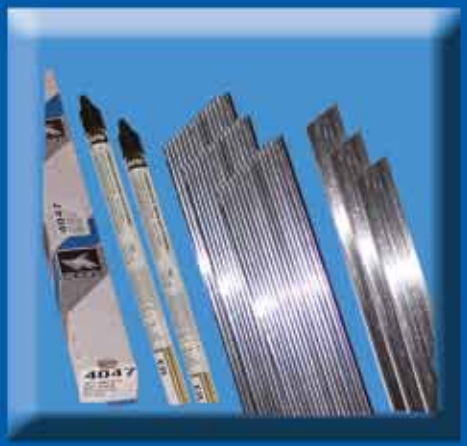
ALUMINUM

WELDING RODS AND WIRES



WA. ALLOY CO.

Aluminum Alloy guide for proper filler metal selection

Base Metal Combinations	201.0 206.0 224.0	319.0 333.0 354.0 355.0 C355.0	356.0 A356.0 357.0 A357.0 413.0 443.0 A444.0	511.0 512.0 513.0 514.0 535.0	7004 7005 7039 710.0 712.0	6009 6010 6070	6005 6061 6063 6101 6151 6201 6351 6951	5456	5454	5154 5254[i]	5086	5083	5052 5652[i]	5005 5050	3004 Alc 3004	2219	2014 2036	1100 3003 Alc 3003	1060 1070 1080 1350
1060, 1070, 1080, 1350, 100, 3003, Alc 3003	ER4145	ER4145	ER4043[a,h]	ER5356[e,j]	ER5356[e,j]	ER4043[a,j]	ER4043[b]	ER5356[e]	ER4043[b,j]	ER5356[e,j]	ER5356[e]	ER5356[e]	ER4043[b,j]	ER1100[h,j]	ER4043[b,j]	ER4145[h,j]	ER4145	ER1100[h,j]	ER1188[h,e,h,j]
2014, 2036 2219 3004, Alc 3004 3005, 3050 5052, 5652[i] 5083 5086 5154, 5254[i] 5454 5456	ER4145[e] ER2319[h]	ER4145[e] ER4145[e] ER4043[e] ER4043[e] ER4043[e] ER4043[e]	ER4145 ER4145[b,e] ER4043[e] ER4043[e] ER4043[f] ER5356[e,d] ER5356[e,d] ER4043[f] ER4043[f] ER5356[e,d]	ER4043 ER5356[f] ER5356[f] ER5356[d] ER5356[d] ER5356[f] ER5356[f] ER5356[f] ER5356[d]	ER4043 ER5356[e] ER5356[f] ER5356[d] ER5183[d] ER5356[d] ER5356[e] ER5356[e] ER5556[d]	ER4145 ER4043[a,j] ER4043[e] ER4043[e] ER4043[e] ER4043[e]	ER4145 ER4043[a,j] ER4043[e,f] ER4043[e,f] ER5356[e] ER5356[e,f] ER5356[e] ER5356[f] ER5356[d] ER5356[d]	ER5356[e] ER5356[f] ER5356[f] ER5183[d] ER5356[d] ER5356[f] ER5356[f] ER5356[f] ER5356[f] ER5356[d]	ER4043[b] ER5356[f] ER5356[f] ER5356[f] ER5356[d] ER5356[d] ER5356[f] ER5356[f] ER5554[f,i] ER5356[d]	ER4043 ER5356[f] ER5356[f] ER5356[f] ER5356[d] ER5356[d] ER5356[f] ER5356[f] ER5654[f,i] ER5356[d]	ER5356[e] ER5356[e] ER5356[e] ER5356[e] ER5356[d] ER5356[d]	ER5356[e] ER5356[e] ER5356[e] ER5356[e] ER5183[e]	ER4043[b] ER5356[e,f] ER5356[e,j] ER5356[e,f,i]	ER4145 ER4043[a,b] ER5356[e,f] ER5356[e,j]	ER4145 ER4043[a,b] ER5356[e,f]	ER4145[e] ER2319[e]	ER4145[e]		
6005, 6061, 6063, 6101, 6151, 6201, 6351, 6951	ER4145	ER4145[b,e]	ER4043[e,f,g]	ER5356[f]	ER5356[e,f]	ER4043[a,e,g]	ER4043[e,f,g]												
6009, 6010, 6070	ER4145	ER4145[b,e]	ER4043[a,b,g]	ER4043	ER4047	ER4043[a,b,g]													
7004, 7005, 7039 710.0, 712.0		ER4043[e]	ER4043[e,f]	ER5356[f]	ER5356[d]														
511.0, 512.0, 513.0, 514.0, 535.0			ER4043[f]	ER5356[f]															
356.0, A356.0, 357.0, A357.0, 413.0, 443.0 A444.0	ER4145	ER4145[b,e]	ER4043[e,f]																
319.0, 333.0, 354.0, 355.0, C355.0	ER4145[e]	ER4145[b,e,j]																	
201.0, 206.0, 224.0	ER2319[e,h]																		

Information courtesy: American Welding Society, Inc. ANSI/AWS A5.10-92

Code Key:

a. ER4145 may be used in some applications
b. ER4047 may be used in some applications
c. ER4043 may be used in some applications
d. ER5183, ER5356 or ER5556 may be used
e. ER2319 may be used in some applications
Higher strengths can be achieved when the weldment is post-weld solution heat treated and aged.
f. ER5183, ER5356, ER5554, ER5556 or ER5654 may be used. In certain cases they provide improved color match after anodizing, higher weld ductility and higher weld Strength. ER5554 is suitable for sustained elevated temperature service.
g. ER4643 provides high strength in ½" or thicker groove welds in 6XXX base alloys when post-weld solution heat-treated and aged.
h. Filler metal with the same analysis as the base metal is sometimes used. The following wrought filler metals possess the same chemical composition limits as cast filler alloys: ER4009 and R4009 as R-C355.0, ER4010 and R4010 as R-A356.0 and R4011 as R-A357.0.
i. Base metal alloys 5254 and 5652 are used in hydrogen peroxide service. ER5654 filler metal is used for welding both alloys for service temperatures below 150°F (66°C).
j. ER1100 may be used in some applications.

Notes:

1. Service conditions, such as immersion in fresh or salt water, exposure to certain chemicals, or sustained high temperature service (150° F [66° C]) may limit the choice of filler metals.
2. The recommendations in this table are for Gas shielded arc welding processes only. For oxy-fuel gas welding or brazing, ER1188, ER1100, ER4043, ER4047 and ER4145 Are ordinarily used.
3. Where no filler metal is suggested, this base metal combination is not recommended for welding.
4. If you have a base metal or metal combination not listed in this table, consult the supplier of the alloy for proper welding procedures.

Caution: Some aluminum alloys manufactured for specific uses, such as aerospace applications, are made for high strength and are considered "un-weldable", due to alloying elements that are added to increase strength. Base metal groups to watch for are the 2000 series and 7000 series aluminums. Some alloys in these groups can be brazed or repaired but cannot be welded successfully.

ER1100
AWS/SFA 5.10, AMS 4180

Washington Alloy ER1100
is a 99% aluminum filler metal available in spools and cut length for MIG and TIG welding processes. ER1100 is a softer alloy that is commonly used in architectural and decorative applications on furniture and piping, thin gauge materials and foil products. It's softness make it easy to shape and form giving it an advantage in decorative work or where attractive weld appearance is critical.

ER1100 is used on 1100, 3003, and Alc. 3003 to similar base metals or to 1060, 1070, 1080 and 1350. It is also used extensively as low strength tie wire in chemical baths due to its resistance to weathering and chemical attack.

It's melting range is 1190-1215°F with a density of .098 lbs/ci. It's post anodized color is slightly golden. Typical tensile strength is 13,500 psi.

Typical Weld Metal Chemistry (%)

Si & Fe	0.95 max.
Cu	0.05-0.20
Mn	0.05 max.
Zn	0.10 max.
Al	99.0 Min.
Other*	0.15 Total max.

ER4043
AWS/SFA 5.10, AMS 4190

Washington Alloy 4043
is a 5% Silicon aluminum filler metal that is one of the most widely used aluminum welding alloys for general repair and fabrication.

The smoother running ER4043 is often preferred because of it's flowing characteristics and it's reduced crack sensitivity over other aluminum welding wires.

ER4043 is available in spools and cut lengths for both MIG and TIG welding and is recommended for base metals 3003,3004, 5052, 6061, 6063 and casting alloys 43, 355, 356 and 214.

ER4043 has a melting range of 1065 - 1170°F and a density of .097 lbs/ci It's post anodizing color is gray.

ER4043 has a typical Tensile strength of 29,000 psi.

Typical Weld Metal Chemistry (%)

Si	4.5 - 6.0
Fe	0.80 max.
Cu	0.30 max.
Mn	0.05 max.
Mg	0.05 max.
Zn	0.10 max.
Ti	0.20 max.
Al	Balance
Other*	0.15 total

*Be shall not exceed 0.0008%

ER4047 (718)
AWS/SFA 5.10 AWS A5.8 BAlSi-4, AMS 4185

Washington Alloy ER4047 (718)
is an aluminum welding alloy with a 12% silicon content. Originally formulated for brazing, it's features are high fluidity, narrow freeze range, low melting range and low shrinkage. ER4047 is a good general purpose, free flowing filler metal with good corrosion and hot cracking resistance when welded. It can also be used in sustained elevated temperatures.

It comes in spools and cut length for MIG, TIG and brazing applications on 1060, 1350, 3003, 3004, 3005, 5005, 5050, 6053, 6061, 6951, 7005, and cast alloys 710.0 and 711.0.

ER4047 has a melting range of 1070-1080°F and a density of 0.96 lbs/ci. It's typical tensile strength is 27,500 psi and it's post anodized color is gray-black.

Typical Weld Metal Chemistry (%)

Si	11.0-13.0
Fe	0.80 max.
Cu	0.30 Max.
Mn	0.15 max.
Mg	0.10 max.
Zn	0.20 max.
Al	Balance
Other*	0.15 Total max.

*Be shall not exceed 0.0008%

ER5183
AWS/SFA 5.10

Washington Alloy ER5183
is an aluminum filler metal containing higher levels of manganese, magnesium and chrome. ER5183 is formulated to provide the highest possible "as-welded" strength in high magnesium alloys.

Available in spools and cut length for MIG and TIG applications. ER5183 is known for it's high fracture and impact toughness and exposure to corrosive elements. Applications include marine components, drilling rigs, cryogenics, etc. Base metals include 5083, 5086 and 5456 to similar base metals or to 5052, 5652 and 5056. It's melting range is 1075-1180°F, it's density is 0.96 lbs/ci. The typical tensile strength is 41,000 psi and the post anodizing color is white.

Typical Weld Metal Chemistry (%)

Si	0.40 max.
Fe	0.40 max.
Cu	0.10 max.
Mn	0.5-1.0
Mg	4.3-5.2
Cr	0.5-0.25
Zn	0.25 max.
Ti	0.15 max.
Al	Balance
Other*	0.15 total max.

*Be shall not exceed 0.0008%

ER5356
AWS/SFA 5.10

Washington Alloy ER5356
is a 5% magnesium aluminum filler metal, available in spools and cut length for both MIG and TIG applications. ER5356 has increased levels of Mg, Ti and Mn along with the addition of Crome and a slight reduction in silicon. These changes work together to increase it's corrosion resistance, making it the best aluminum for use in or near saltwater. ER5356 is commonly used on 5050, 5052, 5083, 5356, 5454, and 5456 and is the second most widely used aluminum filler metal. ER5356 has a melting range of 1060-1175°F, a density of 0.96 lbs/ci and a typical tensile strength of 38,000 psi. It's post anodizing color is white.

Typical Weld Metal Chemistry (%)

Si	0.25 max.
Fe	0.40 max.
Cu	0.10 max.
Mn	05-.20
Mg	4.5-5.5
Cr	05-.20
Zn	0.10 max.
Ti	06-.20
Al	Balance
Other*	0.15 max.

*Be shall not exceed 0.0008%

ER5556
AWS/SFA 5.10

Washington Alloy ER5556
is an aluminum filler metal with higher levels of manganese, zinc and magnesium than ER5356, giving ER5556 increased crack resistance and good ductility. Available in MIG and TIG forms.

While tensile strengths are among the highest in aluminum filler metals, the higher magnesium content can decrease it's resistance to stress corrosion cracking in prolonged tempeatures above 150°F. Commonly used on 5154, 5254, 5454 and 5456.

ER5556 has a melting range of 1065-1175°F, and has a density of 0.96 lbs/ci. It's typical tensile strength is 42,000 psi and the post anodizing color is white.

Typical Weld Metal Chemistry (%)

Si	0.25 max.
Fe	0.40 max.
Cu	0.10 max.
Mn	0.50-1.00
Mg	4.70-5.50
Cr	0.05-0.20
Zn	0.25 max.
Ti	0.05-0.20
Al	Balance
Other*	0.15 total max.

*Be shall not exceed 0.0008%

ER2319
AWS/SFA 5.10, AMS 4191

Washington Alloy ER2319
is an aluminum welding wire with an elevated copper content and a controlled manganese level that provides tough resistance to stress corrosion cracking and providing good service in high elevated temperatures. ER2319 was developed to be used on 2219 in applications, such as aircraft, where high structural strength is required. ER2319 comes on spools and cut length for both MIG and TIG welding.
ER2319 is heat treatable and can also be used on 319.0, 333.0, 354.0, 355.0,380.0 and casting alloy C355.0.
ER2319 has a melting range of 1010-1190˚F and has a density of .100 lbs/ci. It's typical tensile strength is 37,500 psi and the post anodizing color is golden.

Typical Weld Metal Chemistry (%)

Si	0.20 max.
Fe	0.30 max.
Cu	5.80-6.80
Mn	0.20-0.40
Mg	0.02 max.
Zn	0.10 max.
Ti	0.10-0.20
Al	Balance
Other*	0.15 total max.

*Be shall not exceed 0.0008%

ER4145
AWS/SFA 5.10 AWS A5.8 BAISi-3, AMS 4184

Washington Alloy ER4145
is an aluminum filler metal with a high silicon content that was originally developed as a brazing alloy, due to it's low melting temperature and high puddle fluidity. ER4145 has very good resistance to weld cracking when used on 2000 series alloys as well as aluminum-copper and aluminum-copper-silicon castings. ER4145 is available in spools and cut length for MIG, TIG and brazing applications on a variety of base metals.
Because of it's lower tensile strength, it should not be used in high strength applications or on high magnesium alloys.
ER4145's melting range is 970-1085˚F and has a density of 0.099 lbs/ci. The typical tensile strength is 27,000 psi and the post anodized color is gray-black.

Typical Weld Metal Chemistry (%)

Si	3.60-4.60
Fe	0.80 max.
Cu	0.10 max.
Mn	0.05 max.
Mg	0.10-0.30
Zn	0.10 max.
Ti	0.15 max.
Al	Balance
Other*	0.15 total max.

*Be shall not exceed 0.0008%

ER5554
AWS/SFA 5.10

Washington Alloy 5554
is an aluminum filler metal available in spools and cut length for both MIG and TIG welding applications.
ER5554 has a relatively limited use in industry, as it is designed specifically to weld 5454 aluminum base metal.
The chemistry of 5554 allows it's service to hold up under sustained elevated temperatures exceeding 150 F, where it is noted for it's resistance to stress corrosion cracking.
For this reason, ER5554 sees most of it's use in hot chemical storage tanks.
It's melting range is 1155-1195 F and it's density is 0.97 lbs/ci. It has a typical tensile strength of 33,000 psi and it's post anodized color is white.

Typical Weld Metal Chemistry (%)

Si	0.25 max.
Fe	0.40 max.
Cu	0.10 max.
Mn	0.50-1.0
Mg	2.4-3.0
Cr	0.05-0.20
Zn	0.25 max.
Ti	0.05-0.20
Al	Balance
Other*	0.15 total max.

*Be shall not exceed 0.0008%

ER5654
AWS/SFA 5.10

Washington Alloy ER5654
is an aluminum filler metal with elevated magnesium levels, designed to be used in hydrogen peroxide storage tanks, although it can be used in a variety of welding applications in both MIG and TIG processes. ER 5654 can be used on 5XXX, 6XXX and 7XXX series aluminum as well as many 3XX and 4XX alloys. Due to it's high magnesium content, ER5654 should not be used where elevated temperatures can lower it's resistance to stress corrosion cracking.
ER5654's melting range is 1100-1190˚F and has a density of 0.096 lbs/ci.
It has a typical tensile strength of 32,000 psi and the post anodized color is white.

Typical Weld Metal Chemistry (%)

Si + Fe	0.45 max.
Cu	0.05 max.
Mn	0.01 max.
Mg	3.10-3.90
Cr	0.15-0.35
Zn	0.20 max.
Ti	0.05-0.15
Al	Balance
Other*	0.15 total max.

*Be shall not exceed 0.0008%

A356.0
Casting Alloy ER4008, AMS 4181

Washington Alloy A356 (R & ER4008)
is an aluminum casting repair alloy with controlled chemistry to precisely match that of the original casting. A356.0 is suitable for welding both A356.0 and 356.0 (which has a higher iron content than A356) castings, and can be post weld heat treated for desired results.
A356.0's melting range is 1035-1135˚F and has a density of 0.097 lbs/ci. It has a typical tensile strength of 40,000 psi and a post anodized color of gray.

Typical Weld Metal Chemistry (%)

Si	6.50-7.50
Fe	0.09 max.
Cu	0.05 max.
Mn	0.05 max.
Mg	0.30-0.45
Zn	0.05 max.
Ti	0.04-0.15
Al	Balance
Other*	0.15 total max.

*Be shall not exceed 0.0008%

C355.0
Casting Alloy ER4009, AMS 4245

Washington Alloy C355.0 (R & ER4009)
is an aluminum filler metal which has a specific chemistry designed to weld on 355.0, A355.0 and C355.0. This alloy has a higher copper content to inhance it's heat treating properties. C355.0 also contains a small amount of iron to increase tensile strength in premium castings. C355.0 has a melting range of 1015-1150˚F and a density of 0.098 lbs/ci
The typical tensile strength is 39,000 psi and the post anodized color is gray.

Typical Weld Metal Chemistry (%)

Si	4.50-5.50
Fe	0.20 max.
Cu	1.00-1.50
Mn	0.10 max.
Mg	0.40-0.60
Zn	0.10 max.
Ti	0.20 max.
Al	Balance
Other*	0.15 total max.

*Be shall not exceed 0.0008%

When repairing or joining casting alloys, it is extremely important to match the base material as closely as possible. Because other alloys will solidify at different rates as the base metal, weld cracking can easily occur from shrinking stresses. Furthermore, a variance in chemistry can be detrimental to the repair integrity when the part undergoes post weld heat treating. Therefore, be certain of your cast base material and match the chemistry as precisely as possible.

AL345
Extruded Maintenance & Repair Electrode
AWS/SFA 5.3 E4043

DC+ (Reverse Polarity)

Washington Alloy AL345
is a flux-coated aluminum electrode for use in low temperature fabricating, maintenance and repair of cast and wrought aluminum sheets plates, castings and extrusions. AL345 is an all-position electrode that produces a dense, porosity-free machinable weld with good corrosion resistance. AL345 is not heat treatable, and is not designed to be used on A356.0, A357.0, C355.0 or other similar mold castings. It's typical applications include tanks, pipes, refrigeration equipment, automobile, chemical and food equipment parts, Typical tensile strength is 34,000 psi and the post anodizing color is gray. Density is 0.097 lbs/ci

Welding Procedures

Clean the joint area thouroghly, the flux has it's own cleansing action but the cleaner the weld zone is the better.

Heavy sections should be beveled at a 60-70° vee (see figs. C, E or G in the joint design section). Heavy sections may require a preheat (not to exceed 150°F) especially if the base metal is cold or has moisture on it. Preheating will result in a flatter bead with less required amperage. Using DC+ current, maintain a short arc length while tilting the electrode in the direction of travel.

Experiment first on a scrap piece to get the feel of the travel speed. AL345 runs at similar amperages as mild steel, but the burn rate is much faster. Use a straight drag method, adjusting travel speed to allow the puddle to fully form, rather than attempting to weave the rod.

Interpass temperatures should be kept to a minimum. Allow each pass to cool and remove all slag prior to the next pass. A stainless steel brush with warm water is recommended (a 10% suluric acid solution may also be used). It is not recommended to use a chipping hammer to remove slag.

Amperage settings

3/32" (2.4mm).....50-85 amps
1/8" (3.2mm).....85-140 amps
5/32" (4.0mm).....110-165 amps

Typical Weld Metal Chemistry (%)

Si.....4.50-6.00	Zn.....0.10 max.
Fe.....0.80 max.	Ti.....0.20 max
Cu.....0.30 max.	Al.....Balance
Mn.....0.05 max.	Other* 0.15 total max.
Mg.....0.05 max.	*Be shall not exceed 0.0008%

FLUX-CORED ALUMINUM
TUBULAR BRAZING ALLOY

Washington Alloy
Flux-cored Aluminum
is an all-position, oxy-acetylene brazing rod with a 4% silicon content for superior flow characteristics in the brazing repair of non-structural extrusions and castings. Based on a 4043 chemistry, our flux-cored aluminum will readily bond with a large variety of base metals in thin sheet metal, worn or broken parts, mold/die changes, model work, non-structural flanges, etc.

Flux-cored aluminum has a broad operating range, where the self-contained flux offers protection against moisture and handling. The flux is hydroscopic (absorbs atmospheric humidity), requiring the ends of the rods to be sealed to preserve it's potency. Partially used rods may not function well after a short period of time. Flux-cored Aluminum has good plasticity and is readily machinable.

Brazing Procedures

Clean the weld zone of any plating, dirt, grease, ink, coatings, oxides or surface impurities. A stainless steel brush is recommended along with a toluene solvent.

The gap to be joined should not exceed 1/8". Bevel heavy sections to a 60-75°vee (see figs. C, E or G in the joint design section). Use a slightly carburizing flame setting and heat the work area, keeping the flame 1-2" from the weld zone. As the area heats up, start dabbing the filler rod to the weld zone under torch flame until small amounts of alloy are deposited and the filler metal begins to flow through the gap. be sure that each drop flows and bonds to the base metal. **Do not melt the base metal.** Allow the joint to cool and wash the flux residue off with warm water and a stiff brush.

Specifications

Liquidus.....1,100°F
Tensile Strength.....3,200 psi
Color Match.....Good
Not to be anodized.

Typical Deposited Chemistry (%)

Si.....4.00-4.25
Fe.....0.24 max.
Cu.....0.01 max.
Mn.....0.01 max.
Mg.....0.01 max.
Zn.....0.02 max.
Ti.....0.013 max.
Al.....Balance
Other*.....0.15 total max.
*Be shall not exceed 0.0008%

ALU-ZINC
ALUMINUM REPAIR ALLOY
MIL-R4208

Washington Alloy Alu-zinc
Is a self-fluxing, low temperature joining alloy that can be used with oxy-acetylene equipment or TIG welded with AC (high frequency) and an argon shielding gas.

It is excellent for use in new fabrication, maintenance or repair of zinc based metals, pot metal, aluminum and other white metals. No flux is required.

Common uses include aluminum doors & windows, furniture, boats, engine heads & housings, crank cases, power mower parts, jigs & fixtures, carburetors, gears, pumps, trophies, ornaments, models, kirksite dies, etc.

This alloy is often sold at fairs and home shows as a "miracle alloy" to repair pots and pans. It will also join very thin dissimilar metals such as aluminum to copper.

Procedures

Clean joint area from dirt, plating, ink, coatings, scale, oil, grease and oxides. A stainless steel brush with toluene solvent is recommended.

Preheat to 400°F(+/-). Turn torch away the joint itself and continue heat build up being careful not to melt the base metal. As the part heats up, begin touching the alloy to the joint until it begins to flow which should be 730-740°F. As the Alu-zinc flows into the joint, use the rod tip to stir and break up any surface skin that starts to develop. This film can prevent a sound bond in the joint. Be sure to rub the rod firmly into the joint area as it continues to flow.

Once the repair is complete, allow the part to cool at room temperature. **DO NOT QUENCH** the joint.

Clean up: After the repair has cooled, use a stainless steel brush or warm water to remove surface residue. The cleaned joint can now be painted or plated to suit.

Specifications

Elastic limit.....33,000 psi
Tensile Strength.....39,000 psi
Melting Range.....715-735°F
Brinell-500 kg load.....100
Compression Strength..60,000 to 75,000 psi
Shear srength.....34,000 psi
Elongation.....3% in 2 inches
Density.....0.02 lbs/ci
Ductility.....Good

Typical Deposited Chemistry is proprietary

Tips for Welding Aluminum

CLEAN the Weld Zone:

Aluminum ***must*** be properly prepared and cleaned prior to welding to insure good results.

Some of the primay causes of problems that occur when welding aluminum are due to improper plate cleanliness and preparation.

Before welding all moisture, lubricants,coatings, ink, dirt and oxides must be properly removed from the base metal.

It is first necessary to make sure there is no **moisture** present and the aluminum is at room temperature. Cold aluminum can condense moisture when welding and create porosity. If neccessary, aluminum may be preheated up to 150°F to eliminate moisture. **Lubricants** and **coatings** are the next step. Most aluminum will be supplied with some sort of protective oil or coating. This should be first treated with toluene solvent, which will remove the oils and greases that may be present. All joint areas should be thoroughly cleaned and dried with a clean, un-contaminated cloth. Do not use compressed air to dry components, as this will most likely contain contaminants.

Oxides that form on the surface of aluminum are one of the more common reasons for poor or failed joining of the filler metal to the base plate when welding. These oxides can be removed a couple of ways; The first way is to use a stainless steel scratch brush that has not been used on any ferritic steels, as the brush can pick up carbon or other contaminates from carbon steel (Clean the brush frequently with toluene solvent). Power brushing may also be done. Run your brush at low RPM's to avoid heating up and deforming the base metal.

The second is an acid cleanser (*your distributor may have this in stock*). After cleaning the area should be rinsed and dried, followed by brushing as noted above.

Heavy oxidation can also be removed with a hot sodium hydroxide etching solution with a nitric acid rinse. This is more stringent cleaning method and necessitates milling or wire brushing before welding.

Grinding may also be performed in surface preparation, but be sure to use a flexible disc that is **rated for aluminum**. Typically a 30 - 50 grit is adequate to prevent loading up the disc surface.

keep pressure light to prevent deforming the base metal surface. Wheel grinding is not recommended.

Shielding Gas:

Aluminum requires a completely inert shielding gas (no oxygen or CO2).

Recommended gases are: **100% argon, 100% helium or an argon/helium mix.**

The most widely used shielding gas in aluminum welding is 100% argon. This is due to a couple of factors; first is the cost. Helium is significantly more expensive than argon, but argon gives good resuilts in both TIG and MIG welding of aluminum.

The second is availability. Argon is readily available at most distributors any time it is needed but helium can sometimes be very difficult to obtain on short notice.

Helium does enhance penetration, and is sometimes used when welding on heavier guage materials. usually this is not the case in TIG welding as most applications are on thin to medium guage material.

Use Proper Equipment:

Today's aluminum welding equipment has vastly improved over the years.

If you are a hobbyist it may not be worth the expense to buy new equipment. If you want to upgrade your old equipment, your distributor can also provide the parts necessary for the best results. When upgrading older equipment or that which is set up for steel, some of the basic things you will need are a teflon liner, U-shaped drive rolls, teflon or nylon input and output guides and a straight neck torch as opposed to a gooseneck torch. Your distributor should have these items in stock or can easily get them for you.

If you do a lot of aluminum welding then it would be wise to consult your distributor for the latest equipment available for your application. This will insure that you have the best results possible and with the least amount of trouble.

Air Humidity is another factor that is often overlooked when welding aluminum. Many times a welder may experience unforseen porosity even after all the proceedures above have been followed, not realizing he is welding in a humid enviornment that is effecting his weld quality.

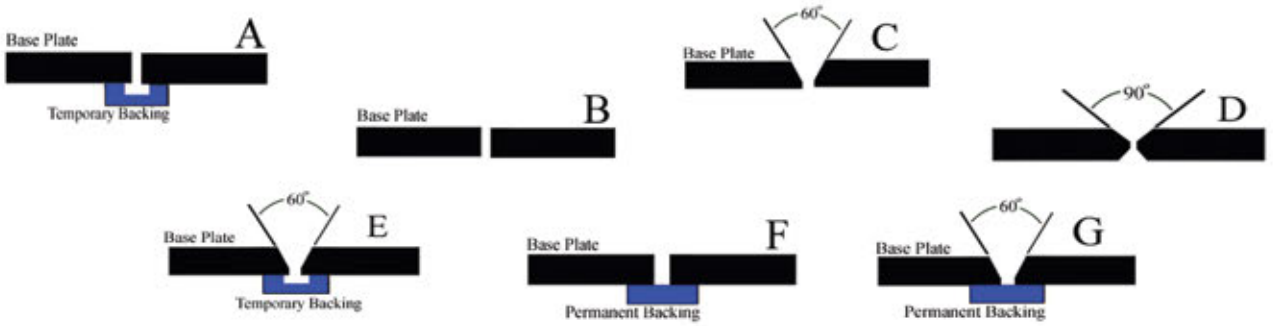
Hydrogen atoms are released from moisture at welding temperatures and will cause porosity in the weld. Special care should be taken to keep shop conditions as dry as possible and the base metal kept at proper temperature to avoid condensation. Some porosity may not be seen on the weld surface, but will show up under x-ray.

MIG Welding Parameters by Joint Design

Base metal Thickness	Welding Position	Joint Type *	Root Gap/in	No. of passes	Electrode diameter	Welding **A**mps	Arc **V**olts	Travel Speed In./min.	Gas flow rate Cf/hr
1/16 – 14 Ga	F	A	0	1	.030	70-110	15-20	25-45	25
		F	3/32						
3/32 - 11 Ga	F	A	0	1	.030-.047	90-150	18-22	25-45	30
	F,V,H,O	F	1/8		.030	110-130	18-23	23-30	30
1/8 - 8 Ga	F,V,H	A	0-3/32	1	.030-.047	120-150	20-24	24-30	30
	F,V,H,O	F	3/16			110-135	10-23	18-28	30
3/16 - 4.5 Ga	F,V,H	B	0-1/16	1f-1b	.030-.047	130-175	22-26	24-30	35
	F,V,H	E	0-1/16	1	.047	140-180	23-27	24-30	35
	O	E	0-1/16	2f	.047	140-175	23-27	24-30	60
	F,V	G	3/32-3/16	2	.047-.062	140-185	23-27	24-30	35
	H,O	G	3/16	3	.047	130-175	23-27	25-35	60
1/4 - 2 Ga	F	B	0-3/32	1f, 1b	.047-.062	175-200	24-28	24-30	40
	F	E	0-3/32	2	.047-.062	185-225	24-29	24-30	40
	V,H	E	0-3/32	3f, 1b	.047	165-190	25-29	25-35	45
	O	E	0-3/32	3f, 1b	.047-.062	180-200	25-29	25-35	60
	F,V	G	1/8-1/4	2-3	.047-.062	175-225	25-29	24-30	40
	O,H	G	1/4	4-6	.047-.062	170-200	25-29	25-40	60
3/8	F	C-90°	0-3/32	1f, 1b	.062	225-290	26-29	20-30	50
	F	E	0-3/32	2f, 1b		210-275		25-35	50
	V,H	E	0-3/32	3f, 1b		190-220		24-30	55
	O	E	0-3/32	5f, 1b		200-250		25-40	80
	F,V	G	1/4-3/8	4		210-290		24-30	50
	O,H	G	3/8	8-10		190-260		25-40	80
3/4	F	C-60°	0-3/32	3f, 1b	.062-3/32	340-400	26-31	14-20	60
	F	E	0-1/8	4f, 1b	3/32	325-375	26-31	16-20	60
	V,H,O	E	0-1/16	8f, 1b	.062	240-300	26-30	24-30	80
	F	D	0-1/16	3f, 3b	.062	270-330	26-30	16-24	60
	V,H,O	D	0-1/16	6f, 6b	.062	230-280	26-30	16-24	80

Weld Positions: F, flat, V, vertical, H, horizontal, O, overhead Weld Passes: f, front, b, back

Joint Designs for Metal, Inert Gas (MIG) Welding



WARNING! PROTECT yourself and others. Read and understand this information. BRAZING AND SOLDERING ALLOYS AND FLUXES MAY PRODUCE FUMES AND GASES DANGEROUS TO YOUR HEALTH. FLUXES MAY CONTAIN FLUORIDES. FLUXES MAY BURN EYES and SKIN ON CONTACT AND CAN BE FATAL IF SWALLOWED! Before use, read, understand and follow manufacturer's instructions, Material Safety Data Sheets (MSDS) and your employer's safety practices. *Keep head out of fumes. Use enough ventilation and exhaust to keep fumes and gases away from your breathing zone and the general area. *Avoid flux contact with eyes and skin. *Do not take flux internally. *Keep out of reach of children and those unfamiliar with, or unwilling to use safe handling practices. *See American National Standard Z49.1, *Safety in Welding and Cutting* published by the American Welding Society (AWS), 550 NW LeJeune Rd, P.O. Box 351040, Miami, FL 33135: OSHA *Safety and Health Standards 29 CFR 1910*, available from the US Government Printing Office, Superintendant of Documents, P.O. Box 37194 Pittsburg, PA 15250-7954. MSDS sheets are available from U.S. ALLOY CO. Charlotte,NC 28216, on our website at www.weldingwire.com, from your employer or by contacting your supplier.

TIG Welding Parameters for Lap and Fillet Welds

Power source: AC or DC GTAW
Shielding Gas: 100% Argon (recommended)
Tungsten: Pure or Zirconated

Parameters are provided for welding with pure tungsten.
Zirconated tungsten may require slight adjustments.
F, flat, H, horizontal, V, vertical, O, overhead

Material Thickness, in.	Welding position	Wire Dia. In.	Tungsten Size, in.	Gas cup I.D., in.	Gas flow cf/hr	Amps AC	Travel speed In./min.	Filler consumption Lb/100 ft
1/16	F,H,V	3/32	1/16-3/32	3/8	16	70-110	8-10	.50
	O	3/32	1/16-3/32	3/8	20	65-90	8-10	.50
3/32	F	3/32-1/8	1/8-5/32	3/8	18	110-145	8-10	1.00
	H,V	3/32	3/32-1/8	3/8	18	90-125	8-10	1.00
	O	3/32	3/32-1/8	3/8	20	110-135	8-10	1.00
1/8	F	1/8	1/8-5/32	7/16	20	135-175	10-12	2.00
	H,V	1/8	3/32-1/8	3/8	20	115-145	8-10	2.50
	O	1/8	3/32-1/8	7/26	25	125-155	8-10	2.00
3/16	F	5/32	5/32-3/16	1/2	25	190-245	8-10	4.50
	H,V	5/32	5/32-3/16	1/2	25	175-210	8-10	5.50
	O	5/32	5/32-3/16	1/2	30	185-225	8-10	4.50
1/4	F	3/16	3/16-1/4	1/2	30	240-295	8-10	7.00
	H,V	3/16	3/16	1/2	30	220-265	8-10	9.00
	O	3/16	3/16	1/2	30	230-275	8-10	7.00

TROUBLESHOOTING

Problem	TIG Welding	MIG Welding	Solution
Poor Arc Starting	Broken circuit - bad ground	Broken circuit - bad ground	Check connections and re-ground.
	No shielding gas	No shielding gas	Check gas supply and regulator pressure, pre-purge.
	Wrong polarity	Wrong polarity	Change polarity.
	Anodizing or coating on metal	Anodizing or coating on metal	Perform proper metal cleaning.
	Defective cooling system	Improper wire feed rate	Repair cooling system or dial in wire feed rate.
Unstable Arc	Inconsistant voltage flow	Inconsistant voltage flow	Check or repair electrical connections.
	Contaminated joint area	Contaminated joint area	Perform proper metal cleaning.
	Arc blow (strong magnetic field)	Arc blow	Stop welding, adjust ground clamp position to eliminate magnetic field.
	Oversized electrode diameter	Conduit angle too high	Reduce electrode size or adjust angle.
	Workpiece is too cold	Workpiece is too cold	Let stand at room temperature for 24 hours or preheat to 150 F.
Porosity	Hydrogen contamination on wire or base metal	Hydrogen contamination on wire or base metal	Keep wire in a low humidity container and perform proper metal cleaning.
	Base metal cooling too fast	Base metal cooling too fast	Pre-heat heavy sections or slow travel speed.
	Wet or dirty gas shield	Wet or dirty gas shield	Replace gas supply.
	Insufficient or interrupted gas flow	Insufficient or interrupted gas flow	Increase flow rate or block cross wind.
	Current setting too low	Current setting too low	Increase welding current.
Dirty welds	Inadequate gas shield	Inadequate gas shield	Increase gas flow rate, block cross wind, change gun angle, replace clogged or damaged gas nozzle, hold nozzle closer to work.
	Contaminated filler metal	Contaminated filler metal	If wire was stored and handled properly, contact Washington Alloy.
	Contamination/oxides in joint area	Contamination/oxides in joint area	Perform proper metal cleaning.

continued....

TROUBLESHOOTING continued

Problem	TIG Welding	MIG Welding	Solution
Lack of fusion or penetration	Welding current too low	Welding current too low	Increase welding current.
	Travel speed too fast	Travel speed too fast	Slow travel speed, allow puddle to penetrate.
	Arc length too long	Arc length too long	Reduce arc length or increase wire feed speed
	Contaminated weld joint	Contaminated weld joint	Perform proper metal cleaning.
	Wrong groove shape	Wrong groove shape	Reconfigure joint (see fig. A thru G in joint design secton).
	Oxides on base metal	Oxides on base metal	Perform proper metal cleaning.
Weld Cracking	Wrong filler metal	Wrong filler meal	Re-check Alloy selection chart and sub notes.
	Voltage too high	Voltage too high	Check parameter chart and adjust voltage.
	Too little filler metal in joint	Too little filler metal in joint	Slow travel speed, allow full puddle to form.
	Contaminated weld joint	Contaminated weld joint	Perform proper metal cleaning.
	Shrinkage due to joint design	Shrinkage due to joint design	Narrow joint gap or increase bevel angle.
	Wrong welding technique	Wrong welding technique	Pre-heat heavy sections.
			Clamp parts to minimize stress.
			Reduce heat zone with higher traverse speed.
			Make convex beads, not concave.
			Make sure weld puddle is not too small.
			Minimize super-heated molten metal.
Burn back	Tungsten touches puddle	Contact tip touches puddle	Adjust arc length or recess contact tip
		Wire feed too slow	Increase feed speed for C.C. and decrease voltage on C.V.
		Current surge arcing in tip	Reduce Run-in feed speed for C.V.
		Wire too soft or kinked	Contact Washington Alloy or supplier.
		Conduit dirty, damaged or too long.	Replace conduit and consider a push-pull gun if shortening the conduit is not feasible.
		MIG gun over-heating	Lower duty cycle or replace gun with a water cooled model.
		Arcing in tip	Match the tip size with wire diameter.
		Spatter build up on tip	Clean or replace tip
		Aluminum shavings in liner or contact tip.	Use "U" shaped drive roll. Properly align with input guide, drive roll tension should be just enough to prevent slipping. Make sure you are using a teflon liner.
		Wrong polarity	Change polarity.
		Line voltage fluctuation	Use line voltage control.
Color mis-match	Wrong filler metal	Wrong filler metal	Consult alloy selection chart and foot notes.

Equipment check for MIG welding:

For optimum performance when MIG welding, the following equipment should be used; "U"-shaped drive rolls with proper tension (Aluminum can easily be deformed by over-tightening or by using "V" or knursed drive rolls), teflon or nylon liners and guides, make sure contact tips and nozzles are free of damage or spatter build-up, See that drive rollers are aligned properly with input and output guides, Check all gas connections and water cooling system for leaks, and make sure contact tips are the correct size for your wire dia. It is best to use a MIG gun with a straight or slightly curved neck (sharp bends can cause binding). Check all electrical connections and replace worn or damaged components or tighten where necessary (C.V. power supplys rely on good electrical connections in order to send the proper signal back to the machine).

Tungsten choices:

The standard tungsten electrode for aluminum welding is the Pure Tungsten, EWP (green tip). It produces a stable arc once the ball is formed.Although it's high purity somewhat diminishes it's current carrying capacity, pure tungsten is generally more obtainable and has long been the industry standard. The Zirconated Tungsten, EWZr (Brown tip) is similar to the Pure but with better current carrying capacity. EWZr-1 is more resistant to contamination than pure tungsten and has good radiographic-quality welding properties.

DC TIG welding

Nearly all aluminum TIG welding is done with AC curent (high frequency), and is the only recommended way to TIG weld aluminum. However, the question comes up regularly if DC TIG will work on aluminum. The principal factor here are the oxides that form on the surface of aluminum. Aluminum melts at approx. 1200˚F, while aluminum oxides melt at approx. 3,700˚F. These oxidizes form almost instantly once aluminum is clean and unprotected. DC current simply does not have the "bite" necessary to cut through the oxides as high frequency AC current does. While DC TIG can be performed with the use of pharmaseutical grade High Purity Helium and a powerful etching solution, It is usually not worth the effort and expense.