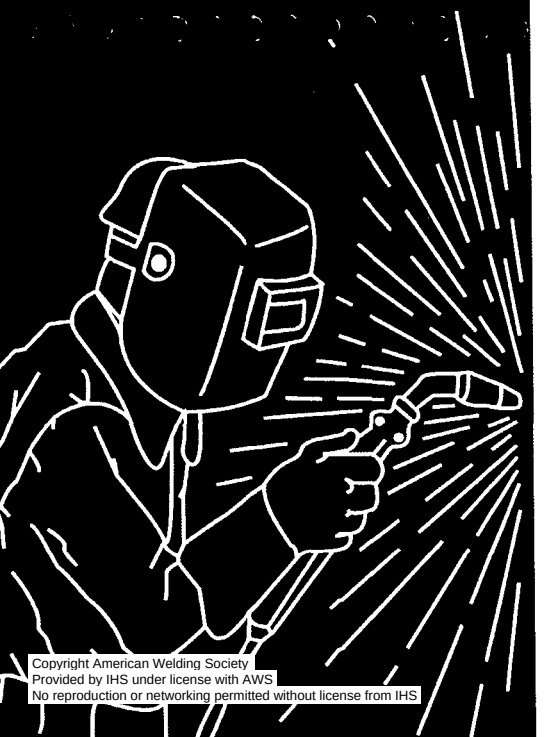

The Everyday Pocket Handbook for Arc Welding Steel

a series

Compiled as a useful tool for on-the-job welding personnel by an AWS Presidential Task Group

American Welding Society

Printed in the United States of America

Note: Although care was taken in choosing and presenting the data in this guide, AWS cannot gurantee that it is error free. Further, this guide is not intended to be an exhaustive treatment of the topic and therefore may not include all available information, including with respect to safety and health issues. By publishing this guide, AWS does not insure anyone using the information it contains against any liabliity or injury to property or persons arising from that use.

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Basic Safety Precautions

Burn Protection. Molten metal, sparks, slag, and hot work surfaces are produced by welding, cutting, and allied processes. These can cause burns if precautionary measures are not used. Workers should wear protective clothing made of fire-resistant material. Pant cuffs, open pockets, or other places on clothing that can catch and retain molten metal or sparks should not be worn. High-top shoes or leather leggings and fire-resistant gloves should be worn. Pant legs should be worn over the outside of high-top shoes. Helmets or hand shields that provide protection for the face, neck, and ears, and a head covering to protect the head should be used. In addition, appropriate eye protection should be used.

Electrical Hazards. Electric shock can kill. However, it can be avoided. Live electrical parts should not be touched. The manufacturer's instructions and recommended safe practices should be read and understood. Faulty installation, improper grounding, and incorrect operation and maintenance of electrical equipment are all sources of danger.

All electrical equipment and the workpiece should be grounded. The workpiece lead is not a ground lead. It is used only to complete the welding circuit. A separate connection is required to ground the workpiece. The workpiece should not be mistaken for a ground connection.

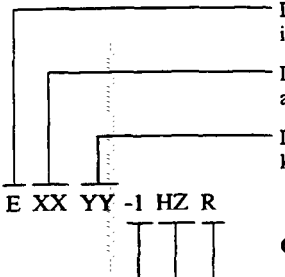
Fumes and Gases. Many welding, cutting, and allied processes produce fumes and gases which may be harmful to health. Avoid breathing the air in the fume plume directly above the arc. Do not weld in a confined area without a ventilation system. Use point-of-welding fume removal when welding galvanized steel, zinc, lead, cadmium, chromium, manganese, brass, or bronze. Do not weld on piping or containers that have held hazardous materials unless the containers have been inerted properly.

Compressed Gas Cylinders. Keep caps on cylinders when not in use. Make sure that gas cylinders are chained to a wall or other structural support.

Radiation. Arc welding may produce ultraviolet, infrared, or light radiation. Always wear protective clothing and eye protection to protect the skin and eyes from radiation. Shield others from light radiation from your welding operation.

AWS also recommends a personal copy of "Arc Welding Safely" and "Fire Safety in Welding and Cutting".

Classification System for Carbon Steel Electrodes for SMAW



Designates an electrode. This designator may be deleted from the product imprint required for identification of the electrode.

Designates the tensile strength (minimum), in ksi, of the weld metal when produced in accordance with the test assembly preparation procedure of this specification.

Designates the welding position in which electrodes are usable, the type of covering, and the kind of welding current for which the electrodes are suitable.

Optional Supplemental Designators:

Designates that the electrode meets the requirements of the absorbed moisture test (an optional supplemental test for all low hydrogen electrodes except the E7018M classification, for which the test is required).

Designates that the electrode meets the requirements of the diffusible hydrogen test (an optional supplemental test of the weld metal from low hydrogen electrodes, as-received or conditioned — with an average value not exceeding "Z" mL of H_2 per 100g of deposited metal, where "Z" is 4, 8, or 16).

Designates that the electrode (E7016, E7018, or E7024) meets the requirements for improved toughness — and ductility in the case of E7024.

SMAW Electrodes		
E6010		
Diameter (in.)	Amps	Dep. Rate[1]
3/32	50	0.8
	70	1.2
1/8	100	2.1
	130	2.3
5/32	140	2.8
	170	2.9
3/16	160	3.3
	190	3.5
7/32	190	4.5
	230	5.1

1. Deposition rate in lbs/hr based on 100% arc time. May vary within ±10%. The efficiency, with a 2" stub loss, is approximately 60%.

SMAW Electrodes		
E6011		
Diameter (in.)	Amps	Dep. Rate[1]
3/32	50	0.8
	70	1.2
1/8	110	2.0
	130	2.3
5/32	140	3.5
	175	4.0
3/16	170	4.0
	190	4.2
7/32	175	4.5
	220	5.1

1. Deposition rate in lbs/hr based on 100% arc time. May vary within ±10%. The efficiency, with a 2" stub loss, is approximately 60%.

SMAW Electrodes		
E6012		
Diameter (in.)	Amps	Dep. Rate[1]
1/8	100	2.4
	130	2.9
5/32	165	3.2
	200	3.4
3/16	220	4.0
	240	4.2
7/32	275	4.8
	320	5.6
1/4	320	5.6
	380	7.1

1. Deposition rate in lbs/hr based on 100% arc time. May vary within ±10%. The efficiency, with a 2" stub loss, is approximately 60%.

SMAW Electrodes		
E6013		
Diameter (in.)	Amps	Dep. Rate[1]
3/32	60	0.9
	75	1.2
1/8	100	1.8
	135	3.0
5/32	140	2.6
	180	3.5
3/16	180	3.2
	220	4.1
7/32	250	5.3
	290	6.1

1. Deposition rate in lbs/hr based on 100% arc time. May vary within ±10%. The efficiency, with a 2" stub loss, is approximately 60%.

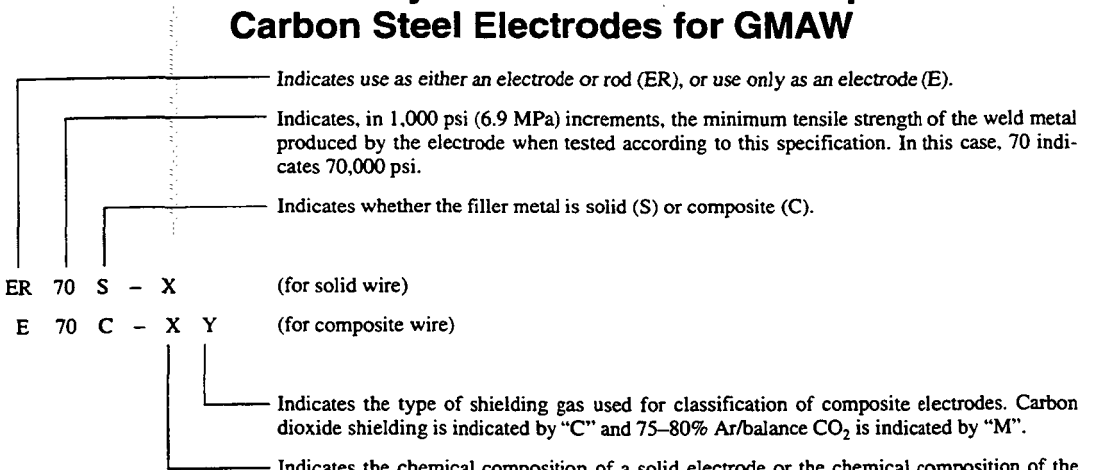
SMAW Electrodes		
E7018		
Diameter (in.)	Amps	Dep. Rate[1]
3/32	70	1.4
	110	1.7
1/8	120	2.6
	160	3.0
5/32	150	3.1
	200	4.3
3/16	200	4.9
	275	5.6
7/32	250	6.5
	340	7.4

1. Deposition rate in lbs/hr based on 100% arc time. May vary within ±10%. The efficiency, with a 2" stub loss, is approximately 60%.

SMAW Electrodes		
E7024		
Diameter (in.)	Amps	Dep. Rate[1]
1/8	140	4.2
	180	5.1
5/32	180	5.3
	240	7.2
3/16	245	7.5
	290	9.1
7/32	320	9.4
	360	11.6
1/4	400	12.6

1. Deposition rate in lbs/hr based on 100% arc time. May vary within ±10%. The efficiency, with a 2" stub loss, is approximately 60%.

Classification System for Solid and Composite Carbon Steel Electrodes for GMAW



GMAW Electrodes			
ER70S-X Short Arc			
Diameter (in.)	Amps	Volts	Dep. Rate[1]
.030	70	15	1.2
	130	21	2.1
.035	80	16	2.1
	190	22	7.3
.045	100	17	2.7
	225	22	8.0

1. Deposition rate in lbs/hr based on 100% arc time. May vary within ±10%. Deposition efficiency is assumed to be 94%.

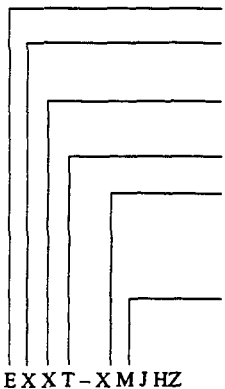
GMAW Electrodes			
ER70S-X Spray Arc			
Diameter (in.)	Amps	Volts	Dep. Rate[1]
.030	150	24	4.1
	200	28	6.8
.035	175	24	6.1
	290	28	12.0
.045	200	24	6.7
	315	30	12.5
1/16	275	24	8.7
	500	32	18.0
3/32	350	29	10.0
	600	33	20.0

1. Deposition rate in lbs/hr based on 100% arc time. May vary within ±10%. Deposition efficiency is assumed to be 98%.

E70C-XX GMAW Electrodes			
Metal Cored 75% Ar/25% CO_2 Shielded			
Diameter (in.)	**Amps**	**Volts**	**Dep. Rate[1]**
.035	150	25	4.4
	250	29	9.4
.045	250	28	8.0
	300	32	11.6
.052	275	29	8.0
	325	30	10.1
1/16	300	30	8.6
	450	34	16.2
5/64	350	27	11.6
	500	29	20.4
3/32	400	31	11.5
	550	32	21.0

1. Deposition rate in lbs/hr based on 100% arc time. May vary within ±10%. Deposition efficiency is assumed to be 92%.

Classification System for Carbon Steel Electrodes for FCAW



Designates an electrode.

This designator is either 6 or 7. It indicates the minimum tensile strength (in psi × 10,000) of the weld metal when the weld is made in the manner prescribed by this specification.

This designator is either 0 or 1. It indicates the positions of welding for which the electrode is intended. (0 is for flat and horizontal position only. 1 is for all positions.)

This designator indicates that the electrode is a flux cored electrode.

This designator is some number from 1 through 14 or the letter "G" with or without an "S" following. The number refers to the usability of the electrode. The "G" indicates that the external shielding, polarity, and impact properties are not specified. The "S" indicates that the electrode is suitable for a weld consisting of a single pass. Such an electrode is not suitable for a multi-pass weld.

An "M" designator in this position indicates that the electrode is classified using 75–80% argon/balance CO_2 shielding gas. When the "M" designator does not appear, it signifies that either the shielding gas used for classification is CO_2 or that the product is a self-shielded product.

Optional Supplemental Designators

Designates that the electrode meets the requirements of the diffusible hydrogen test (an optional supplemental test of the weld metal with an average value not exceeding "Z" mL of H_2 per 100g of deposited metal where "Z" is 4, 8, or 16).

Designates that the electrode meets the requirements for improved toughness by meeting a requirement of 20 ft-lb_f at –40 °F (27J at –40°C). Absence of the "J" indicates normal impact requirements.

FCAW Electrodes				
E7XT-X Gas-Shielded				
Diam. (in.)	WFS (ipm)	Volts	Amp (DCEP)	Dep. Rate[1]
.045	200	28	150	4.2
	600	34	320	12.7
.052	150	25	155	4.4
	600	37	430	17.6
1/16	150	27	190	6.1
	500	39	500	20.1
5/64	112	26	250	6.4
	258	31	450	14.8
3/32	124	30	350	9.6
	278	34	550	21.3
7/64	140	30	550	17.1
	190	36	700	23.0
1/8	111	32	600	16.2
	194	38	850	24.2

1. Deposition rate in lbs/hr based on 100% arc time. May vary within ±10%.

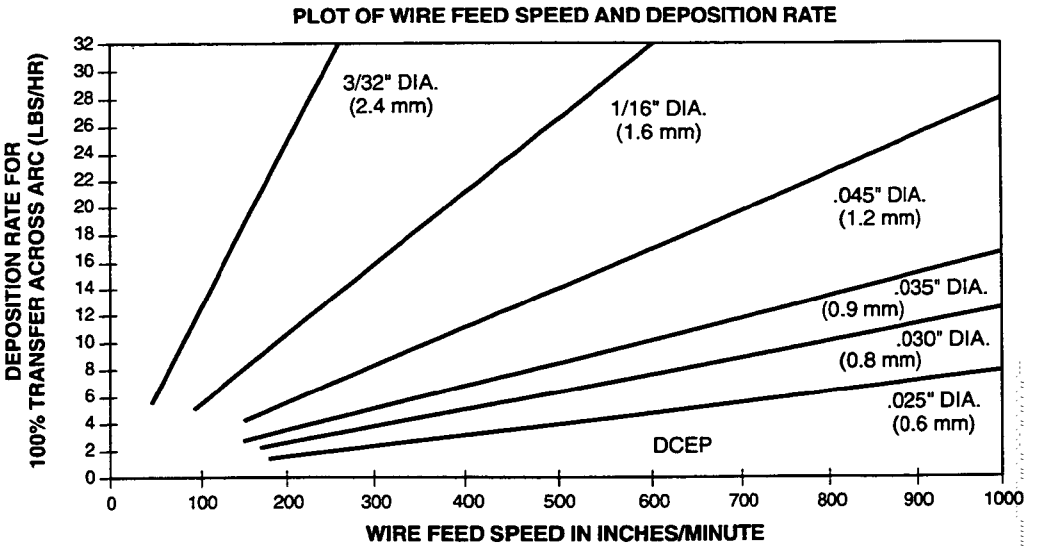
FCAW Electrodes				
Self-Shielded				
Diam. (in.)	WFS (ipm)	Volts	Amp	Dep. Rate[1]
E71T-11			**(DCEN)**	
.045	54	15	95	0.9
	140	18	225	2.6
.068	56	17	160	2.1
	132	19	275	5.2
E70T-4			**(DCEP)**	
3/32	165	28	354	13.8
	263	30	400	16.1
.120	101	29	450	13.0
	123	33	550	15.5
E70T-7			**(DCEN)**	
3/32	135	27	325	8.8
	200	29	400	12.6
7/64	120	29	400	11.5
	175	31	490	15.8

1. Deposition rate in lbs/hr based on 100% arc time. May vary within ±10%.

Carbon Arc Gouging Electrodes

Suggested Current Ranges for the Commonly Used CAC-A Electrode Types and Diameters					
Electrode Diameter		DC Electrode with DCEP, A		AC Electrode with AC, A	
in.	mm	min	max	min	max
5/32	4.0	90	150	—	—
3/16	4.8	150	200	150	200
1/4	6.4	200	400	200	300
5/16	7.9	250	450	—	—
3/8	9.5	350	600	300	500
1/2	12.7	600	1000	400	600
5/8	15.9	800	1200	—	—
3/4	19.1	1200	1600	—	—
1	25.4	1800	2200	—	—

Deposition Rate for Mild Steel for GMAW



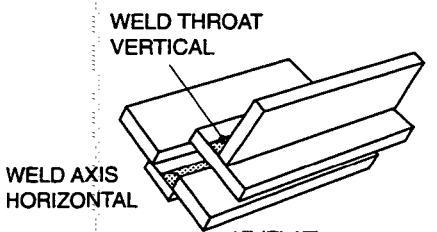
Recommended Copper Cable Sizes

Cable Sizes for Combined Lengths of Electrode and Work Cables					
Amperes	**Percent Duty Cycle**	**0 to 50 ft.**	**50 to 100 ft.**	**100 to 150 ft.**	**150 to 200 ft.**
100	20	8	4	3	2
150	40	6	5	3	2
225	20	4	3	2	1
250	40	2	2	1	1
300	60	1/0	1/0	1/0	2/0
350	60	1/0	1/0	2/0	2/0
400	60	2/0	2/0	2/0	3/0
500	60	2/0	2.0	3/0	3/0

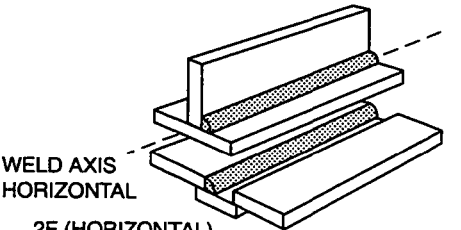
Guide to Electrode Conditioning and Storage

AWS Electrode Classification	Air Conditioned Storage Before Opening RH = Relative Humidity	Holding Temperature After Opening	Reconditioning Temperature and Time to Affect Weld Quality	
			Recondition Step #1	Rebake Step #2
EXX10, EXX11, EXX12, EXX13	Keep Dry @ Room Temperature 40°–120°F 60% (±10%) RH	100°F (±25°)	Not Required NEVER STORE ABOVE 130° OR BELOW 50% RH	Not Required
EXX20, EXX30 Iron Powder EXX14, EXX24, EXX27	90°F (±20°) 50% Max. RH	150°–200°F	250°–300°F ONE HOUR	350°F (±25°) ONE HOUR
			TWO HOUR TOTAL	
Iron Powder–Low Hydrogen EXX18, EXX28 Low Hydrogen EXX15, EXX16	90°F (±20°) 50% Max. RH	300°F (±50°)	500°–600°F ONE HOUR	700°F (±50°) ONE-HALF HOUR
			ONE & ONE-HALF HOUR TOTAL	
Low Hydrogen–High Tensile EXXX15, EXXX16, EXXX18	90°F (±20°) 50% Max. RH	300°F (±50°)	500°–600°F ONE HOUR	650°F (±50°) ONE-HALF HOUR
			ONE & ONE-HALF HOUR TOTAL	

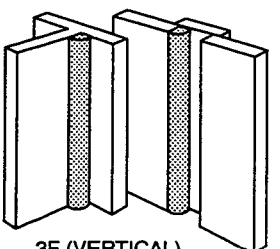
Welding Positions — Fillet (plate)



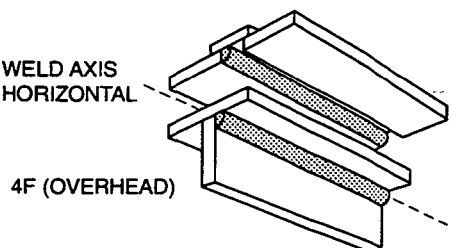
1F (FLAT)



2F (HORIZONTAL)



3F (VERTICAL)

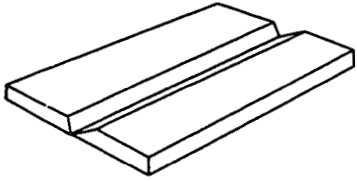


4F (OVERHEAD)

Welding Positions — Groove (plate)

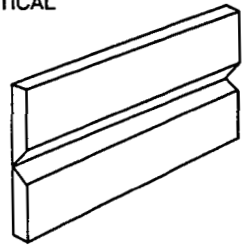
PLATES HORIZONTAL

1G

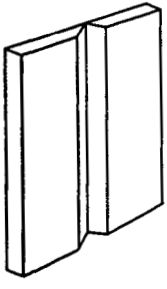


PLATES VERTICAL

2G



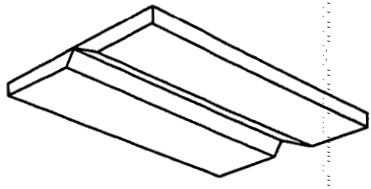
3G



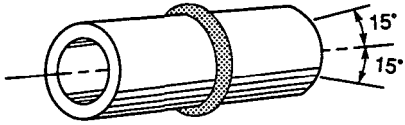
PLATES VERTICAL

PLATES HORIZONTAL

4G



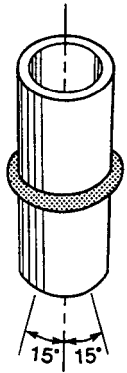
Welding Positions — Pipe



PIPE HORIZONTAL, ROTATED.
WELD FLAT (±15°). DEPOSIT
FILLER METAL AT OR NEAR THE TOP.

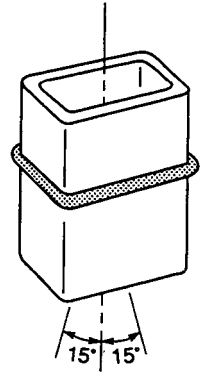
1G ROTATED

2G



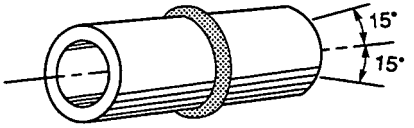
PIPE OR TUBE VERTICAL; NOT
ROTATED DURING WELDING.
WELD HORIZONTAL (±15°).

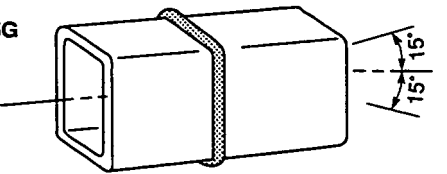
2G



Welding Positions — Pipe (cont'd)

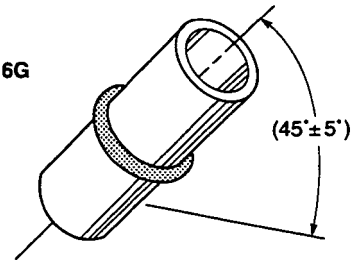
5G





PIPE OR TUBE HORIZONTAL (±15°); NOT ROTATED DURING WELDING. WELD FLAT, VERTICAL, OVERHEAD.

6G

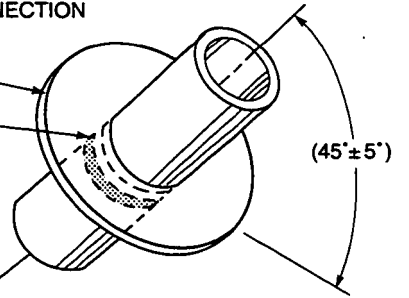


6GR; T, K, Y CONNECTION

RESTRICTION RING

TEST WELD

PIPE INCLINED FIXED (45°±5°); NOT ROTATED DURING WELDING.



Thickness and Weight of Steel Plates: 1/32–1 inch

Gauge	Fraction	Decimal	mm	lb/ft²
22	1/32	0.031	0.794	1.275
16	1/16	0.063	1.588	2.550
13	3/32	0.094	2.381	3.825
11	1/8	0.125	3.175	5.100
9	5/32	0.156	3.969	6.375
7	3/16	0.188	4.763	7.650
5	7/32	0.219	5.556	8.925
3	1/4	0.250	6.350	10.200
1	9/32	0.281	7.144	11.475
	5/16	0.313	7.937	12.750
	11/32	0.344	8.731	14.025
	3/8	0.375	9.525	15.300
	13/32	0.406	10.319	16.575
	7/16	0.438	11.112	17.850
	15/32	0.469	11.906	19.125
	1/2	0.500	12.700	20.400

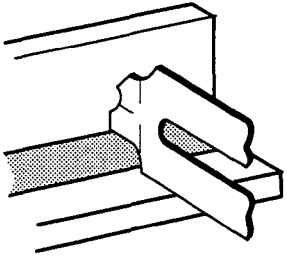
Gauge	Fraction	Decimal	mm	lb/ft²
	17/32	0.531	13.494	21.675
	9/16	0.563	14.287	22.950
	19/32	0.594	15.081	24.225
	5/8	0.625	15.875	25.500
	21/32	0.656	16.669	26.775
	11/16	0.688	17.463	28.050
	23/32	0.719	18.256	29.325
	3/4	0.750	19.050	30.600
	25/32	0.781	19.844	31.875
	13/16	0.813	20.638	33.150
	27/32	0.844	21.431	34.425
	7/8	0.875	22.225	35.700
	29/32	0.906	23.019	36.975
	15/16	0.938	23.813	38.250
	31/32	0.969	24.606	39.525
	1	1.000	25.400	40.800

Thickness and Weight of Steel Plates: 1–2 inch

Fraction	Decimal	mm	lb/ft^2
1-1/32	1.031	26.194	42.075
1-1/16	1.063	26.988	43.350
1-3/32	1.094	27.781	44.625
1-1/8	1.125	28.575	45.900
1-5/32	1.156	29.369	47.175
1-3/16	1.188	30.163	48.450
1-7/32	1.219	30.956	49.725
1-1/4	1.250	31.750	51.000
1-9/32	1.281	32.544	52.275
1-5/16	1.313	33.338	53.550
1-11/32	1.344	34.131	54.825
1-3/8	1.375	34.925	56.100
1-13/32	1.406	35.719	57.375
1-7/16	1.438	36.513	58.650
1-15/32	1.469	37.306	59.925
1-1/2	1.500	38.100	61.200

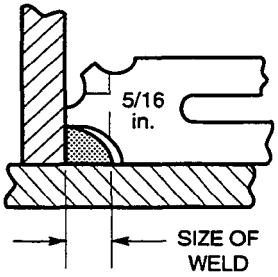
Fraction	Decimal	mm	lb/ft^2
1-17/32	1.531	38.894	62.475
1-9/16	1.563	39.688	63.750
1-19/32	1.594	40.481	65.025
1-5/8	1.625	41.275	66.300
1-21/32	1.656	42.069	67.575
1-11/16	1.688	42.863	68.850
1-23/32	1.719	43.656	70.125
1-3/4	1.750	44.450	71.400
1-25/32	1.781	45.244	72.675
1-13/16	1.813	46.038	73.950
1-27/32	1.844	46.831	75.225
1-7/8	1.875	47.625	76.500
1-29/32	1.906	48.419	77.775
1-15/16	1.938	49.213	79.050
1-31/32	1.969	50.006	80.325
2	2.000	50.800	81.600

How to Use Weld Fillet Gage

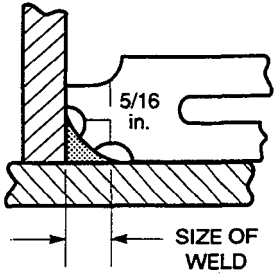


PLACEMENT

BE CERTAIN BLADE EDGE IS SQUARE WITH WELDED PARTS.



CONVEX WELDS



CONCAVE WELDS

FOR CONVEX WELDS: USE BLADE WITH SINGLE ARC AT APPROPRIATE SIZE. FOR CONCAVE WELDS: USE BLADE WITH DOUBLE ARC AT APPROPRIATE SIZE.

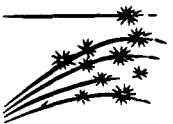
Commercial Pipe Sizes and Wall Thicknesses (ASA-B36.10 and B36.19)

Nominal Pipe Size	Outside Diam.	Nominal Wall Thicknesses in inches for								
		Sched. 5s[1]	Sched. 10s[1]	Stan-dard[2]	Sched. 40	XS[3]	Sched. 80	Sched. 120	Sched. 160	XX Strong
1/8	0.405	—	0.049	*0.068*	0.068	*0.095*	0.095	—	—	—
1/4	0.540	—	0.065	*0.088*	0.088	*0.119*	0.119	—	—	—
3/8	0.675	—	0.065	*0.091*	0.091	*0.126*	0.126	—	—	—
1/2	0.840	0.065	0.083	*0.109*	0.109	*0.147*	0.147	—	0.188	0.294
3/4	1.050	0.065	0.083	*0.113*	0.113	*0.154*	0.154	—	0.219	0.306
1	1.315	0.065	0.109	*0.133*	0.133	*0.179*	0.179	—	0.250	0.358
1-1/4	1.660	0.065	0.109	*0.140*	0.140	*0.191*	0.191	—	0.250	0.382
1-1/2	1.900	0.065	0.109	*0.145*	0.145	*0.200*	0.200	—	0.281	0.400
2	2.375	0.065	0.109	*0.154*	0.154	*0.218*	0.218	—	0.344	0.436
2-1/2	2.875	0.083	0.120	*0.203*	0.203	*0.276*	0.276	—	0.375	0.552
3	3.5	0.083	0.120	*0.216*	0.216	*0.300*	0.300	—	0.438	0.600
3-1/2	4.0	0.083	0.120	*0.226*	0.226	*0.318*	0.318	—	—	—
4	4.5	0.083	0.120	*0.237*	0.237	*0.337*	0.337	0.438	0.531	0.674
5	5.563	0.109	0.134	*0.258*	0.258	*0.375*	0.375	0.500	0.625	0.750
6	6.625	0.109	0.134	*0.280*	0.280	*0.432*	0.432	0.562	0.719	0.864

NOTES:

1. Schedules 5s and 10s are available in corrosion resistant materials and Schedule 10s is also available in carbon steel in sizes 12 in. and smaller.
2. Thicknesses shown in *italics* are also available in stainless steel, under the designation Schedule 40s.
3. Thicknesses shown in *italics* are also available in stainless steel, under the designation Schedule 80s.

Material Identification

Test	Low Carbon Steel	Med. Carbon Steel	High Carbon Steel	High Sulphur Steel
Appearance Test	Dark Grey	Dark Grey	Dark Grey	Dark Grey
Magnetic Test	Strongly Magnetic	Strongly Magnetic	Strongly Magnetic	Strongly Magnetic
Chisel Test	Continuous Chip Smooth Edges Chips Easily	Continuous Chip Smooth Edges Chips Easily	Hard to Chip Can Be Continuous	Continuous Chip Smooth Edges Chips Easily
Fracture Test	Bright Grey	Very Light Grey	Very Light Grey	Bright Grey Fine Grain
Flame Test	Melts Fast Becomes Bright Red Before Melting	Melts Fast Becomes Bright Red Before Melting	Melts Fast Becomes Bright Red Before Melting	Melts Fast Becomes Bright Red Before Melting
*Spark Test**				
*For best results, use at least 5,000 surface feet per minute on grinding equipment. $\left(\frac{\text{Cir.} \times \text{R.P.M.}}{12}\right)$ = S.F. per Min.	Long Yellow Carrier Lines (Approx. 20% Carbon or Below)	Yellow Lines Sprigs Very Plain Now (Approx. 20% to 45% Carbon)	Yellow Lines Bright Burst Very Clear Numerous Star Burst (Approx. 45% Carbon and Above)	Swelling Carrier Lines Cigar Shape

Material Identification (cont'd)

Test	Manganese Steel	Stainless Steel	Cast Iron	Wrought Iron
Appearance Test	Dull Cast Surface	Bright, Silvery Smooth	Dull Grey Evidence of Sand Mold	Light Grey Smooth
Magnetic Test	Non Magnetic	Depends on Exact Analysis	Strongly Magnetic	Strongly Magnetic
Chisel Test	Extremely Hard to Chisel	Continuous Chip Smooth Bright Color	Small Chips About 1/8 in., Not Easy to Chip, Brittle	Continuous Chip Smooth Edges, Soft & Easily Cut & Chipped
Fracture Test	Coarse Grained	Depends on Type Bright	Brittle	Bright Grey Fibrous Appearance
Flame Test	Melts Fast Becomes Bright Red Before Melting	Melts Fast Becomes Bright Red Before Melting	Melts Slowly Becomes Dull Red Before Melting	Melts Fast Becomes Bright Red Before Melting
*Spark Test**  *For best results, use at least 5,000 surface feet per minute on grinding equipment. $\left(\frac{\text{Cir.} \times \text{R.P.M.}}{12}\right)$ = S.F. per Min.	 Bright White Fan-Shaped Burst	 1. Nickel-Black Shape Close to Wheel. 2. Moly-Short Arrow Shape Tongue (only). 3. Vanadium-Long Spear-point Tongue (only)	 Red Carrier Lines (Very Little Carbon Exists)	 Long, Straw Color Lines (Practically Free of Bursts or Sprigs)

Guide for Manual Oxyfuel Gas Cutting Using Natural Gas

Plate Thickness (in.)	Diameter of Cutting Orifice[1] (in.)	Nominal Oxygen Pressure (psi)	Minimum Natural Gas Pressure (psi)	Cutting Speed[2] (in./min)
1/8	0.046	30–40	3–6	20–28
1/4	0.046	30–40	3–6	18–28
3/8	0.046	30–40	3–6	16–20
1/2	0.059	30–40	3–6	13–17
3/4	0.059	30–40	3–6	10–15
1	0.059	30–40	3–6	9–13
1-1/2	0.067	40–50	3–6	7–12
2	0.067	40–50	3–6	6–10
2-1/2	0.067	40–50	3–6	6–9
3	0.093	40–55	3–9	5–8
4	0.093	40–55	3–9	5–7
5	0.093	50–60	3–10	4–6
6	0.110	50–60	3–10	4–6
7	0.110	50–70	3–12	3–5
8	0.110	50–70	3–12	3–4
10	0.110	50–70	3–12	3–4
12	0.110	50–70	3–12	2–3

1. Use two-piece tips.
2. Variations in cutting speeds may be caused by mill scale on plate, variation in oxygen purity, flame adjustment, condition of equipment, impurities in steel, and variation in heat content of natural gas.
3. Tip, drill or orifice diameter size will vary with each tip according to manufacturer's specification.

Guide for Manual Oxyfuel Gas Cutting Using Acetylene

Material Thickness (in.)	Drill Size	Cutting Orifice Diameter (in.) (center hole)	Approximate Pressure of Gas (psi)		Manual Travel Speed (in./min.)
			Acetylene	Oxygen	
1/8	60	0.040	3	10	20–22
1/4	60	0.040	3	15	16–18
3/8	55	0.052	3	20	14–16
1/2	55	0.052	3	25	12–14
3/4	55	0.052	4	30	10–12
1	53	0.060	4	35	8–11
1-1/2	53	0.060	4	40	6–7
2	49	0.073	4	45	5–7
3	49	0.073	5	50	5–6
4	49	0.073	5	55	4–5
5	45	0.082	5	60	3–4
6	45	0.082	6	70	3–4
8	45	0.082	6	75	3

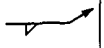
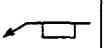
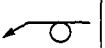
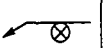
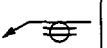
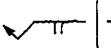
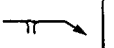
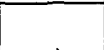
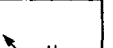
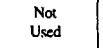
1. Tip, drill or orifice diameter size will vary with each tip according to manufacturer's specification.

Guide for Manual Oxyfuel Gas Cutting Using Propylene

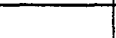
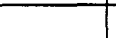
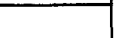
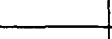
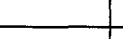
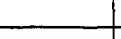
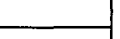
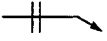
Plate Thickness (in.)	Tip Size	Fuel Gas Pressure (psi)	Cutting Oxygen Pressure (psi)	Cutting Speed (ipm)
1/8	0000	3–7	30–50	24–34
3/16	000	3–7	30–50	24–34
1/4	00	5–10	30–50	22–32
3/8	0	5–10	30–50	20–30
1/2	0	5–10	30–50	18–28
3/4	1	5–10	40–50	16–22
1	1	5–10	40–50	14–20
2	2	5–10	40–50	10–15
2-1/2	3	5–10	50–60	9–14
3	3	5–10	50–60	8–13
4	4	5–10	50–60	7–12
6	5	5–10	70–80	5–9
8	6	10–15	60–70	4–8
10	7	10–15	60–70	4–6
12	8	10–15	40–70	3–5
14	9	10–15	50–85	2–4
15	10	10–15	50–90	2–3
16	11	10–15	50–90	1–2-1/2
18	12	10–15	50–90	1–2

1. Tip, drill or orifice diameter size will vary with each tip according to manufacturer's specification.

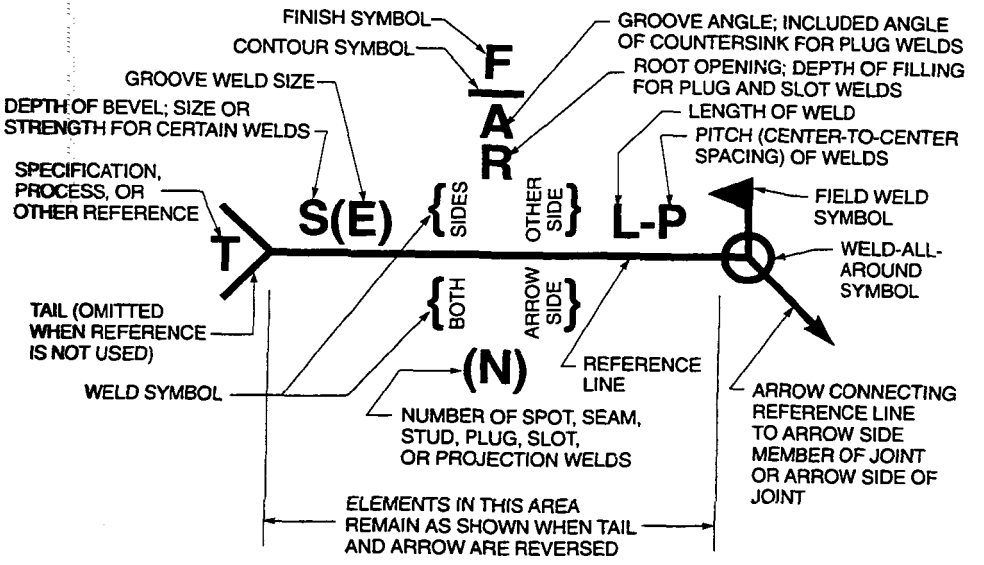
Basic Welding Symbols and Their Location Significance

Location Significance	Fillet	Plug or Slot	Spot or Projection	Stud	Seam	Back or Backing	Surfacing	Flange Corner	Flange Edge
Arrow Side									
Other Side				Not Used			Not Used		
Both Sides		Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
No Arrow Side or Other Side Significance	Not Used	Not Used		Not Used		Not Used	Not Used	Not Used	Not Used

Basic Welding Symbols and Their Location Significance (cont'd)

Location Significance	Groove							Scarf for Brazed Joint
	Square	V	Bevel	U	J	Flare-V	Flare-Bevel	
Arrow Side								
Other Side								
Both Sides								
No Arrow Side or Other Side Significance		Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used

Location of Elements of a Welding Symbol



Other Publications Also Available from AWS

Title	Order Number
Welding Processes: Welding Handbook, Vol. 2, 8th edition	WHB-2.8
Recommended Practices for Gas Metal Arc Welding	C5.6-94R
Recommended Practices for Welding Austenitic Chromium-Nickel Stainless Steel Piping and Tubing	D10.4-92R
Recommended Practices and Procedures for Welding Low Carbon Steel Pipe	D10.12-89
Guide for Visual Inspection of Welds	B1.11-88
Welding Inspector's Tool Kit	TK
Standard for AWS Certified Welders (FREE)	QC7
Specifications for Qualification and Certification of Welding Inspectors (FREE)	QC1

American Welding Society

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