SMAW

(Sheilded metal arc welding)

The SMAW process is an arc welding process which produces coalescence of metal by heating them with an arc between a covered metal electrode and the work. Sheilding is obtained from decomposition of the electrode covering. Pressure is not used. Filler metal is obtained from the electrode (ANSI/AWS A3.0, *Welding Terms and Definitions*).

Typical SMAW setup

1. Welding power source (suitable for work to be performed)
2. Length of suitable welding cable
3. Length of suitable ground cable
4. Suitable electrode holder
5. Suitable ground clamp
6. Covered electrode (matched to base metal)
7. Welding helmet and protective equipment

A constant current type power source is most commonly used : these are available in AC, AC/DC combination or DC output with mechanical, electrical, solid state controls, either static or dynamic.

Constant current power sources come in a large variety of output characteristics, capacities and controls. They can be static or dynamic.

All AC and AC/DC combination static power sources require single phase input (primary power).

The industrial classes are usually reconnectable on different voltages i.e. 230, 460 or 575 ; while the limited input machines are single voltage connection i.e. 208, 230 or 575.

Most of the DC output machines require three phase primary power. These are also normally reconnectable on different voltages.

SMAW

There are well over 150 different types of covered electrodes in use today; within the mild, low alloy-stainless and specialty steels alone.

So it is of utmost importance to know how to select the proper one, in order to achieve soud welds that will yield mechanical and chemical properties compatible with those of the base materials being used. However, we must also take into consideration the mass of the weldment, the type of service and the environment to which the weldment will be subjected.

Designation of classifications :

for mild steel covered electrodes
CSA W48.1-M
AWS A5.1

for low alloy steel covered electrodes
CSA W48.3-M
AWS A5.5

U.S. System		CDN System	
Example :	E6010	Becomes :	E41010
where E =	Electrode	where E =	Electrode
60 =	Minimum tensile stength in 1000 psi	410 =	Minimum tensile strength in megapascals (MPa)
1 =	Usability position*	1 =	Usability position*
0 =	Type of covering, current, polarity	0 =	Type of covering, current, polarity

* 0 = All positions with excellent vertical down (V-D) features
1 = All positions except vertical down (V-D)
2 = Flat, horizontal
3 = Flat only
4 = Vertical down

Note : For full details on chemical and mechanical requirements, consult CSA Standard W48.1-M,
W48.3-M as well as AWS A5.1 and A5.5.

F NUMBERS

ASME QW-432 F numbers grouping of electrodes and welding rods for qualification

QW	F N°	ASME Specification N°	AWS Classification N°
432.1	1	SFA-5.1 and 5.5	EXX 20, EXX 24, EXX 27, EXX 28
	2	SFA-5.1 and 5.5	EXX 12, EXX 13, EXX 14
	3	SFA-5.1 and 5.5	EXX 10, EXX 11
	4	SFA-5.1 and 5.5	EXX 15, EXX 16, EXX 18
	4	SFA-5.4 Nom. Total Alloy 6 % or less	EXX 15, EXX 16
	4	SFA-5.4 Nom. Total Alloy more than 6 %	EXX 15, EXX 16
	5	SFA-5.4 Cr-Ni Electrode	EXX 15, EXX 16
	6	SFA-5.2	RGXX
	6	SFA-5.17	FXX-XXXX
	6	SFA-5.9	ERXX
	6	SFA-5.18	EXXS-X,EXXU-X
	6	SFA-5.20	EXXT-X
	6	SFA-5.22	EXXXT-X
	6	SFA-5.23	FXX-EXXX-X, FXX-ECXXX-X and FXX EXXX-XN, FXX-ECXXX-XN
	6	SFA-5.28	ER-XXX-X and E-XXX-X

A NUMBERS

ASME QW-442 A numbers classification of weld metal analysis for procedure qualification

QW	A N°	Types of weld deposit	ANALYSIS*					
			C %	Cr %	Mo %	Ni %	Mn %	Si %
442	1	Mild Steel	0.15				1.60	1.00
	2	Carbon-Moly	0.15	0.50	0.40-0.65		1.60	1.00
	3	Chrome (0.4 to 2 %)-Moly	0.15	1.40-2.00	0.40-0.65		1.60	1.00
	4	Chrome (2 to 6 %)-Moly	0.15	2.00-6.00	0.40-1.50		1.60	2.00
	5	Chrome (6 to 10.5 %)-Moly	0.15	6.00-10.50	0.40-1.50		1.20	2.00
	6	Chrome-Martensitic	0.15	11.00-15.00	0.70		2.00	1.00
	7	Chrome-Ferritic	0.15	11.00-30.00	1.00		1.00	3.00
	8	Chromium-Nickel	0.15	14.50-30.00	4.00	7.50-15.00	2.50	1.00
	9	Chromium-Nickel	0.30	25.00-30.00	4.00	15.00-37.00	2.50	1.00
	10	Nickel to 4 %	0.15		0.55	0.80-4.00	1.70	1.00
	11	Manganese-Moly	0.17		0.25-0.75	0.85	1.25-2.25	1.00
	12	Nickel-Chrome-Moly	0.15	1.50	0.25-0.80	1.25-2.80	0.75-2.25	1.00

* Single values shown above are maximum.

GTAW

(Gas tungsten arc welding)

An arc welding process which produces coalescence of metals by heating them with an arc between a tungsten (non-consumable) electrode and the work.

Shielding is obtained from a gas or gas mixture. Pressure may or may not be used and filler metal may or may not be used. (ANSI/AWS A3.0, *Welding Terms and Definitions*.)

Note : This process has sometimes been called TIG (Tungsten Inert Gas) welding.

Typical GTAW setup

1. Welding power source (suitable to work to be performed)•
2. Length of suitable welding cable
3. Suitable ground clamp
4. Suitable torch and cable assembly
5. Remote control
6. Suitable gas or gas mixture
7. Suitable regulator/flowmeter
8. Suitable tungsten electrode
9. Filler metal (matched to base metal)
10. Welding helmet and protective equipment

- Constant current power source commonly used is either AC, AC/DC combination or DC output with or without high frequency built in. These power sources are available with either mechanical, electrical or solid state controls.

Constant current power sources come in a large variety of output characteristics, capacities and controls. They can be static or dynamic.

All AC and AC/DC combination static power sources require single phase input (primary power).

The industrial class is usually reconnectable on different voltages i.e. 230/460/575; while the limited input machines are single voltage connection i.e. 208, 230 or 575.

Most DC output machines require three phase primary power. These also are normally reconnectable on different voltages.

Most of the power sources used for GTAW are available with high frequency units built in.

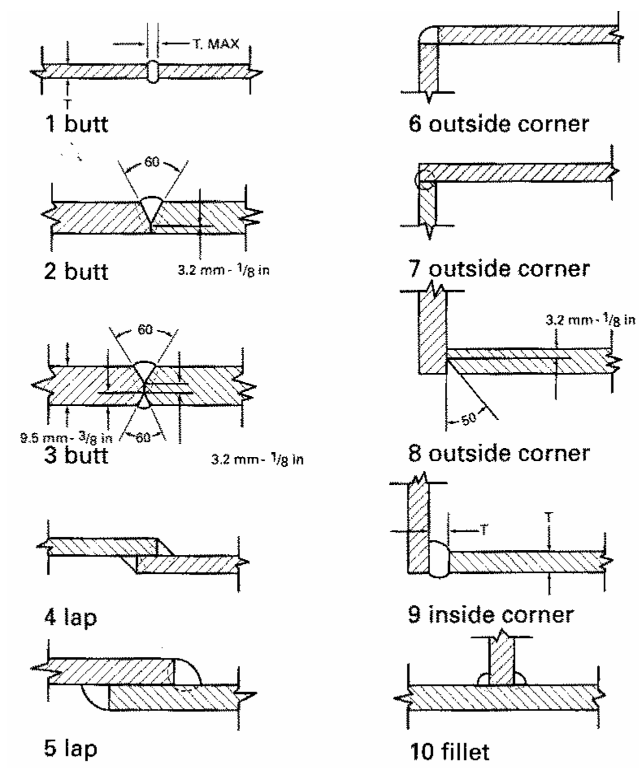
In addition, a full complement of remote controls, high frequency generators, pulsing controls and water cooling recirculators is available. The accessories, when properly selected, can transform any conventional drooper type of power source into a GTAW system.

GTAW

Guiding procedures

Welding aluminum

The use of GTA (gas tungstene arc) welding for aluminum has many advantages for both manual and automatic processes. Filler metal can be either wire or rod and should be compatible with the base alloy. Filler metal must be dry, free of oxides, grease or other foreign matter. If filler metal becomes damp, heat for 2 hours at 95 °C (200 °F) before using. Although AC high-frequency stabilized current is recommended, DC reverse polarity has been successfully used for thicknesses up to 2.5 mm ($^{3}/_{32}$ in). Argon shielding gas is normally used. However for increased welding speed and optimized penetration profiles, BLUESHIELD 1, 2 or 3 (argon-helium mixtures) are recommended.



AIR LIQUIDE

Aluminum – Manual Welding
High Frequency Stabilised Alternating Current

Work thickness		Weld type	Joint n°	Tungsten electrode diameter		Filler rod (if any) diameter		Current (flat weld)		Gas		Speed	Remarks
mm	in			mm	in	mm	in	Type	Amperes•	Type	Flow L/min – cfh	cm/min – cfh	
1.6	$^{1}/_{16}$	butt lap corner fillet	1 4, 5 6, 7 10	1.6	$^{1}/_{16}$	1.6	$^{1}/_{16}$	AC AC AC AC	◇ 60 – 80 ◇ 70 – 90 ◇ 60 – 80 ◇ 70 – 90	Argon or BLU **1**	7 – 15	305 – 12 254 – 10 305 – 12 254 – 10	
3.2	$^{1}/_{8}$	butt lap corner fillet	1 4, 5 6, 7 10	2.4	$^{3}/_{32}$	2.4, 3.2 2.4 1.6, 2.4	$^{3}/_{32}$, $^{1}/_{8}$ $^{3}/_{32}$ $^{1}/_{16}$, $^{3}/_{32}$	AC AC AC AC	◇ 125 – 145 ◇ 140 – 160 ◇ 125 – 145 ◇ 140 – 160		8 – 17	305 – 12 254 – 10 305 – 12 254 - 10	use 2.4 mm – $^{3}/_{32}$ in filler rod vertical and overhead
5.0	$^{3}/_{16}$	butt lap corner fillet	1 4, 5 6, 7 10	3.2	$^{1}/_{8}$	3.2	$^{1}/_{8}$	AC AC AC AC	◇ 190 – 200 ◇ 210 – 240 ◇ 190 – 220 ◇ 210 – 240	Argon or BLU **2**	10 – 21	279 – 11 229 – 9 279 – 11 229 – 9	
6.0	¼	butt lap corner fillet	1 4, 5 9 10	5.0	$^{3}/_{16}$	2.4 or 5.0	$^{3}/_{32}$ or $^{3}/_{16}$	AC AC AC AC	□ 260 – 300 □ 290 – 340 □ 280 – 320 □ 280 – 320		12 – 25	254 – 10 203 – 8 254 – 10 203 – 8	use 3.2 mm – $^{1}/_{8}$ in filler rod two passes vertical and overhead
9.5	$^{3}/_{8}$	butt lap corner fillet	2 5 8 10	5.0 or 6.0	$^{3}/_{16}$ or ¼	5.0 or 6.0	$^{3}/_{16}$ or ¼	AC AC AC AC	□ 330 – 380 □ 330 – 380 □ 350 – 400 □ 330 – 380	Argon or BLU **3**	14 – 30	* * * *	two passes two passes two passes two passes
13	½	butt lap corner fillet	2 5 8 10	5.0 or 6.0	$^{3}/_{16}$ or ¼	5.0 or 6.0	$^{3}/_{16}$ or ¼	AC AC AC AC	□ 440 – 450 □ 400 – 450 □ 420 – 470 □400 – 450		15 – 32	* * * *	two or three passes three passes three passes three passes

NOTES :
- • reduce currents 10 to 20% for vertical and overhead
- ◇ ceramic cup should be used for currents to 250 amps
- □ water-cooled cup should be used for currents above 250 amps
- * welding speed for multiple passes cannot be accurately predicted

GTAW

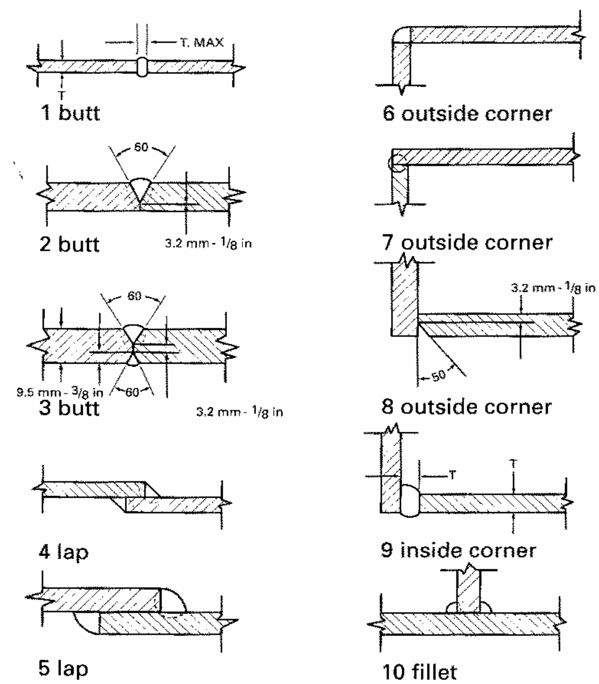
Guiding procedures

Welding magnesium

Magnesium alloys are in 3 groups. They are:

1) aluminum – zinc – magnesium;
2) aluminum – magnesium;
3) manganese – magnesium.

Since magnesium will absorb a number of harmful ingredients and oxidize rapidly when subjected to welding heat, GTA (gas tungsten arc) welding in an inert gas atmosphere is distinctly advantageous. The welding of magnesium is similar, in many respects, to the welding of aluminum. Mangesium was one of the first metals to be welded commercially by the inert-gas non-consumable process (GTAW). For increased welding speed and optimized penetration profiles, BLUESHIELD 1, 2 or 3 (argon-helium mixtures) are recommended.



Magnesium – Manual Welding
High Frequency Stabilised Alternating Current

Work thickness		Weld type	Joint n°	Tungsten electrode diameter		Filler rod (if any) diameter		Current (flat weld)		Gas		Speed	Remarks
								Type	Amperes•	Type	Flow L/min – cfh		
mm	in			mm	in	mm	in					cm/min – cfh	
1.0	0.04	butt fillet	1 10	1.6	1/16	1.6, 2.4 2.4, 3.2	1/16, 3/32 3/32, 1/8	AC AC	◇ 45 ◇ 45	Argon or BLU **1**	6 – 13	508 – 20	backup
1.6	1/16	butt corner fillet	1 9 10	1.6	1/16	2.4, 3.2 2.4, 3.2 2.4, 3.2	3/32, 1/8 3/32, 1/8 3/32, 1/8	AC AC AC	◇ 60 ◇ 35 ◇ 60		6 – 13	508 – 20	backup no backing
2.0	5/64	butt corner fillet	1 9 10	2.4	3/32	3.2 3.2 3.2	1/8 1/8 1/8	AC AC AC	◇ 50 ◇ 50 ◇ 80		6 – 13	432 – 17	no backing
2.6	0.1	butt corner fillet	1 9 10	2.4	3/32	3.2 3.2 3.2	1/8 1/8 1/8	AC AC AC	◇ 100 ◇ 70 ◇ 100	Argon or BLU **2**	9 – 19	432 – 17	backup no backing
3.2	1/8	butt corner fillet	1 9 10	2.4	3/32	3.2, 4.0 3.2, 4.0 3.2, 4.0	1/8, 5/32 1/8, 5/32 1/8, 5/32	AC AC AC	◇ 115 ◇ 85 ◇ 115		9 – 19	432 – 17	backup no backing
5.0	3/16	butt butt	1 1	3.2	1/8	3.2, 4.0 4.0, 5.0	1/8, 5/32 3/32, 3/16	AC AC	◇ 120 ◇ 130		9 – 19	610 – 24 712 – 28	one pass one pass
6.0	¼	butt butt	2 1	5.0	3/16	4.0, 5.0 4.0, 5.0	5/32, 3/16 5/32, 3/16	AC AC	◇ 85 ◇ 130		9 – 19 11 – 23	* 610 – 24	two passes one pass
9.5	3/8	butt	2	6.0	¼	4.0, 5.0	5/32, 3/16	AC	◇ 100	Argon or BLU **3**	9 – 19	*	two passes
13	½	butt	2	6.0	¼	5.0	3/16	AC	□ 260		11 – 23	*	two passes
19	¾	butt	3	6.0	¼	5.0, 6.0	3/16, ¼	AC	□ 370		17 – 35	*	two passes

NOTES :

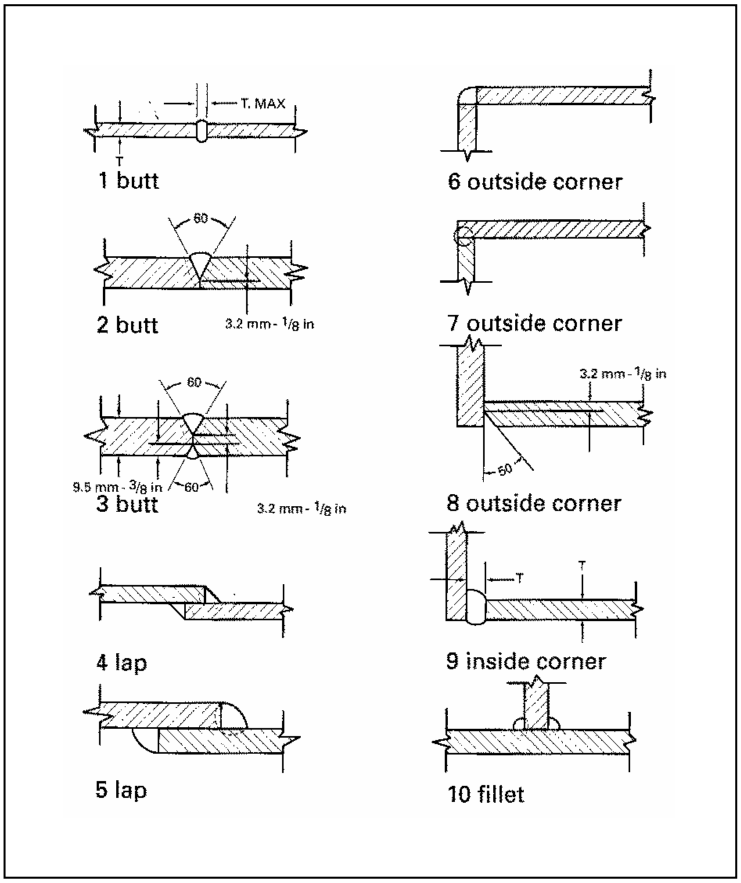
- • reduce currents 10 to 20% for vertical and overhead
- ◇ ceramic cup should be used for currents to 250 amps
- □ water-cooled cup should be used for currents above 250 amps
- * welding speed for multiple passes cannot be accurately predicted

GTAW

Guiding procedures

Welding stainless steel

The GTAW process is widely used for welding stainless steels, especially for full-penetration welds in thin-gauge materials and root passes in thicker materials. Welding rods having the AWS-ASTM prefixes of E or ER can be used as filler rods. However, only bare uncoated rods should be used. Stainless steel can be welded using AC high-frequency stabilized current, however, for DC staigth polarity current, recommendations must be increased 25%. Light gauge metal less than 1.6 mm ($^{1}/_{16}$ in) thick should always be welded with DC straigth polarity using argon gas. For heavy section, BLUESHIELD 1, 2 or 3 (argon-helium mixture) can be used to achieve greater heat input or higher welding speeds. Additions of hydrogen (BLUESHIELD 11 or 12 automatic only) to argon gas shielding have also been used, only for austenitic stainless steels, to provide higher heat input and a cleaner weld surface. Keep stainless from coming into contact with other metals.



AIR LIQUIDE

Stainless Steel – Manual Welding
Straight Polarity Direct Current

Work thickness mm	Work thickness in	Weld type	Joint n°	Tungsten electrode diameter mm	Tungsten electrode diameter in	Filler rod (if any) diameter mm	Filler rod (if any) diameter in	Current (flat weld) Type	Current (flat weld) Amperes•	Gas Type	Gas Flow L/min – cfh	Speed cm/min – cfh	Remarks
1.6	1/16	butt lap corner fillet	1 4, 5 6, 7, 9 10	1.6	1/16	1.6	1/16	DC DC DC DC	◇ 80 – 100 ◇ 100 – 120 ◇ 80 – 100 ◇ 90 – 100	Argon or BLU 1 or BLU 11	5 – 10	305 – 12 254 – 10 305 – 12 254 – 10	
2.5	3/32	butt lap corner fillet	1 4, 5 6, 7, 9 10	1.6	1/16	1.6	1/16	DC DC DC DC	◇ 100 – 120 ◇ 110 – 130 ◇ 100 – 120 ◇ 110 – 130		5 – 10	305 – 12 254 – 10 305 – 12 254 – 10	
3.2	1/8	butt lap corner fillet	1 4, 5 6, 7, 9 10	1.6	1/16	2.4	3/32	DC DC DC DC	◇ 120 – 140 ◇ 130 – 150 ◇ 120 – 140 ◇ 130 – 150		5 – 10	305 – 12 254 – 10 305 – 12 254 – 10	
5.0	3/16	butt lap corner fillet	1 5 6, 7, 8 10	2.4 2.4, 3.2 2.4 2.4, 3.2	3/32 3/32, 1/8 3/32 3/32, 1/8	3.2	1/8	DC DC DC DC	◇ 200 – 250 □ 225 – 275 ◇ 200 – 250 □ 225 – 275		6 – 13	254 – 10 203 – 8 254 – 10 203 – 8	
6.0	¼	butt lap corner fillet	1, 2 5 6, 7, 9 10	3.2	1/8	4.0	5/32	DC DC DC DC	□ 275 – 350 □ 300 – 375 □ 275 – 350 □ 300 – 375		6 – 13	127 – 5 127 – 5 127 – 5 127 – 5	one or 2 passes one or 2 passes one pass
13	½	butt lap corner fillet	2, 3 5 8 10	3.2, 4.0	1/8, 5/32	6.0	¼	DC DC DC DC	□ 350 – 450 □ 375 – 475 □ 375 – 475 □ 375 – 475		7 – 15	* * * *	2 or 3 passes three passes three passes three passes

NOTES :

- • reduce currents 10 to 20% for vertical and overhead
- ◇ ceramic cup should be used for currents to 250 amps
- □ water-cooled cup should be used for currents above 250 amps
- * welding speed for multiple passes cannot be accurately predicted

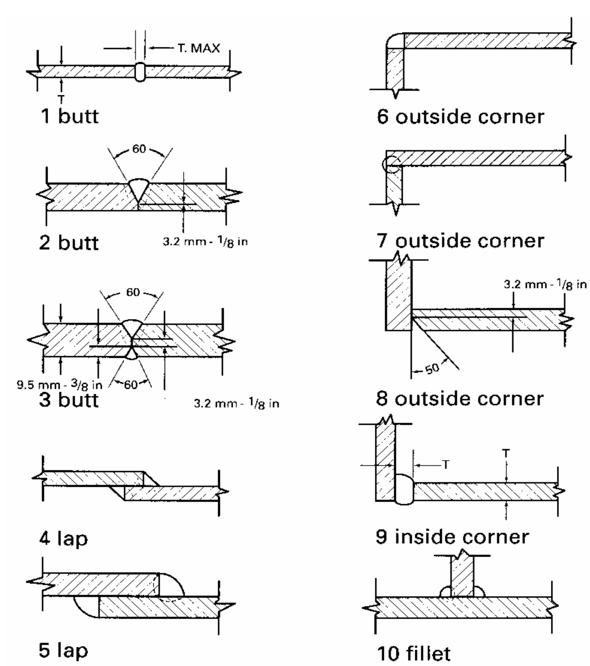
* BLUESHIELD 11 to be used with austenitic stainless steels (300 Series)

GTAW

Guiding procedures

Welding deoxidized copper

Where extensive welding is to be done, the use of deoxidized (oxygen-free) copper is preferable over electrolytic tough pitch copper. Gas tungsten arc welding is well suited for copper and copper alloys because of its intense arc, which produces an extremely high temperature at the joint and a narrow heat-affected zone (HAZ). Although gas tunsgten arc welding has been used occasionnally to weld zinc-bearing copper alloys, such as brass and commercial bronzes, it is not recommended because the shielding gas does not suppress the vaporization of zinc. For the same reason, zinc-bearing filler rods should not be used. Direct current electrode negative (DCEN) is used for GTAW of most copper and copper alloys. This permits the use of an electrode that has a minimum diameter for a given welding current and that provides maximum penetration of the base material. Argon helium or mixtures of the two (BLUESHIELD 1, 2 or 3) are used as shielding gases for GTAW. There is some preference of helium for the inert atmosphere in welding thicknesses above 3.2 mm ($^1/_8$ in) because of the improved weld metal fluidity. Usually, as the thickness increases so does the amount of helium present in the mixture. Preheating recommendations should be followed. Naturally, work must be free of oxides, dirt, oil and moisture.



Deoxidized Copper – Manual Welding
Straight Polarity Direct Current (DCEN)

Work thickness mm	Work thickness in	Weld type	Joint n°	Tungsten electrode diameter mm	Tungsten electrode diameter in	Filler rod (if any) diameter mm	Filler rod (if any) diameter in	Current (flat weld) Type	Current (flat weld) Amperes•	Gas Type	Gas Flow L/min – cfh	Speed cm/min – cfh	Remarks
1.6	1/16	butt lap corner fillet	1, 2 4, 5 6, 7 10	1.6	1/16	1.6	1/16	DC DC DC DC	◇ 110 – 140 ◇ 130 – 150 ◇ 110 – 140 ◇130 – 150	Argon or BLU **2**	7 – 15	305 – 12 254 – 10 305 – 12 254 – 10	one pass
3.2	1/8	butt lap corner fillet	1, 2 4, 5 6, 7 10	2.4	3/32	2.4	3/32	DC DC DC DC	◇ 175 – 225 ◇ 200 – 250 ◇175 – 225 ◇200 – 250		7 – 15	279 – 11 229 – 9 279 – 11 229 - 9	one pass
5.0	3/16	butt lap corner corner fillet	1, 2 4, 5 6, 7 8 10	3.2	1/8	3.2	1/8	DC DC DC DC DC	◇ 190 – 225 ◇ 205 – 250 ◇ 190 – 225 ◇ 205 – 250 ◇ 205 – 250	Helium or BLU **3**	14 – 30	254 – 10 203 – 8 254 – 10 203 – 8 203 – 8	1 pass, preheat 94 °C (200 °F)
6.0	¼	butt lap corner corner fillet	2 5 6, 7 8 10	3.2	1/8	3.2	1/8	DC DC DC DC DC	◇ 225 – 260 □ 250 – 280 ◇ 225 – 260 □ 250 – 280 □ 250 – 280		14 – 30	229 – 9 178 – 7 229 – 9 178 – 7 178 – 7	1 pass, preheat 149 °C (300 °F)
9.5	3/8	butt lap corner corner fillet	2 5 6, 7 8 10	5.0	3/16	5.0	3/16	DC DC DC DC DC	□ 280 – 320 □ 300 – 340 □ 280 – 320 □ 300 – 340 □ 300 – 340		19 – 40	* * * * *	2 pass, preheat 260°C/500°F 2 pass, preheat 260°C/500°F 2 pass, preheat 260°C/500°F 3 pass, preheat 260°C/500°F 3 pass, preheat 260°C/500°F
13	½	butt	3	5.0, 6.0	3/16, ¼	6.0	¼	DC	□ 375 – 525		19 – 40	*	3 pass, preheat 260°C/500°F

NOTES :

- • reduce currents 10 to 20% for vertical and overhead
- ◇ ceramic cup should be used for currents to 250 amps
- □ water-cooled cup should be used for currents above 250 amps
- * welding speed for multiple passes cannot be accurately predicted

GMAW

(Gas metal arc welding)

An arc welding process which produces coalescence of metals by heating them with an arc between a continuous filler metal (consumable) electrode and the work. Shielding is obtained entirely from an externally supplied gas or gas mixture. Some methods of this process are called MIG (metal inert gas) or CO_2 welding (non-preferred terms).

(ANSI/AWS A3.0, *Welding Terms and Definitions*.)

Typical GMAW setup

1. Constant potential power source (suitable to work)•
2. Constant speed wire feeder (suitable to wires to be used)*
3. Electrode (wire) suited to work
4. Regulator/flowmeter (suited to gas or mixture)
5. Cylinder of gas or gas mixture (suited to work)†
6. Appropriate gun and cable assembly
7. Appropriate length of welding cable
8. Appropriate length of ground cable and clamp
9. Welding helmet and protective equipment

• Constant potential (CP) or constant voltage (CV) power sources are available with mechanical, electrical or solid state controls in a variety of capacities.

* Constant speed wire feeders are available in a variety of capacities i.e. wire sizes, wire feed speeds, etc.

† See BLUESHIELD and ARCAL shielding gas mixture in Appendix D.

GMAW

Identification of classifications for continuous electrodes for GMAW
CSA W48.4-M

US system		CDN system	
Example :	ER70S-3	Becomes :	ER480S-3
ER =	Electrode	ER =	Electrode or rod
70 =	Minimum tensile strength in 1000 psi	480 =	Minimum tensile strength in megapascals (MPa)
S =	Solid wire	S =	Solid wire
3 =	Suffix for particular class, based on chemical analysis and physical properties	3 =	Suffix for particular class, based on chemical analysis and physical properties

Note : For full details on chemical and mechanical requirements, consult specifications CSA W48.4-M *Solid Carbon Steel Filler Metal for Gas Shielded Arc Welding* and AWS A5.18 *Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding*.

FCAW

(Flux cored arc welding)

An arc welding process which produces coalescence of metals by heating them with an arc between a continuous filler metal (consumable) electrode and the work.

Shielding is provided by a flux contained within the tubular electrode. Additional shielding may or may not be obtained from externally supplied gas or gas mixture.

(ANSI/AWS A3.0 – 1978, *Welding Terms and Definitions*.)

Typical FCAW setup

1. Constant potential power source (suitable to work) •
2. Constant speed wire feeder (suitable to wires to be used) *
3. Electrode (wire) suited to work
4. Regulator/flowmeter (suited to gas or mixture)
5. Cylinder of gas or gas mixture (suited to work) †
6. Appropriate gun and cable assembly
7. Appropriate length of welding cable
8. Appropriate length of ground cable and clamp
9. Welding helmet and protective equipment

• Constant potential (CP) or constant voltage (CV) power sources are available with mechanical, electrical or solid state controls in a variety of capacities.

* Constant speed wire feeders are available with a variety of capacities i.e. wire sizes, wire feed speeds, etc.

† See *BLUESHIELD* and *ARCAL* Shielding Gases in Appendix D.

FCAW

Identification of classifications for continuous electrodes for FCAW

CSA W48.5-M

US system		CDN system	
Example :	E70T-9	Becomes :	E4802[2]T9 "CH" [1]
E =	Electrode	E =	Electrode
70 =	Minimum tensile strength in 1000 psi	480 =	Minimum tensile strength in megapascals (MPa)
T =	Tubular wire	T =	Tubular wire
9 =	Particular class of wire based on chemical analysis and physical properties	9 =	Particular class of wire based on chemical analysis and physical properties

Note : (1) The weld deposits that meet the diffusible hydrogen requirements bear the suffix "CH".
(2) In the new system, the digit which was added after the first three is used to indicate position in which the electrode may by used

i.e. : 1 = all positions
2 = flat or horizontal position

For full details on chemical and mechanical requirements, refer to specifications CSA W48.5-M *Carbon steel electrodes for flux and metal-core arc welding* and AWS A5.20-M *Specifications for carbon steel electrodes for flux cored arc welding*.

SAW

(Submerged arc welding)

An arc welding process which produces coalescence of metals by heating them with an arc or arcs between a bare metal electrode or electrodes and the work.

The arc is shielded by a blanket of granular, fusible material on the work. Pressure is not used and filler metal is obtained from the electrode and sometimes from a supplementary welding rod.

(ANSI/AWS A3.0 latest edition, *Welding Terms and Definitions*.)

Typical SAW setup

1. Welding power source (suitable for choice of electrode)
2. Control (suitable for wire drive unit)
3. Welding gun (suitable for amperage used)
4. Wire drive unit (suitable for wire feed speed requirement)
5. Flux hopper
6. Ground cable (suitable for amperage used)
7. Electrode cable (suitable for amperage used)
8. Flux recovery system (optional)
9. Safety equipment

SAW

Identification of classifications for bare mild steel electrodes and fluxes for SAW

CSA W48.6-M

U.S. system		CDN system	
Example :	F72-EM12K	Becomes :	F48A3-EM12K
F =	Flux	F =	Flux
7 =	Minimum tensile strength in 1000 psi	48 =	Minimum tensile strength in megapascals (480 MPa)
		A =	As welded
2 =	* Test temperature at which impact strength of weld metal will equal or exceed 20 ft-lb	3 =	* Test temperature at which impact strength of weld metal will equal or exceed 27 joules
E =	Electrode	E =	Electrode
M12K =	Chemical composition of the electrode (See Note 1)	M12K =	Chemical composition of electrode (See Note 1)

Note 1 : In M12K :

M = indicates a medium manganese content
L = indicates low manganese content
H = indicates high manganese content
12 = indicates the nominal carbon content of the electrode in 1/100 of a per cent
K = the electrode is made from a heat of steel which has been silicon killed
* Test temperature : -30 °C (-20 °F)

For full details on electrode compositin, test temperature, etc., consult CSA Standard W48.6-M, *Fluxes and carbon steel electrodes for submerged arc welding* or AWS A5.17, *Specification for carbon steel electrodes and fluxes for submerged arc welding*.

SAW

LOW ALLOY STEEL
and composite electrodes and fluxes for submerged arc welding

FXXX-ECXXXN-XNHX

- Indicates a submerged arc welding flux.
- Indicates the minimum tensile strength – in increments of 10,000 psi (69 MPa) – of weld metal with the flux and some specific classification of electrode deposited according to the welding conditions specified herein. Two digits are used for weld metal of 100,000 psi (690 MPa) tensile strength and higher.
- Designates the condition of heat treatment in which the tests were conducted: “A” for as-welded and “P” for postweld heat treated.
- Indicates the lowest temperature at which the impact strength of the weld metal referred to above meets or exceeds 20 ft-lb (27 J).
- Indicates electrode.
- Indicates that the electrode is a composite electrode. Omission of the “C” indicates that the electrode is a solid electrode.
- Classification of the electrode used in producing the weld metal referred to above.
- Indicates the chemical composition of the weld metal obtained with the flux and the electrode. One or more letters or digits are used.
- Optional supplemental diffusible hydrogen designator.
- The “N” is used only for electrodes intended for welds in the core belt region of nuclear reactor vessels.

ANSI / AWS A5.23 – Specification for low alloy steel electrodes and fluxes for submerged arc welding.