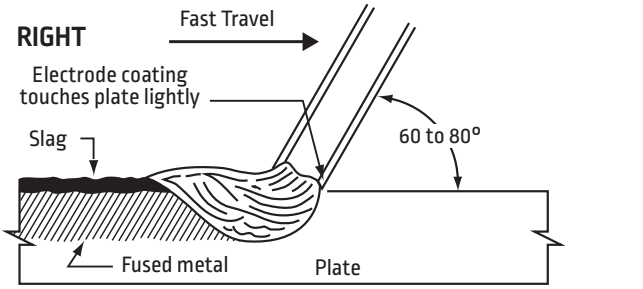
JETWELD OPERATING TECHNIQUES

Polarity and Current – Use AC for fast welding speeds, high deposit rates, and good arc characteristics. DC can be used but the resulting arc blow may complicate control of the molten puddle.

Optimum current for most jobs is 5-10 amps above the center of the electrodes range. Do not exceed the center of the range for x-ray quality deposits.

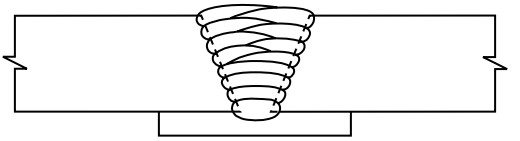
Use a Drag Technique – Tip the electrode 10 to 30° in the direction of travel and make stringer beads. Weld with the electrode end lightly dragging on the work to force the molten metal out from under the electrode tip allowing adequate penetration. The smooth welds look almost like automatic welds.





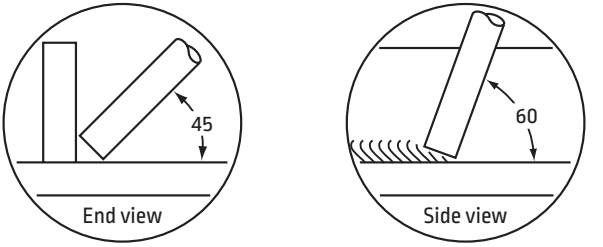
Travel fast, but not too fast for good slag coverage. Stay about 1/4 in. (6.4 mm) to 3/8 in. (0.375 mm) ahead of the molten slag. If travel speed is too slow, a small ball of molten slag may form and roll ahead of the arc causing erratic bead shape, spatter, and poor penetration.

Deep Groove Groove Welds – To hold the large pool of molten weld metal from Jetweld electrodes, either a weld backing plate or a root pass made with deep penetrating electrode (usually E6010 or E6011) is required. Deposit Jetweld beads with a stringer technique or a slight weave to obtain fusion to both plates. Split weave welds are better than a wide weave near the top of deep grooves. Size the second to last layer so the last layer will not exceed a 1/16 in. (1.6 mm) buildup.



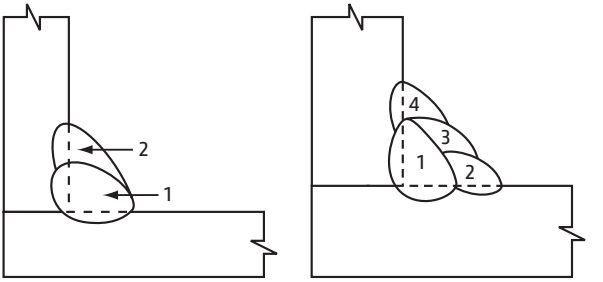
Fillet and Lap Welds – The ideal fillet or lap weld has equal legs and a flat or slightly convex bead. Excess convexity wastes weld metal. A concave bead is susceptible to shrinkage cracks.

Flat fillet and lap welds are made with the same general techniques as groove welds.



Weld single pass fillets using a drag technique with the tip of the electrode touching both plates. Usually weld with the electrode at a 45° angle (end view) from the horizontal plate. However, adjust this angle from as little as 30° to as much as 60° when required to maintain equal leg sizes on both plates.

When two passes are needed, deposit the first bead mostly on the bottom plate. To weld the second pass hold the electrode at about 45° angle fusing into the vertical plate and the first bead.



Make multiple pass horizontal fillets as shown in the sketch. Put the first bead in the corner with fairly high current even though there may be slight undercut, succeeding passes will burn it out. Deposit the second bead on the horizontal plate fusing into the first bead. Hold the electrode angle needed to deposit the filter beads as shown, putting the final bead against the vertical plate.

LAP WELDS

Use fillet weld procedures for laps on 3/8 in. (0.375 mm) and thicker plate.

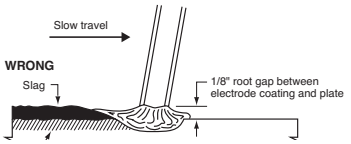


Plate Size – T (in)	3/16	1/4	5/16
Leg Size – L (in)	3/16	1/4	5/16
No. of Passes	1	1	1
Electrode/AWS Class	Jetweld® 1 / E7024-1		
Diameter – in (mm)	3/16 (4.8)	7/32 (5.6)	7/32 (5.6)
Current (Amps)	290	360	360
Polarity	AC	AC	AC
Arc Speed, in/min	15-1/2	15	13
Ft of Weld/Hr[1]	78	75	65
Lbs of Elec/ft of Weld	0.170	0.211	0.253

CORNER WELDS

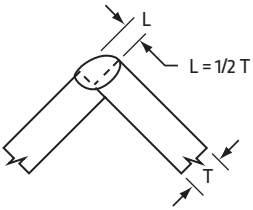
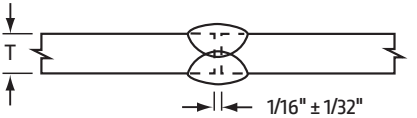


Plate Size – T (in)	3/16	1/4	5/16	3/8	1/2
Leg Size – L (in)	3/32	1/8	5/32	3/16	1/4
Pass	1	1	1	1	1
Electrode/AWS Class	Jetweld® 1 / E7024-1				
Diameter – in (mm)	5/32 (4.0)	3/16 (4.8)	7/32 (5.6)	7/32 (5.6)	1/4 (6.4)
Current (Amps)	215	260	330	340	390
Polarity	AC	AC	AC	AC	AC
Arc Speed, in/min	24.5	21	20.5	18	15.5
Ft of Weld/Hr[1]	120	105	103	90	77
Lbs of Elec/ft of Weld	0.075	0.114	0.152	0.175	0.250

NOTE: Maximum strength, full size corner welds, as illustrated, can be made using the next smaller E7024 electrode, lower currents, slower arc speed and slower travel speed. Use 2 passes on 1/2 in. (12.7 mm) plate when making full size corner weld.

(1) 100% operating factor.

GROOVE WELDS



Do not use for code quality work

This square edge groove joint requires the deep penetration of Fleetweld® 5P or 5P+.

Plate Size – T (in) Pass	3/16 2	1/4 2	5/16 2	3/8 2
Electrode/AWS Class	Fleetweld® 5P, Fleetweld® 5P+ / E6010			
Diameter – in (mm)	1/4 (6.4)	5/16 (7.9)	5/16 (7.9)	5/16 (7.9)
Current (Amps) Polarity Arc Speed, in/min[1]	240 DC+ 18	325 DC+ 18	30 DC+ 18	10 DC+ 18
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	45 0.171	45 0.275	45 0.315	45 0.330

(1) Both passes. (2) Total for all passes. 100% operating factor.

GROOVE WELDS

FIRST PASS
3/16 in. Jetweld® 2 E6027
300 amps. AC at 14 in/Min.

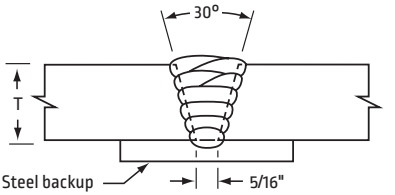
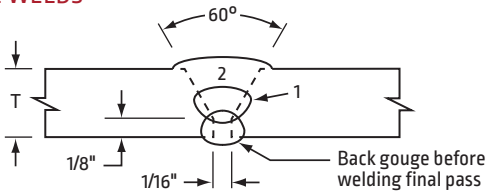


Plate Size – T (in) Pass	5/16 2-3	3/8 2-3	1/2 2-4	3/4 2-6	1 2-8
Electrode/AWS Class	Jetweld® 2 / E6027				
Diameter – in (mm)	1/4 (6.4)				
Current (Amps) Polarity Arc Speed, in/min[1]	390 AC 14				
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld[3]	20 0.524	22 0.697	17 1.00	11 1.69	8.2 2.37

(1) First pass only. On later passes adjust arc speed to obtain proper bead size.
(2) Total for all passes. 100% operating factor. (3) Plus 0.228 lbs. of 3/16 in. (4.8 mm) E6027/ft. of weld for first pass.

DEEP GROOVE WELDS

Joint A
Pass 1
E6011



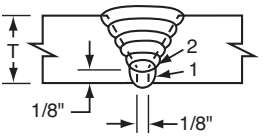
Root passes - Joints A, B & C - 3/16 Fleetweld® 35 (E6011), 175-180 Amps. AC at 6-9 in/min.

JOINT A				
Plate Size – T (in) Pass	3/8 2-3	1/2 2-3	5/8 2-3	5/8 4
Electrode/AWS Class	Jetweld® 2 / E6027			
Diameter – in (mm)	3/16 (4.8)	7/32 (5.6)	1/4 (6.4)	7/32 (5.6)
Current (Amps) Polarity	280 AC	340 AC	375 AC	340 AC
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	21 0.366	19 0.4810	14 0.795	14 0.235

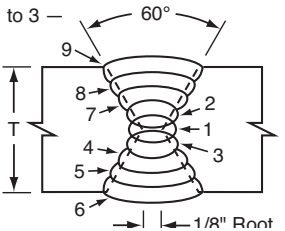
(1) Total for all passes. 100% operating factor. (2) Plus 0.160 lbs. of 3/16 in. (4.8 mm) E6011/ft. of weld for each root pass.

OVER E6011 ROOT PASSES

Joint B
5/16" & 3/8" Pass 1 — E6011
1/2" - 1" Pass 1 & 2 — E6011



Joint C
Passes 1 to 3 —
E6011



	JOINT B					JOINT C		
Plate Size – T (in) Pass	5/16 2	3/8 2-3	1/2 3	3/4 3-6	1 3-10	3/4 4-5	1 4-7	1-1/2 4-9
Electrode/AWS Class	Jetweld® 2 / E6027							
Diameter – in (mm)	5/32 (4.0)	5/32 (4.0)	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)		
Current (Amps) Polarity	220 AC	220 AC	390 AC	390 AC	390 AC	390 AC		
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld[3]	21 0.142	16 0.284	14 0.354	8.2 1.47	5.3 2.94	9.0 0.728	6.2 1.45	4.1 3.04

(1) Total for all passes. 100% operating factor. (2) Plus 0.160 lbs. of 3/16 in. (4.8 mm) E6011/ft. of weld for each root pass.

FLAT FILLET WELDS

Also see Low Hydrogen Procedures.

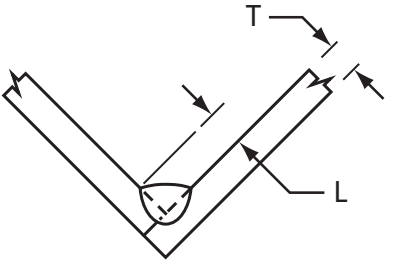


Plate Size – T No. of Passes Leg Size – L (in)	14 ga 1 –	12 ga 1 –	10 ga 1 –	3/16 in 1 5/32	3/16 in 1 5/32	1/4 in 1 3/16	1/4 in 1 3/16
Electrode/AWS Class	Jetweld® 1 / E7024-1						
Diameter – in (mm)	3/32 (2.4)	1/8 (3.2)	1/8 (3.2)	1/8 (3.2)	5/32 (4.0)	5/32 (4.0)	3/16 (4.8)
Current (Amps) Polarity Arc Speed, in/min[1]	95 AC 15	150 AC 17-1/2	160 AC 17-1/2	180 AC 17	210 AC 16-1/2	230 AC 17	270 AC 14-1/2
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	75 0.049	88 0.076	88 0.082	85 0.117	83 0.162	85 0.20	72 0.29

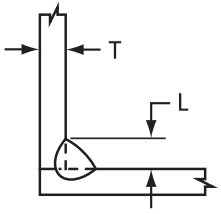
(1) First pass only. On later passes adjust arc speed to obtain proper bead size.
(2) Total for all passes. 100% operating factor.

For X-ray quality:

1. Use low hydrogen procedures, pages 24-34.
   (or)
2. Weld 3/16 in. (4.8 mm) to 5/16 in. (7.9 mm) fillets with E6027 electrodes at the E7024 procedures. Weld 3/8 in. (9.5 mm) and larger fillets with 1/4 in. (6.4 mm) E6027 at about 400 amps. Travel speed will be slower.

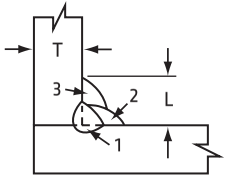
Plate Size – T	14 ga	12 ga	10 ga	3/16 in	1/4 in	5/16 in	3/8 in	1/2 in	5/8 in	3/4 in	3/4 in	1 in
No. of Passes	1	1	1	2-3	1	2-4	1-5	1-2	1-3	1-4	1-5	
Leg Size – L (in)	–	–	–	5/32	3/16	1/4	5/16	3/8	1/2	9/16	5/8	3/4
Electrode/AWS Class	Jetweld® 1 / E7024-1											
Diameter – in (mm)	3/32 (2.4)	1/8 (3.2)	1/8 (3.2)	5/32 (4.0)	3/16 (4.8)	7/32 (5.6)	1/4 (6.4)	1/4 (6.4)				
Current (Amps)	95	150	160	210	270	325	375	375				
Polarity	AC	AC	AC	AC	AC	AC	AC	AC				
Arc Speed, in/min[1]	15	17.5	17.5	17	16	17	13.5	11				
Ft of Weld/Hr[2]	75	88	88	85	80	85	68	55	28	22	17	12
Lbs of Elec/ft of Weld	0.050	0.077	0.083	0.119	0.166	0.21	0.30	0.41	0.73	0.92	1.15	1.62

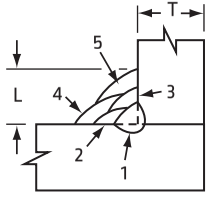
(1) First pass only. On later passes adjust arc speed to obtain proper bead size. (2) Total for all passes. 100% operating factor.



For X-ray quality:

1. Use low hydrogen procedures, pages 24-34.
   (or)
2. Weld 3/16 in. (4.8 mm) to 1/2 in. (12.7 mm) plate, use E6027 at slightly lower currents and arc speeds.





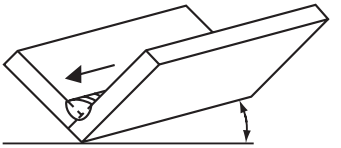
Welding Inclined Plates

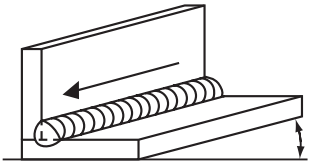
These procedures are used when:

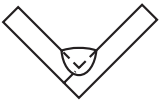
1. The work cannot be positioned in the level position for high speed welding with High Deposition Jetweld® electrodes.
2. The weld is made partly in the level position and partly downhill.

Fleetweld® 47 electrodes have a fairly high iron powder content in the coating, which provides a good deposition rate consistent with downhill welding ability.

Using a drag technique, maintain about a 5/32 in. (4.0 mm) distance between the end of the electrode and the molten slag. If the distance is too great, skips occur in the weld. If the distance is too short, the slag will flow under the arc causing slag holes.







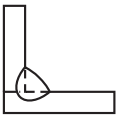


Plate Size – T	0	60[1]	90[2]	0	30[1]	60[2]	0	10[1]	35[2]	0	10[1]	20[2]	0-5[2]
No. of Passes Leg Size – L (in)	1 5/32			1 1/4			1 1/4			1 5/16			1 3/8
Electrode/AWS Class	Fleetweld® 47 / E7014												
Diameter – in (mm)	5/32 (4.0)			3/16 (4.8)			7/32 (5.6)			1/4 (6.4)			1/4 (6.4)
Current (Amps) Polarity	200 AC			250 AC			310 AC			370 AC			400 AC
Ft of Weld/Hr[3] Lbs of Elec/ft of Weld	13 0.095	13 0.095	16 0.081	12 0.110	12 0.110	13 0.121	11 0.191	11 0.191	13 0.180	9 0.270	9 0.270	11 0.240	7.5 0.390

(1) Maximum downhill angle for full size welds. (2) Welds made at the maximum downhill angles listed for each electrode size tend to be concave and undersized.
(3) 100% operating factor.

High Speed Welding (Sheet Metal)

Welding sheet steel (18 through 12 gauge) requires electrodes that weld at high travel speeds with minimum skips, misses, slag entrapment, and undercut.

PROCEDURES

ALTERNATE ELECTRODES

When the recommended electrodes are not available, or if preferred, the following electrodes can be substituted using approximately the same procedures:

ELECTRODE	CLASS	ALTERNATE
Fleetweld® 5P	E6010	E6011
Fleetweld® 5P+	E6010	E6011
Fleetweld® 35	E6011	E6010
Fleetweld® 7	E6012	E6013
Fleetweld® 37	E6013	E7014

WELDING TECHNIQUES

Generally, use the highest current possible that will not burnthrough, undercut, or melt the edges of lap, corner, or edge welds. Fast welding depends upon the operators skill at staying on the joint and traveling at a uniform speed. A few days practice may be needed by good welders when first starting sheet metal welding.

For maximum welding speed, minimum distortion and flat welds generally position joints for welding 45° to 75° downhill.

The procedure tables assume tight fit-up and adequate clamping or tacking for fast travel speeds and minimum distortion. Use copper backing whenever possible to decrease burnthrough tendencies. When poor fit-up is encountered:

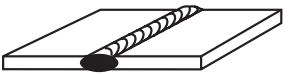
1. Reduce the current.
2. Increase the drag angle.
3. With E6010 or E6011 electrodes use a quick whip technique with a slight circular motion in the crater to bridge the gap.
4. With E6012 or E6013 electrodes, use a small quick weave technique to bridge the gap.

When welding with High Speed electrodes (E6012 and E6013) deposit the entire weld in one pass using non-weave beads or a slight weave. Drag the electrode on the joint and stay ahead of the molten pool. Use enough drag angle so the arc force pushes the weld metal back. Use currents in the high portion of the electrode's range.

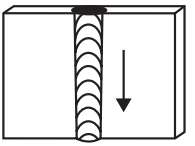
When welding with Out-Of-Position electrodes (E6010 and E6011), deposit the entire weld in one pass using non-weave beads or a slight weave. Hold a 1/8 in. (3.2 mm) or shorter arc. Move as fast as possible while maintaining good fusion. Use currents in the middle of the electrode's range.

Weld overhead joints using E6010 or E6011 electrodes with a whip technique and a slight circular motion in the crater. Do not weave. Point the electrode directly into the joint and slightly forward into the direction of travel. Use a fairly short arc and travel fast enough to avoid spilling. Use currents in the lower portion of the electrode's range. Overhead welding of 18 gauge and thinner is not recommended.

GROOVE WELDS



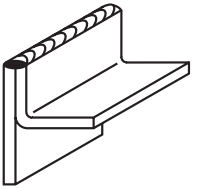
Flat



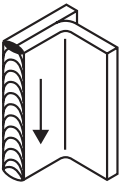
Vertical (welded down)

Plate Size - ga	18	16	14	12	10
Electrode/AWS Class	Fleetweld® 5P, Fleetweld® 5P+ / E6010				
Diameter – in (mm)	3/32 (2.4)	1/8 (3.2)	1/8 (3.2)	5/32 (4.0)	3/16 (4.8)
Position[1]	0-30° Downhill				
Current (Amps)	40	70	80	120	135
Polarity[2]	DC-	DC-	DC+	DC+	DC+
Arc Speed, in/min[3]	24	32	28	22	19
Lbs of Elec/ft of Weld	0.024	0.029	0.026	0.049	0.070
Position[1]	30-90° Downhill				
Current (Amps)	45	75	90	130	150
Polarity[2]	DC-	DC-	DC+	DC+	DC+
Arc Speed, in/min[3]	28	36	30	25	20
Lbs of Elec/ft of Weld	0.023	0.028	0.027	0.048	0.073

EDGE WELDS



Flat

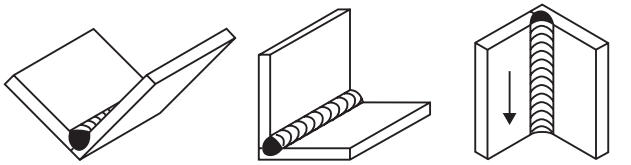


Vertical (welded down)

Plate Size - ga	18	16	14	12	10
Electrode/AWS Class	Fleetweld® 5P, Fleetweld® 5P+ / E6010				
Diameter – in (mm)	3/32 (2.4)	1/8 (3.2)	1/8 (3.2)	5/32 (4.0)	3/16 (4.8)
Position[1]	0-30° Downhill				
Current (Amps)	40	70	80	120	135
Polarity[2]	DC-	DC-	DC+	DC+	DC+
Arc Speed, in/min[3]	24	32	28	22	19
Lbs of Elec/ft of Weld	0.024	0.029	0.026	0.049	0.070
Position[1]	30-90° Downhill				
Current (Amps)	45	75	90	130	150
Polarity[2]	DC-	DC-	DC+	DC+	DC+
Arc Speed, in/min[3]	28	36	30	25	20
Lbs of Elec/ft of Weld	0.023	0.028	0.027	0.048	0.073

(1) 45 to 75° downhill position recommended for easy operation and fast speeds.
(2) AC can be used – see page 22. (3) For ft. of weld/hr. multiply in./min. by 5. 100% operating factor.

FILLET WELDS

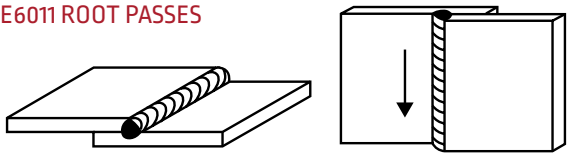


Flat | Horizontal | Vertical (welded down)

Also see High Deposition Procedures on page 28 for 14 to 10 gauge fillet welds with Jetweld® electrodes.

Plate Size - ga	18	16	14	12	10
Electrode/AWS Class	Fleetweld® 37 / E6013				
Diameter – in (mm)	3/32 (2.4)	1/8 (3.2)	5/32 (4.0)	5/32 (4.0)	3/16 (4.8)
Position[1]	0-30° Downhill[5]				
Current (Amps)	70	105	155	160	210
Polarity[2]	AC	AC	AC	AC	AC
Arc Speed, in/min[3]	15	16	17	16	16
Lbs of Elec/ft of Weld	0.045	0.053	0.071	0.079	0.110
Position[1]	30-90° Downhill				
Current (Amps)	75	115	165	170	225
Polarity[2]	AC	AC	AC	AC	AC
Arc Speed, in/min[3]	16	19	21	20	18
Lbs of Elec/ft of Weld	0.042	0.049	0.062	0.070	0.100

OVER E6011 ROOT PASSES

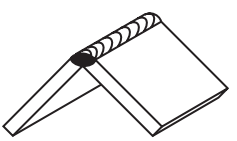


Flat | Vertical (welded down)

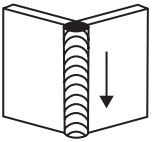
Plate Size - ga.	18	16	14	12	10
Electrode/AWS Class	Fleetweld® 37 / E6013				
Diameter – in (mm)	3/32 (2.4)	1/8 (3.2)	1/8 (3.2)	5/32 (4.0)	5/32 (4.0)
Position[1]	0-30° Downhill[5]				
Current (Amps)	75	115	120	165	170
Polarity[2]	AC	AC	AC	AC	AC
Arc Speed, in/min[3]	17	18	16	16	12
Lbs of Elec/ft of Weld	0.042	0.055	0.075	0.085	0.110
Position[1]	30-90° Downhill				
Current (Amps)	85	125	130	185	180
Polarity[2]	AC	AC	AC	AC	AC
Arc Speed, in/min[3]	21	22	21	21	14
Lbs of Elec/ft of Weld	0.038	0.050	0.061	0.069	0.100

(1) Total for all passes. 100% operating factor. (2) Plus 0.160 lbs. of 3/16 in. (4.8 m) E6011/ft. of weld for each root pass.

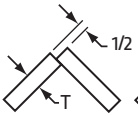
CORNER WELDS



Flat



Vertical
(welded down)



18 to
10 gauge

Permissible for
18 & 16 gauge

Plate Size - ga	18	16	14	12	10
Electrode/AWS Class	Fleetweld® 5P, Fleetweld® 5P+ / E6010				
Diameter – in (mm)	3/32 (2.4)	1/8 (3.2)	1/8 (3.2)	5/32 (4.0)	3/16 (4.8)
Position[1]	0-30° Downhill				
Current (Amps)	45	80	85	110	155
Polarity[2]	DC-	DC-	DC-	DC-	DC+
Arc Speed, in/min[3]	33	43	38	36	30
Lbs of Elec/ft of Weld	0.020	0.028	0.030	0.043	0.051
Position[1]	30-90° Downhill				
Current (Amps)	50	90	95	120	170
Polarity[2]	DC-	DC-	DC-	DC-	DC+
Arc Speed, in/min[3]	38	43	43	40	36
Lbs of Elec/ft of Weld	0.018	0.028	0.029	0.044	0.046

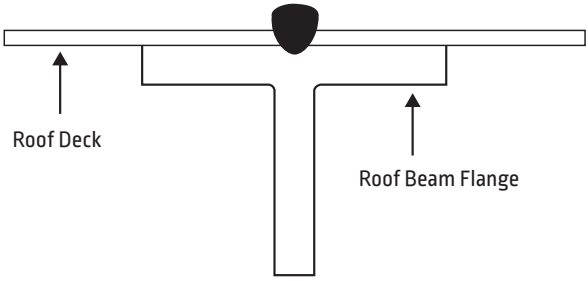
(1) 45 to 75º downhill position is recommended for easy welding and fast speeds. Corner welds on 10 gauge steel can be welded 5-7 in./min. faster when positioned 75 to 90º downhill rather than 45 to 75º downhill.
(2) For AC welding use:
a. E6011 in place of E6010 or E6013 in place of E6012.
b. The same electrode diameters.
c. About 10% higher current.
d. The following arc speeds:

Arc Speed (inch/min)

Weld Type/Position	18 ga	16 ga	14 ga	12 ga	10 ga
Fillet Welds					
0-30°	15	16	17	16	16
30-90°	18	19	21	20	18
Lap Welds					
0-30°	17	18	18	16	15
30-60°	21	22	23	21	18
Groove Welds					
0-30°	22	30	29	27	25
30-60°	26	32	30	29	27
Edge Welds - Same as DC					
Corner Welds - Same as DC					

(3) For ft. of weld/hr. multiply in./min. by 5. 100% operating factor.

BURNTHROUGH SPOT WELDS (ROOF DECKING TO BEAM)



Roof Deck Thickness - ga	22	20		12		10
Electrode/AWS Class	Fleetweld® 37 / E6013					
Diameter – in (mm)	1/8 (3.2)	1/8 (3.2)	5/32 (4.0)	1/8 (3.2)	5/32 (4.0)	5/32 (4.0)
Position[1]	Flat					
Current (Amps)	110	120	150	150	165	180
Polarity[2]	DC- & AC					

Low Hydrogen Welding

Low hydrogen electrodes are recommended for three broad areas of application:

1. On low alloy, high carbon, high sulfur, or other steels where cracking is a problem.
2. When specified by governing codes.
3. For lowest costs on vertical, overhead and horizontal groove welds on heavy (over 1/2 in. (12.7 mm)) plate.

PROCEDURES

RECOMMENDED	CLASS
Jetweld® LH-70	E7018
Jet-LH® 78 MR®	E7018
Excalibur® 7018	E7018
Excalibur® 7018-1	E7018-1

JETWELD LH-3800 (E7028) TECHNIQUES

Employ the same techniques for this High-Deposition electrode as recommended for E7024 electrodes. Clean the slag from every bead on multiple pass welds to prevent slag inclusions which would appear on X-ray inspection.

EXX18 WELDING TECHNIQUES

Procedures and techniques for E7018 electrodes can be used for E8018, E9018, or E11018 Lincoln Electric electrodes.

Polarity - Whenever possible use electrode positive for 5/32 in. (4.0 mm) and smaller electrodes. AC can be used at about 10% higher currents.

Use AC on 3/16 in. (4.8 mm) and larger diameter electrodes to minimize arc blow for best operating characteristics. DC+ can also be used at about 10% lower currents.

Drag the electrode lightly. Since low hydrogen electrodes rely on the molten slag for shielding, never hold a long arc, whip, leave the crater, or move rapidly in any direction. Failure to follow these techniques may result in porosity and/or reduce mechanical properties.

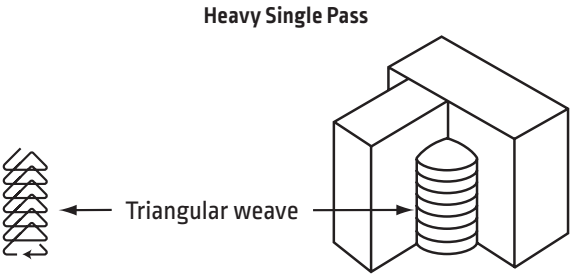
For Clean Tie-Ins – Strike the arc ahead of the crater, move quickly back into the crater, then proceed in the direction of welding. This technique welds over the striking area, eliminating porosity or tendency for poor starting bead shape.

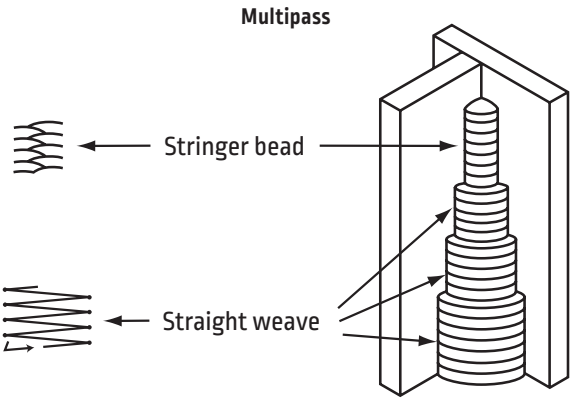
Multiple Pass Welds – Clean the slag after each bead. When welding in the downhand position, use stringer beads or small weaves rather than wide weaves to avoid slag inclusions.

VERTICAL TECHNIQUES

Use 5/32 in. (4.0 mm) or smaller electrodes and currents in the lower portion of the electrode's range. Techniques are as follows:

1. Use a triangular weave for heavy single pass welds.

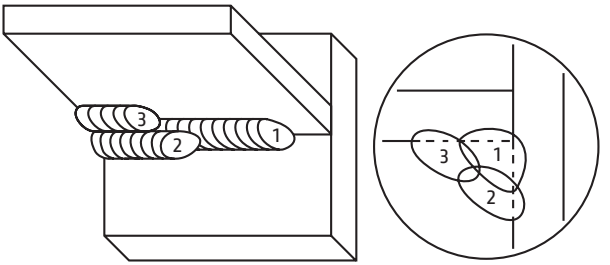




2. For multipass welds, deposit a first pass bead using a slight weave. We emphasize the importance of moving into the corner to assure penetration into the corner. Weld additional layers with a side-to-side weave hesitating at the sides long enough to melt out any small slag pockets and minimize undercut. Travel slow enough to maintain the shelf without spilling weld metal.
3. With this technique, slag spills down the weld. As long as no metal spills, operation is normal. Once welders are familiar with the EXX18 techniques, they will quickly learn to make sound welds of excellent appearance.

HORIZONTAL GROOVE AND OVERHEAD WELD TECHNIQUES

Weld with a series of first pass beads using a slight circular motion in the crater. Do not whip. Use 5/32 in. (4.0 mm) or smaller electrodes and currents in the lower portion of the electrode's range.



VERTICAL UP GROOVE WELDS

Also see Out-of-Position Procedures, page 4.

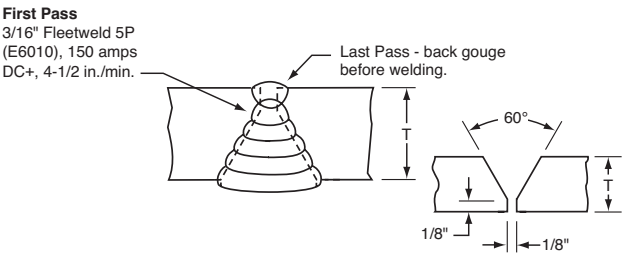


Plate Size – T [in]	1/2	5/8	3/4	1	1.25
No. of Passes	3	4	5	7	9
Electrode/AWS Class	Jet-LH 78 MR, Excalibur® 7018 / E7018 Excalibur® 7018-1 / E7018-1				
Diameter – in (mm)	5/32 (4.0)				
Current (Amps)	155				
Polarity	DC+				
Arc Speed, in/min[1]	3.5				
Ft of Weld/Hr[2]	5.4	3.7	2.7	1.6	1.0
Lbs of Elec/ft of Weld	0.750[3]	1.21[3]	1.78[3]	3.20[3]	5.05[3]

OVERHEAD GROOVE WELDS

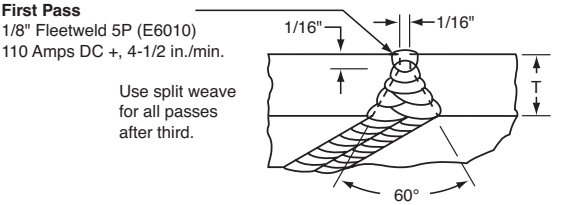
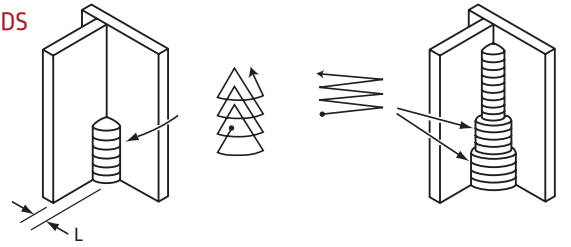


Plate Size – T [in]	5/16	3/8	1/2	3/4	1
No. of Passes	1	1	1	1	1
Electrode/AWS Class	Jet-LH® 78 MR®, Excalibur® 7018 / E7018 Excalibur® 7018-1 / E7018-1				
Diameter – in (mm)	5/32 (4.0)				
Current (Amps)	160	160	160	160	160
Polarity	DC+	DC+	DC+	DC+	DC+
Arc Speed, in/min[1]	3.5	3.5	3.5	4	4
Ft of Weld/Hr[2]	10	7.5	5.0	2.5	1.5
Lbs of Elec/ft of Weld	0.330[4]	0.450[4]	0.840[4]	1.88[4]	3.34[4]

(1) First low hydrogen pass only. On later passes adjust Arc Speed to obtain proper bead size.
(2) Total for all passes. 100% operating factor. (3) Plus 0.280 lbs. of 3/16 in. (4.8 mm) E6010/ft. of weld for first pass.
(4) Plus 0.160 lbs. of 1/8 in. (3.2 mm) E6010/ft. of weld for first pass.

VERTICAL UP FILLET WELDS

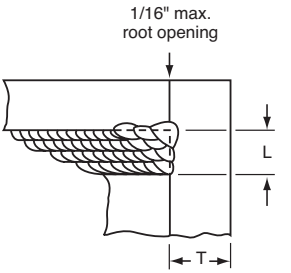


Leg Size – L (in) No. of Passes	3/16 1	1/4 1	5/16 1	3/8 1	1/2 1	5/8 2	3/4 3
Electrode/AWS Class	Jet-LH® 78 MR®, Excalibur® 7018 / E7018 Excalibur® 7018-1 / E7018-1						
Diameter – in (mm)	3/32 (2.4)	1/8 (3.2)	1/8 (3.2)	5/32 (4.0)	5/32 (4.0)	5/32 (4.0)	5/32 (4.0)
Current (Amps) Polarity[2] Arc Speed, in/min[1]	80 DC+ 4	130 DC+ 4	130 DC+ 2.5	155 DC+ 2	155 DC+ 1.5	155 DC+ 2.25	155 DC+ 2.25
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	19 0.13	20 0.22	13 0.33	11 0.47	6.8 0.79	4.5 1.18	3.1 1.71

OVERHEAD FILLET WELDS

Also see Out-of-Position Procedures, page 4.

After first bead, the sequence of bead placement starts on vertical plate for each layer.



Leg Size – L (in) No. of Passes	3/16 1	1/4 1	5/16 3	3/8 4	1/2 6	5/8 10	3/4 15
Electrode/AWS Class	Jet-LH® 78 MR®, Excalibur® 7018 / E7018 Excalibur® 7018-1 / E7018-1						
Diameter – in (mm)	1/8 (3.2)	5/32 (4.0)	5/32 (4.0)	5/32 (4.0)	5/32 (4.0)	5/32 (4.0)	5/32 (4.0)
Current (Amps) Polarity[2] Arc Speed, in/min[1]	130 DC+ 6.5	130 DC+ 3.5	160 DC+ 8.5	160 DC+ 9	160 DC+ 7.5	160 DC+ 7.5	160 DC+ 8.5
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	33 0.13	18 0.24	15 0.35	10 0.51	5.9 0.91	3.8 1.42	2.6 2.05

(1) First low hydrogen pass only. On later passes adjust arc speed to obtain proper bead size.
(2) Total for all passes. 100% operating factor.

HORIZONTAL GROOVE WELDS

Back gouge first bead as needed

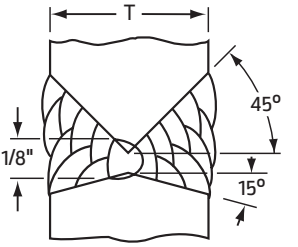


Plate Size – T (in)	1		2	
No. of Passes	1-2	3-12	1-20	21-38
Electrode/AWS Class	Jet-LH® 78 MR®, Excalibur® 7018 / E7018 Excalibur® 7018-1 / E7018-1			
Diameter – in (mm)	3/16 (4.8)			
Current (Amps) Polarity[2] Arc Speed, in/min[1]	230 DC+ 9	200 DC+ 8.5	230 DC+ 9	200 DC+ 8.5
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	2.5 2.81		0.76 9.49	

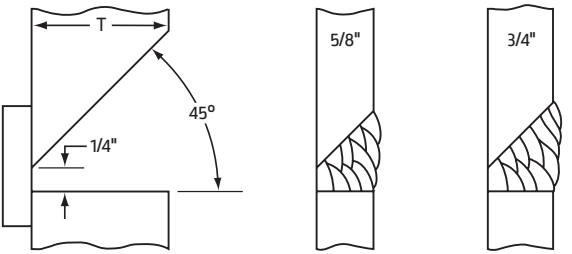


Plate Size – T (in)	5/8		3/4	
No. of Passes	5	9	6	11
Electrode/AWS Class	Jet-LH® 78 MR®, Excalibur® 7018 / E7018 Excalibur® 7018-1 / E7018-1			
Diameter – in (mm)	3/16 (4.8)			
Current (Amps) Polarity[2] Arc Speed, in/min[1]	230 DC+ 9	200 DC+ 8.5	230 DC+ 9	200 DC+ 8.5
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	3.2 2.26		2.5 2.95	

(1) Arc speed for first pass approximately 5 in./min. (2) Total for all passes. 100% operating factor.

HORIZONTAL GROOVE WELDS

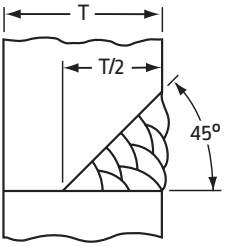


Plate Size – T (in)	1-1/2		3	
No. of Passes	4	9	12	22
Electrode/AWS Class	Jet-LH® 78 MR®, Excalibur® 7018 / E7018 Excalibur® 7018-1 / E7018-1			
Diameter – in (mm)	3/16 (4.8)			
Current (Amps) Polarity[2] Arc Speed, in/min[1]	230 DC+ 9	200 DC+ 8.5	230 DC+ 9	200 DC+ 8.5
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	3.6 3.12		1.2 6.19	

Use steel backing (as on page 29).

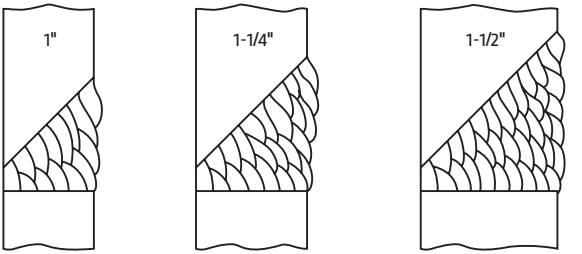


Plate Size – T (in)	1		1-1/4		1-1/2	
No. of Passes	1-11	12-17	1-16	17-24	1-22	23-33
Electrode/AWS Class	Jet-LH® 78 MR®, Excalibur® 7018 / E7018 Excalibur® 7018-1 / E7018-1					
Diameter – in (mm)	3/16 (4.8)					
Current (Amps) Polarity[2] Arc Speed, in/min[1]	230 DC+ 9	200 DC+ 8.5	230 DC+ 9	200 DC+ 8.5	230 DC+ 9	200 DC+ 8.5
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	1.6 4.58		1.1 6.56		0.85 8.83	

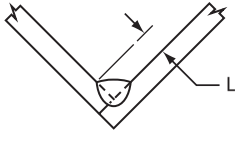
(1) Arc speed for first pass approximately 5 in./min. (2) Total for all passes. 100% operating factor.

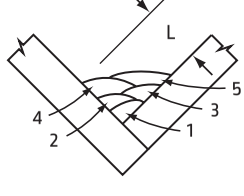
Also see, High Deposition Procedures, page 8.

With E7028 Electrode

Plate Size – T (in) No. of Passes	5/32 1	3/16 1	1/4 1	5/16 1	3/8 1	1/2 2	5/8 3	3/4 4
Electrode/AWS Class	Jetweld® LH-3800/E7028							
Diameter – in (mm)	5/32 (4.0)	3/16 (4.8)	3/16 (4.8)	7/32 (5.6)	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)
Current (Amps) Polarity[2] Arc Speed, in/min[1]	200 AC 14	260 AC 14	280 AC 11.5	330 AC 10.5	400 AC 9	400 AC 10.5	400 AC 10	400 AC 9
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	70 0.104	70 0.147	58 0.208	53 0.285	45 0.437	26 0.776	16 1.24	11 1.78

(1) First pass only. On later passes, adjust arc speed to obtain proper bead size. (2) Total for all passes. 100% operating factor.
NOTE: E7028 can produce code quality welds. E7028 is recommended for making high speed low cost welds using High-Deposition electrode (high iron powder) techniques described on pages 11-15.



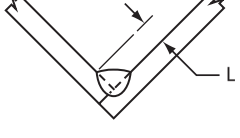


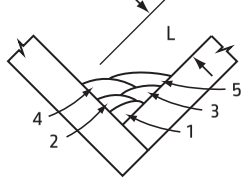
Also see, High Deposition Procedures, page 11.

With E7028 Electrode

Plate Size – T (in) No. of Passes	5/32 1	3/16 1	1/4 1	5/16 1	3/8 1	1/2 2	5/8 4	3/4 5
Electrode/AWS Class	Jet-LH® 78MR®, Jetweld® LH-70, Excalibur® 7018, Excaliibur® 7018-1							
Diameter – in (mm)	3/16 (4.8)	7/32 (5.6)	7/32 (5.6)	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)
Current (Amps) Polarity[2] Arc Speed, in/min[1]	240 AC 14	275 AC 13.5	275 AC 9.5	350 AC 7.5	350 AC 6.5	350 AC 7.5	350 AC 7	350 AC 7
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	70 0.109	68 0.132	48 0.195	38 0.272	33 0.409	17 0.727	12 1.14	8 1.50

(1) First pass only. On later passes, adjust arc speed to obtain proper bead size. (2) Total for all passes. 100% operating factor.
NOTE: E7018 can produce code quality welds. E7018 procedures are used when E7028 is not available and for electrodes E8018 and E11018.

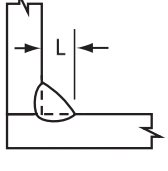


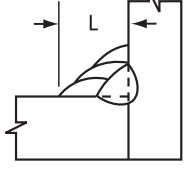


With E7028 Electrode

Plate Size – T (in) No. of Passes	5/32 1	3/16 1	1/4 1	5/16 1	3/8 2	1/2 2	5/8 3	3/4 4
Electrode/AWS Class	Jetweld® LH-3800 /E7028							
Diameter – in (mm)	5/32 (4.0)	3/16 (4.8)	7/32 (5.6)	7/32 (5.6)	7/32 (5.6)	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)
Current (Amps) Polarity[2] Arc Speed, in/min[1]	215 AC 13	260 AC 12	335 AC 12.5	335 AC 10	335 AC 12	390 AC 9.5	390 AC 9.5	390 AC 8.5
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	65 0.112	60 0.157	63 0.236	50 0.320	30 0.483	24 0.819	15 1.28	11 1.82

(1) First pass only. On later passes, adjust arc speed to obtain proper bead size. (2) Total for all passes. 100% operating factor.
NOTE: E7028 can produce code quality welds. E7028 is recommended for making high speed low cost welds using High-Deposition electrode (high iron powder) techniques described on pages 11-15.

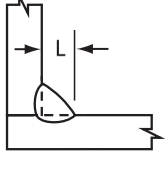


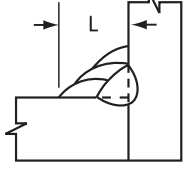


With E7028 Electrode

Plate Size – T (in) No. of Passes	5/32 1	3/16 1	1/4 1	5/16 1	3/8 2	1/2 3	5/8 4	3/4 5
Electrode/AWS Class	Jet-LH® 78MR®, Jetweld® LH-70, Excalibur® 7018, Excalibur® 7018-1							
Diameter – in (mm)	3/16 (4.8)	7/32 (5.6)	7/32 (5.6)	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)
Current (Amps) Polarity[2] Arc Speed, in/min[1]	240 AC 13	275 AC 11.5	275 AC 9	350 AC 7	350 AC 9	350 AC 10	350 AC 8	350 AC 7.5
Ft of Weld/Hr[2] Lbs of Elec/ft of Weld	65 0.111	58 0.140	45 0.203	35 0.335	26 0.480	17 0.785	11 1.18	7.5 1.62

(1) First pass only. On later passes, adjust arc speed to obtain proper bead size. (2) Total for all passes. 100% operating factor.
NOTE: E7018 can produce code quality welds. E7018 procedures are used when E7028 is not available and for electrodes E8018 and E11018.





Minimum Preheat and Interpass Temperature[1]

For stick electrode welding only Based on AWS Specification D1.1

		Low Hydrogen Electrodes		
Plate Size – T (in)	Col. 1	Col. 2	Col. 3	Col. 4
Thru 3/4 in.	32°F[2]	32°F[2]	50°F	32°F
3/4 thru 1-1/2	150°F	50°F	150°F	32°F
1-1/2 thru 2-1/2	225°F	150°F	225°F	32°F
Over 2-1/2 in.	300°F	225°F	300°F	32°F

DEFINITIONS

T Thickness of the thickest part at point of welding.

Col. 1 For the following steels when welded with other than low hydrogen electrodes ASTM A36; A53 Grade B; A106 Grade B; A131 Grades A, B, CS, D, DS, E; A139 Grade B; A381 Grade Y35; A500 Grades A, B; A501; A516; A524 Grades I & II; A570 All grades; A573 Grade 65; A709 Grade 36 (≤ 3/4 in. [20mm]); AP15L Grades B, X42; ABS Grades A, B, C, D, CS, DS, E.

Col. 2 For the following steels: All steels listed in Column 1, and additionally: ASTM A36 (>3/4 in. [20mm]); A53 Grade B; A106 Grade B; A131 Grades A, B, CS, D, DS, E, AH32 & 36, DH 32 & 36, EH 32 & 36; A139 Grade B; A381 Grade Y35; A441; A500 Grade A, Grade B; A501; A516 Grades 55 & 60, Grades 65 & 70, A524 Grades 1 & 2; A529 Grades 50 & 55; A537 Classes I & II; A570 All Grades; A572 Grades 42, 50, 55; A573 Grade 60; A588, A595 Grades A, B, C; A606; A607 Grades 45, 50, 55; A618 Grades Ib, II, III; A633 Grades A, B, Grades C, D; A709 Grades 36 (≤ 3/4 in. [20mm]), 50, 50W; A710 Grade A, Class 2 (≤ 2 in. [50mm]); A808; A913 Grade 50; A992; API 5L Grade B, Grade X42; API Spec. 2H Grades 42, 50; API 2W Grades 42, 50, 50T; API 2Y Grades 42, 50, 50T; ABS Grades AH 32 & 36, DH 32 & 36, EH 32 & 36; ABS Grades A, B, D, CS, DS, Grade E

Col. 3 For steels ASTM A572 Grades 60 and 65, A633 Grade E; API 5L Grade X52; ASTM A913 Grades 60, 65; A710 Grade A, Class 2 (≤ 2 in. [50mm]); A710 Class 3 (≤ 2 in. [50mm]); A709 Grade 70W; A852, API 2W Grade 60; API 2Y Grade 60

Col. 4 All thicknesses ≥ 1/8 in. [3mm]. ASTM A710 Grade A (all classes); ASTM A913 Grades 50, 60, 65. SMAW electrodes capable of depositing weld metal with a maximum diffusible hydrogen content of 8 ml/100g (H8), when tested according to AWS A4.3.

Minimum Preheat and Interpass Temperature[1] cont.

For stick electrode welding only Based on AWS Specification D1.1

NOTES

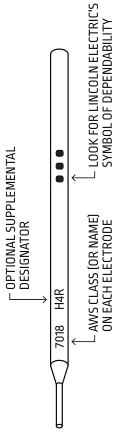
1. Welding shall not be done when ambient temperature is lower than 0°F. Parts on which metal is being deposited shall be at or above the specified temperature for a distance equal to the thickness of the part being welded, but not less than 3 in. (76.2 mm), in all directions from the point of welding. Preheat and interpass temperature must be sufficient to prevent cracking. Temperature above the minimum may be required for highly restrained welds. For ASTM A709 Grade 70W and ASTM A852 Grade 70, the maximum preheat and interpass temperature shall not exceed 400°F for thicknesses thru 1-1/2 in. (38.1 mm), and 450°F for greater thicknesses.
2. When the base metal temperature is below 32°F, preheat to at least 70°F and maintain this minimum temperature during welding.

Stick Electrode Typical Operating Procedures

"OUT-OF-POSITION" GROUP

All-purpose stick electrodes for general purpose fabrication and maintenance welding. Capable of X-ray quality welds out-of-position. Particularly good for vertical and overhead. Deep penetration with maximum admixture. Light slag and flat beads with distinctive ripples.

Product Name	AWS Class	Electrode Polarity	Sizes (in (mm)) & Current Ranges (Amps) 3/32 (2.4)	1/8 (3.2)	5/32 (4.0)	3/16 (4.8)	7/32 (5.6)	1/4 (6.4)
Fleetweld® 5P	E6010	DC+	40-70	75-130	90-175	140-225	200-275	220-325
Fleetweld® 5P+	E6010	DC+	40-70	65-130	90-175	140-225	–	–
Fleetweld® 35	E6011	AC DC±	50-85 40-75	75-120 70-110	90-160 80-145	120-200 110-180	150-260 135-235	190-300 170-270
Fleetweld® 180	E6011	AC DC±	40-90 40-80	60-120 55-110	115-150 105-135	– –	– –	– –
Fleetweld® 22	E6022	DC+	–	110-150	150-180	–	–	–
FOR WELDING HIGH TENSILE PIPE								
Shield-Arc® 85	E7010-A1	DC+	50-90	75-130	90-175	140-225	–	–
Shield-Arc® HYP+	E7010-P1	DC+	–	75-130	90-185	140-225	–	–
Shield-Arc® 70+	E8010-G	DC+	–	75-130	90-185	140-225	–	–
Shield-Arc® 80	E8010-G	DC+	–	75-130	90-185	140-225	160-250	–
Shield-Arc® 90	E9010-G	DC+	–	75-130	90-185	140-225	–	–



"HIGH DEPOSITION" GROUP

Highest deposition rates of all electrodes. Flat, horizontal and slightly downhill (15° maximum) position only. Easy slag removal and smooth, ripple-free beads are flat or slightly convex with minimal spatter.

Product Name	AWS Class	Electrode Polarity	Sizes [in (mm)] & Current Ranges (Amps)				
			3/32 (2.4)	1/8 (3.2)	5/32 (4.0)	3/16 (4.8)	1/4 (6.4)
Jetweld® 1	E7024-1	AC DC±	115-175[1] 100-160	180-240 160-215	240-300 220-280	300-380 270-340	340-440 320-400
Jetweld® 2	E7024	AC DC±	115-175[1] 100-160	180-240 160-215	240-315 215-285	300-380 270-340	350-450 315-405
Jetweld® 3	E6027	AC DC±	– –	190-240 175-215	250-300 230-270	300-380 270-340	350-450 315-405

(1) Range for 3/32 in. (2.4 mm) is 65-120 amps AC or 60-110 amps DC±.
NOTE: Electrodes are manufactured in those sizes which current ranges are given.

"HIGH SPEED" GROUP

Operates in all positions, but most widely use downhill, horizontal or in the flat position. Ideal for irregular or short welds that change direction or position. Medium deposit rates and medium penetration. Appearance ranges from smooth and ripple-free to even with distinct ripples.

Product Name	AWS Class	Electrode Polarity	Sizes [in (mm)] & Current Ranges (Amps)					
			3/32 (2.4)	1/8 (3.2)	5/32 (4.0)	3/16 (4.8)	7/32 (5.6)	1/4 (6.4)
Fleetweld® 7	E6012	DC- AC	– –	80-135 90-150	110-180 120-200	155-250 170-275	225-295 250-325	245-325 275-360
Fleetweld® 37	E6013	AC DC±	75-105[1] 70-95	110-150 100-135	160-200 145-180	205-260 190-235	– –	– –
Fleetweld® 47	E7014	AC DC-	80-100 75-95	110-160 110-145	150-225 135-200	200-280 185-235	260-340 235-305	280-425 260-380

(1) Range for 5/64 in. (2.0 mm) Fleetweld® 37 is 50-80 amps AC or 45-75 amps DC.
1/16 in. (1.6 mm) Fleetweld® 37 is 20-45 amps AC or DC.
NOTE: Electrodes are manufactured in those sizes which current ranges are given.

LOW HYDROGEN GROUP

For welding carbon and low alloy steels that require 70,000 psi tensile strength deposits. These low hydrogen electrodes can produce dense, x-ray quality welds with notch toughness properties. The E7018 electrodes have “Fill-Freeze” characteristics and the E7028 electrode has “Fast-Fill” characteristics.

Product Name	AWS Class	Electrode Polarity	Sizes [in (mm)] & Current Ranges (Amps)						
			3/32 (2.4)	1/8 (3.2)	5/32 (4.0)	3/16 (4.8)	7/32 (5.6)	1/4 (6.4)	1/4 (6.4)
Excalibur® 7018 Excalibur® 7018-1	E7018H4R E7018-1H4R	DC+ AC	70-110 80-120	85-150 95-160	125-200 130-210	170-260 180-280	– –	– –	– –
Jetweld® LH-70	E7018H4R	DC+ AC	70-100 80-120	90-150 110-170	120-190 135-225	170-280 200-300	210-330 260-380	290-430 325-440	375-500 400-530
Jetweld® LH-73	E7018H8	AC DC+	75-120 70-115	105-150 100-140	130-200 120-185	– –	– –	– –	– –
Jet-LH® 78 MR®	E7018H4R	DC+ AC	85-110 –	110-160 120-170	130-200 140-230	180-270 210-290	250-330 270-370	300-400 325-420	– –
Jetweld® LH-3800	E7028H8	AC DC+	– –	– –	180-270 170-240	240-330 210-300	275-410 260-380	360-520 –	– –

NOTE: Electrodes are manufactured in those sizes which current ranges are given.

LOW HYDROGEN, LOW ALLOY STEEL GROUP

Made for welding low alloy steels that require specific mechanical or chemical properties of one of these electrodes. Specifically for use in cryogenics, high temperature applications, and for x-ray quality requirements. These electrodes have Low Hydrogen "Fill-Freeze" operating characteristics similar to Jetweld® LH-70.

Product Name	AWS Class	Electrode Polarity	Sizes [in (mm)] & Current Ranges (Amps)					
			3/32 (2.4)	1/8 (3.2)	5/32 (4.0)	3/16 (4.8)	7/32 (5.6)	1/4 (6.4)
Excalibur® 7018-A1 MR®	E7018-A1 H4R	DC+ AC	70-110 80-120	90-160 100-160	130-210 140-210	– –	– –	– –
Jetweld® LH-90 MR®	E8018-B2	DC+ AC	– –	110-150 120-170	130-190 140-225	180-270 210-290	– –	– –
Jet-LH® 8018-B2 MR®	E8018-B2	DC+ AC	70-100 70-95	110-150 85-120	120-190 135-200	– –	– –	– –
Jet-LH® 8018-C1 MR®	E8018-C1 H4R	DC+ AC	– –	90-150 110-160	120-180 140-200	180-270 200-300	– –	250-350 300-400
Excalibur® 8018-C1 MR®	E8018-C1 H4R	DC+ AC	70-110 80-120	90-160 100-160	130-210 140-210	180-300 200-300	250-330 270-370	300-400 325-430
Jet-LH® 8018-C3 MR®	E8018-C3 H4R	DC+ AC	– –	110-150 120-170	130-190 140-225	180-270 210-290	250-330 270-370	300-400 325-420
Excalibur® 8018-C3 MR®	E8018-C3 H4R	DC+ AC	70-110 80-120	90-160 100-160	130-210 140-210	180-300 200-300	250-330 270-370	300-400 325-420
Jet-LH® 9018-B3 MR®	E9018-B3	DC+ AC	70-100 85-120	100-140 110-150	120-190 135-200	– –	– –	– –
Excalibur® 9018M MR®	E9018-M H4R	DC+	70-110	90-160	130-210	180-300	–	–
Jetweld® LH-1100M MR®	E11018-M H4R	DC+ AC	70-110 80-120	90-155 100-170	120-190 135-225	160-280 200-310	190-310 240-350	230-360 290-410

NOTE: Electrodes are manufactured in those sizes which current ranges are given.

NOTE 1: Joining Electrodes, Non-Charpy V-Notch Rated

These electrodes (see below) and others of the same AWS classification, are not required to deposit weld metal capable of delivering any minimum specified Charpy V-Notch (CVN) properties. It should not be used in applications where minimum specified CVN properties are required. Typical applications where minimum specified CVN properties are required include, but are not restricted to, bridges, pressure vessels, and buildings in seismic zones. The user of this product is responsible for determining whether minimum CVN properties are required for the specific application.

- Fleetweld® 7
- Fleetweld® 22
- Fleetweld® 37
- Fleetweld® 47
- Jetweld® 3

NOTE 2: Joining Electrodes, Non-Low Hydrogen

These electrodes (see below) and others of the same AWS classification, are not required to deposit weld metal that is low in diffusible hydrogen. Therefore, these electrodes should not be used in applications where the hydrogen content of the weld metal is required to be controlled, such as applications that involve steels with higher carbon and alloy content, and higher strength.

- Fleetweld® 5P
- Fleetweld® 5P+
- Fleetweld® 35
- Fleetweld® 45LS
- Fleetweld® 180
- Fleetweld® 7
- Fleetweld® 37
- Fleetweld® 22
- Shield-Arc® 85
- Shield-Arc® 90
- Shield-Arc® HYP+
- Fleetweld® 47
- Jetweld® 1
- Jetweld® 2
- Jetweld® 3
- Shield-Arc® 70+
- Shield-Arc® 80

Welding Safety Precautions

WARNINGS

ARC WELDING CAN BE HAZARDOUS. PROTECT YOURSELF AND OTHERS FROM POSSIBLE SERIOUS INJURY OR DEATH. KEEP CHILDREN AWAY. PACEMAKER WEARERS SHOULD CONSULT WITH THEIR DOCTOR BEFORE OPERATING.

Read and understand the following safety highlights. For additional safety information, it is strongly recommended that you purchase a copy of "Safety in Welding & Cutting - ANSI Standard Z49.1" from the American Welding Society, P.O. Box 351040, Miami, Florida 33135 or CSA Standard W117.2-1974. A Free copy of "Arc Welding Safety" booklet E205 is available from the Lincoln Electric Company, 22801 St. Clair Avenue, Cleveland, Ohio 44117-1199.

BE SURE THAT ALL INSTALLATION, OPERATION, MAINTENANCE AND REPAIR PROCEDURES ARE PERFORMED ONLY BY QUALIFIED INDIVIDUALS.

ELECTRIC SHOCK CAN KILL.

1.a. The electrode and work (or ground) circuits are electrically "hot" when the welder is on. Do not touch these "hot" parts with your bare skin or wet clothing. Wear dry, hole-free gloves to insulate hands.

1.b. Insulate yourself from work and ground using dry insulation. Make certain the insulation is large enough to cover your full area of physical contact with work and ground. In addition to the normal safety precautions, if welding must be performed under electrically hazardous conditions (in damp locations or while wearing wet clothing; on metal structures such as floors, gratings or scaffolds; when in cramped positions such as sitting, kneeling or lying, if there is a high risk of unavoidable or accidental contact with the workpiece or ground) use the following equipment:

· Semiautomatic DC Constant Voltage (Wire) Welder.
· DC Manual (Stick) Welder.
· AC Welder with Reduced Voltage Control.

1.c. In semiautomatic or automatic wire welding, the electrode, electrode reel, welding head, nozzle or semiautomatic welding gun are also electrically "hot".

1.d. Always be sure the work cable makes a good electrical connection with the metal being welded. The connection should be as close as possible to the area being welded.

1.e. Ground the work or metal to be welded to a good electrical (earth) ground.

1.f. Maintain the electrode holder, work clamp, welding cable and welding machine in good, safe operating condition. Replace damaged insulation.

1.g. Never dip the electrode in water for cooling.

1.h. Never simultaneously touch electrically "hot" parts of electrode holders connected to two welders because voltage between the two can be the total of the open circuit voltage of both welders.

1.i. When working above floor level, use a safety belt to protect yourself from a fall should you get a shock.

1.j. Also see Items 6.c. and 8.

ARC RAYS can burn.

2.a. Use a shield with the proper filter and cover plates to protect your eyes from sparks and the rays of the arc when welding or observing open arc welding. Headshield and filter lens should conform to ANSI Z87. I standards.

2.b. Use suitable clothing made from durable flame-resistant material to protect your skin and that of your helpers from the arc rays.

2.c. Protect other nearby personnel with suitable, non-flammable screening and/or warn them not to watch the arc nor expose themselves to the arc rays or to hot spatter or metal.

FUMES & GASES

can be dangerous.

3.a. Welding may produce fumes and gases hazardous to health. Avoid breathing these fumes and gases. When welding, keep your head out of the fume. Use enough ventilation and/or exhaust at the arc to keep fumes and gases away from the breathing zone. **When welding hardfacing (see instructions on container or SDS) or on lead or cadmium plated steel and other metals or coatings which produce highly toxic fumes, keep exposure as low as possible and within applicable OSHA PEL and ACGIH TLV limits using local exhaust or mechanical ventilation unless exposure assessments indicate otherwise. In confined spaces or in some circumstances, outdoors, a respirator may also be required. Additional precautions are also required when welding on galvanized steel.**

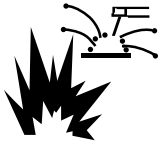
3.b. The operation of welding fume control equipment is affected by various factors including proper use and positioning of the equipment, maintenance of the equipment and the specific welding procedure and application involved. Worker exposure level should be checked upon installation and periodically thereafter to be certain it is within applicable OSHA PEL and ACGIH TLV limits.

3.c. Do not weld in locations near chlorinated hydrocarbon vapors coming from degreasing, cleaning or spraying operations. The heat and rays of the arc can react with solvent vapors to form phosgene, a highly toxic gas, and other irritating products.

3.d. Shielding gases used for arc welding can displace air and cause injury or death. Always use enough ventilation, especially in confined areas, to insure breathing air is safe.

3.e. Read and understand the manufacturer's instructions for this equipment and the consumables to be used, including the Safety Data Sheet (SDS) and follow your employer's safety practices. SDS forms are available from your welding distributor or from the manufacturer.

3.f. Also see item 1.b.



WELDING SPARKS
can cause fire or explosion.

4.a. Remove fire hazards from the welding area. If this is not possible, cover them to prevent the welding sparks from starting a fire. Remember that welding sparks and hot materials from welding can easily go through small cracks and openings to adjacent areas. Avoid welding near hydraulic lines. Have a fire extinguisher readily available.

4.b. Where compressed gases are to be used at the job site, special precautions should be used to prevent hazardous situations. Refer to "Safety in Welding and Cutting" (ANSI Standard Z49.1) and the operating information for the equipment being used.

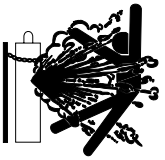
4.c. When not welding, make certain no part of the electrode circuit is touching the work or ground. Accidental contact can cause overheating and create a fire hazard.

4.d. Do not heat, cut or weld tanks, drums or containers until the proper steps have been taken to insure that such procedures will not cause flammable or toxic vapors from substances inside. They can cause an explosion even though they have been "cleaned." For information purchase "Recommended Safe Practices for the Preparation for Welding and Cutting of Containers and Piping That Have Held Hazardous Substances", AWS F4.1 from the American Welding Society (see address above).

4.e. Vent hollow castings or containers before heating, cutting or welding. They may explode.

4.f. Sparks and spatter are thrown from the welding arc. Wear oil free protective garments such as leather gloves, heavy shirt, cuffless trousers, high shoes and a cap over your hair. Wear ear plugs when welding out of position or in confined places. Always wear safety glasses with side shields when in a welding area.

4.g. Connect the work cable to the work as close to the welding area as practical. Work cables connected to the building framework or other locations away from the welding area increase the possibility of the welding current passing through lifting chains, crane cables or other alternate circuits. This can create fire hazards or overheat lifting chains or cables until they fail.



CYLINDER may explode if damaged.

6.a. Use only compressed gas cylinders containing the correct shielding gas for the process used and properly operating regulators designed for the gas and pressure used. All hoses, fittings, etc. should be suitable for the application and maintained in good condition.

6.b. Always keep cylinders in an upright position securely chained to an undercarriage or fixed support.

6.c. Cylinders should be located:

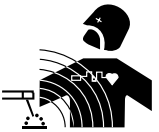
- Away from areas where they may be struck or subjected to physical damage.
- A safe distance from arc welding or cutting operations and any other source of heat, sparks, or flame.

6.d. Never allow the electrode, electrode holder or any other electrically "hot" parts to touch a cylinder.

6.e. Keep your head and face away from the cylinder valve outlet when opening the cylinder valve.

6.f. Valve protection caps should always be in place and hand tight except when the cylinder is in use or connected for use.

6.g. Read and follow the instructions on compressed gas cylinders, associated equipment, and CGA publication P-1, "Precautions for Safe Handling of Compressed Gases in Cylinders,"available from the Compressed Gas Association 1235 Jefferson Davis Highway, Arlington, VA 22202.



ELECTRIC & MAGNETIC FIELDS may be dangerous.

8.a. Electric current flowing through any conductor causes localized Electric and Magnetic Fields (EMF). Welding current creates EMF fields around welding cables and welding machines.

8.b. EMF fields may interfere with some pacemakers, and welders having a pacemaker should consult their physician before welding.

8.c. Exposure to EMF fields in welding may have other health effects which are now not known.

8d. All welders should use the following procedures in order to minimize exposure to EMF fields from the welding circuit:

8.d.1. Route the electrode and work cables together - Secure them with tape when possible.

8.d.2. Never coil the electrode lead around your body.

8.d.3. Do not place your body between the electrode and work cables. If the electrode cable is on your right side, the work cable should also be on your right side.

8.d.4. Connect the work cable to the workpiece as close as possible to the area being welded.

FOR ELECTRICALLY
powered equipment.

2.a. Turn off input power using the disconnect switch at the fuse box before working on the equipment.

2.b. Install equipment in accordance with the U.S. National Electrical Code, all local codes and the manufacturer's recommendations.

2.c. Ground the equipment in accordance with the U.S. National Electrical Code and the manufacturer's recommendations.

FOR ENGINE
powered equipment.

7.a. Turn the engine off before troubleshooting and maintenance work unless the maintenance work requires it to be running.

7.b. Operate engines in open, well-ventilated areas or vent the engine exhaust fumes outdoors.

7.c. Do not add the fuel near an open flame welding arc or when the engine is running. Stop the engine and allow it to cool before refueling to prevent spilled fuel from vaporizing on contact with hot engine parts and igniting. Do not spill fuel when filling tank. If fuel is spilled, wipe it up and do not start engine until fumes have been eliminated.

7.d. Keep all equipment safety guards, covers and devices in position and in good repair. Keep hands, hair, clothing and tools away from V-belts, gears, fans and all other moving parts when starting, operating or repairing equipment.

7.e. In some cases it may be necessary to remove safety guards to perform required maintenance. Remove guards only when necessary and replace them when the maintenance requiring their removal is complete. Always use the greatest care when working near moving parts.

7.f. Do not put your hands near the engine fan. Do not attempt to override the governor or idler by pushing on the throttle control rods while the engine is running.

7.g. To prevent accidentally starting gasoline engines while turning the engine or welding generator during maintenance work, disconnect the spark plug wires, distributor cap or magneto wire as appropriate.

7.h. To avoid scalding, do not remove the radiator pressure cap when the engine is hot.

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