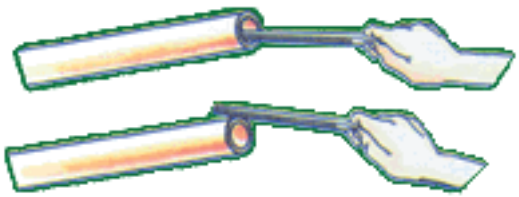
J.W. Harris Brazing References

The information on these pages will be advantageous to the average brazing operator.

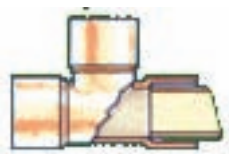
For further study, the J.W. Harris Co. offers a two-day, comprehensive Brazing Workshop at nominal cost covering fundamentals of oxy-acetylene torch brazing. This course is conducted for those persons requiring an extensive and technical knowledge of the brazing process and combines classroom discussion and "hands-on" brazing experience including basic metallurgy, base metals, filler metals, equipment, technique, and safety.



Remove all oil & grease. Clean outside of fitting

Clean Tube And Inside Surface Of Fitting

Apply thin coat of Stay-Silv flux



Assemble tube & fitting

Neutral Flame

Cut Pipe Square

Cut to the exact length required using a tube cutter or hacksaw. If a hacksaw is used, a sawing fixture should also be used to ensure square cuts. Remove all inside and outside burrs with a reamer, file or other sharp edge scraping tool. If tube is out of round, it should be brought to true dimension and roundness with a sizing tool.

Clean outside of copper tubing

The joint surface areas should be clean and free from oil, grease, or oxide contamination. Surfaces may be properly cleaned for brazing by brushing with a stainless steel wire brush, or by a stiff rubbing with emery cloth. If oil or grease is present, clean with a commercial solvent. Remember to remove small foreign particles, such as emery dust, by wiping with a clean, dry cloth. The joint surfaces MUST be clean.

Select Brazing Alloy

When brazing Copper to Copper, low cost Dynaflow is recommended or Stay-Silv 15 may be used. These alloys contain phosphorus and are self-fluxing on copper. When brazing brass or bronze fittings, Stay Silv white flux is required. When brazing iron, steel or other ferrous metals, select a cadmium-free brazing alloy and use Stay-Silv white brazing flux. Do not use phosphorus bearing alloys as the joint may be brittle. To estimate the amount of brazing alloys needed, see Filler Metal Chart
Proper Fluxingis important because the flux absorbs oxides formed during heating and promotes the flow of filler metal. When using Stay-Silv white flux, apply it only with a brush. To prevent excess flux residue inside refrigeration lines , apply a thin layer of flux to only the male tubing and, if possible,revolve the fitting once or twice on the tube to ensure uniform coverage.

Assemble Tube and Fitting

Insert the fluxed tube end into the fitting. Maintain support to ensure the proper alignment until the brazing alloy solidifies. Maintain for a few seconds (or more) depending on the size of the joint area. The assembly is now ready to braze, using brazing alloy in rod, wire or coil form manually fed into the joint.

Adjust Torch Flames

For most brazing jobs using oxygen-acetylene gases, a "neutral" flame should be used. The neutral flame has a well-defined inner cone. Avoid an oxidizing flame.

Oxidizing Flame

Carburizing Flame

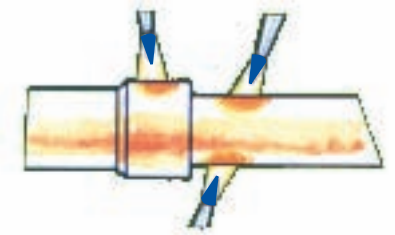
Neutral Flame- Inner cone bluish white, no acetylene feather, tip Bluish to Orange.

Oxidizing Flame - Sharp inner cone bluish white, inner cone two-tenths shorter than cone of neutral flame, tip nearly colorless.

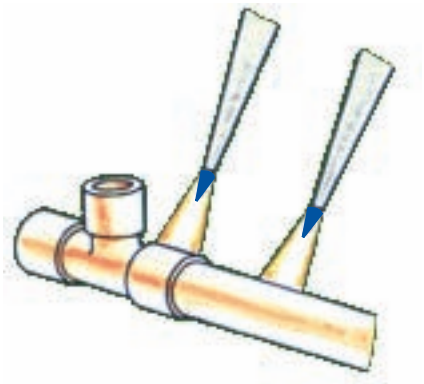
Carburizing (Excess Acetylene) Flame - Inner cone bluish white, acetylene feather bluish white with feathery edge, tip light orange.

Heating The Joint Area - Always keep the torch in short motion then...

1. Start heating the tube, first applying the flame at a point just adjacent to the fitting. Work the flame alternately around the tube and fitting until both reach brazing temperature before applying the brazing filler metal.
2. When a flux is used, it will be a good temperature guide. Continue heating the tube until the flux passes the "bubbling" temperature range and becomes quiet, completely fluid and transparent and has the appearance of clear water.
3. Direct the flame from the tube to the flange-base of the fitting and heat until the flux that may remain in the fitting is also completely fluid.
4. Sweep the flame back and forth along the axis of assembled joint...tube and fitting...to get and then maintain uniform heat in both parts.


Sweep flame back & forth along joint

Do not overheat joint
Keep fitting & tubing uniformly heated


Feed alloy into joint...the torch flame will help melt the alloy but the heat of the joint must flow the alloy into the capillary

Apply The Brazing Alloy

Feed the alloy into the joint between the tube and the fitting. Only after the base metals have been heated to brazing temperature should the filler metal be added. At that time the flame may be directed momentarily to the tip of the filler metal to begin the melting process. Always keep both the fitting and the tube heated by playing the flame over the tube and the fitting as the brazing alloy is drawn into the joint. The brazing alloy will diffuse into and completely fill all joint areas. Do not continue feeding brazing alloy after the joint area is filled. Excess fillets do not improve the quality or dependability of the braze and are a waste of material.

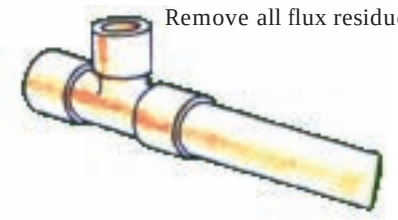
Making Vertical 'Alloy-Up' Joints

Heat the tube first, then apply heat to the fitting. It is important to bring both pieces up to temperature evenly. If the tube is overheated the brazing alloy may run down the tube rather than into the joint.

Making Horizontal Joints

Heat the circumference of the tube first, then apply heat to the fitting. Deciding where to start feeding the alloy will depend on the size of the pipe and operator preference. On large diameter pipe, however, sometimes the best approach is to start at the bottom of the pipe. Apply brazing alloy at the bottom and work around the pipe. As the alloy solidifies, it will create a "dam" and help prevent the brazing alloy from running out of the joint as the remainder of the connection is filled. When adding alloy, make sure both the pipe and the fitting are up to temperature.

Remove all flux residues


Use emery cloth or wire brush to clean joint

Clean After Brazing

All flux residues must be removed for inspection and pressure testing. Immediately after the brazing alloy has set, quench or apply a wet brush or swab to crack and remove the flux residues. Use emery cloth or a wire brush if necessary.

Frequently Asked Questions

Definitions

What is the difference between soldering, brazing and welding?

Soldering - The AWS defines soldering as a group of joining processes that produce coalescence of materials by heating them to the soldering temperature and by using a filler metal (solder) having a liquidus not exceeding 840ºF (450ºC), and below the solidus of the base metals.

Brazing - Brazing joins materials by heating them in the presence of a filler metal having a liquidus above 840ºF (450ºC) but below the solidus of the base metal.

Welding - In welding, fusion takes place with melting of both the base metal and usually a filler metal.

What is the difference between a typical chemical certification and an actual chemical certification?

A typical certification states that the material will fall within chemical limits of the designated specification if tested. Actual certification states that each element in the designated specification was tested for and the result of those tests are listed on the certification.

Soldering

What can be used to clean soldering iron tips?

Ammonium chloride (a.k.a. salimoniac), in a bar or liquid form. (This product is not offered by J. W. Harris.)

What products can be used when soldering in lead-free applications?

J. W. Harris has several lead-free solders, including: Stay-Brite®, Stay-Brite® 8, Bridgit® and 95/5.

What is "babbit" solder?

A tin-based bearing solder. (This product is not offered by J. W. Harris)

How many feet per pound in J. W. Harris solders?

The following is an approximate figure for solid solder:

1/32" = 391'

3/64" = 181'

1/16" = 104'

3/32" = 46'

1/8" = 26'

Brazing

How many troy ounces are there in one pound?

14.583 troy ounces = 1 avoirdupois pound (16 oz.).

I have some very old silver brazing wire and want to know if it can be used with the same results as new silver brazing wire.

Yes, the braze has the same result with no loss in strength. However, all the oxides must be cleaned off the outside of the old silver with a steel wool pad before it is used.

What is the tensile strength of a brazed joint?

Joint strength depends on several factors: clearance between parts, base metal composition, service temperature and joint quality (low voids, good penetration). Joint design will also affect strength.

The bulk tensile strength of silver braze alloys is 40,000-70,000 psi. When brazing copper-based alloys, failure will occur in the copper or brass. For copper this is usually the annealed strength of the copper alloy. When brazing steel or other ferrous metals, joint strength over 70,000 psi can be achieved under the right conditions.

Keep in mind that braze joints are primarily lap type joints, so strength is a combination of tensile and shear. Joint strength is directly influenced by the above mentioned factors. The only way to accurately determine tensile or other values is to test the brazed assembly.

How many inches per pound of brazing material?

See chart.

What do I use to braze (zinc-coated) steel?

The galvanized coating has to be removed from any areas that may affect the brazement. If not removed, the zinc may melt and combine with the filler metal. Use Safety-Silv® 45 or 56 with Stay-Silv® White Flux on the steel.

What braze alloy can be used for silver jewelry?

Safety-Silv 56 provides the best color match.

Does J. W. Harris carry any products that contain cadmium?

No, cadmium fumes are dangerous. For user safety J. W. Harris only manufactures cadmium-free alloys. See the Cadmium Alloy Replacement Chart for recommended replacements for cadmium alloys. Refer page 6.

Welding Procedures

"Basics Steps" to Aluminum Welding

Aluminum base metals are classified as either wrought alloys produced by mechanical working such as rolling, extruding, or forging, or cast alloys produced by pouring into a mold. Wrought alloys are further divided as either heat treatable or non-heat treatable depending on the composition.

Below is a basic step by step guide to follow when welding aluminum.

#1. Safety First

Warning: Protect yourself & others. Read & understand this information.
Fumes & Gases can be hazardous to your health.
Arc Rays can injure eyes & burn skin.
Electric Shock can kill.

* Before use, read & understand the manufacturer's instructions, Material Safety Data Sheets (MSDS) & your employer's safety practices.
* Keep your head out of the fumes.
* Use enough ventilation; exhaust at the arc, or both, to keep fumes & gases from your breathing zone & the general area.
* Wear correct eye, ear, & body protection.
* Do not touch live electrical parts.
* See American National Standard Z49.1, Safety in Welding, Cutting, & Allied Processes, published by the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126; OSHA Safety & Health Standards, available from the U.S. Government Printing Office, Washington, DC 20402

#2. Select Joint Design & Fit up

Start by determining the best manner in which to join your base metals. Correct joint design & fit up are critical steps to insuring a strong bond upon weld completion. Be sure to consider strength required, welding position, metal thickness & joint accessibility.

The five basic types of joints are butt, corner, edge, lap & tee. These five joints can be arranged in many combinations to create a large variety of welds. Fixtures & jigs are helpful in securing the work pieces in place during the joining procedure. Sheet metal & most fillet & lap joints should be clamped tightly over the entire length of the work.

#3. Choose The Welding Process

The most popular processes are Gas Metal Arc Welding (GMAW), sometimes called MIG welding and Gas Tungsten Arc Welding (GTAW) sometimes referred to as TIG welding. A third process, Shielded Metal Arc Welding (SMAW) or stick welding, has limited use on aluminum and is used primarily for small repair jobs on material 1/8" or more thick.

- SMAW - Shielded Metal Arc Welding or Stick Electrode

SMAW is an electric arc welding process in which heat for welding is generated by an electric arc between a covered metal electrode & the base metal. The electrode coating provides shielding. The welding equipment for this process is currently the most inexpensive of the methods described here. However, electrodes do create some inefficiency, such as stub loss & a slag coating, which must be removed.

- Gas Tungsten Arc Welding-Tig Welding

TIG Welding is easily performed on a variety of metals. It generally requires little or no post weld finishing. It is an electric welding process in which heat for welding is generated by an electric arc between the end of a non-consumable tungsten electrode & the base metal. Filler metal may be added, if necessary. An inert shielding gas supplies shielding for the arc. (Inert gas creates a protective atmosphere around the welding in process).

- Gas Metal Arc Welding-Mig Welding

Gas metal arc welding is quick & easy on thin-gauge metal as well as heavy plate. It generally calls for little post weld cleanup. GMAW is an electric arc welding process where heat is produced by an arc between a continuously fed filler metal electrode & the base metal. Shielding is obtained from an externally supplied gas or gas mixture. The two most common types of GMAW are:

Short Circuit Transfer - The arc is broken or short circuited with each drop of metal & restarted. Short circuiting transfer is not used with aluminum welding.

Spray Transfer - Metal is transferred across the arc creating a continuous spray of fine droplets of metal. These droplets are projected down to the base metal.

#4. Determine The Appropriate Inert Shielding Gas

GTAW - Argon is suggested for thicknesses up to approximately 1/2". For thicker sections, argon-helium mixtures or pure helium may be used. Pure helium may also be employed for deeper penetration.
GMAW - Argon is used for most applications. It provides deeper penetration and clean welds. Argon-helium mixtures of 25 – 75% helium are helpful for thicker material (over 1⁄2 inch). Helium produces a hotter arc which is sometimes necessary due to aluminum's high thermal conductivity. It also produces a wider weld fusion shape.

#5. Select The Applicable Filler Metal

Filler metal is based on several factors. One consideration is the ability to provide suitable mechanical properties for heat treatable and non-heat treatable base metals both wrought and cast. Other important factors are freedom from cracking, sevice conditions and weld color after anodizing.

Go to www.jwharris.com.au or page 14 of this catalogue for the Aluminum Filler Metal Selection Guide

Aluminum Filler Metal Selection Guide

Aluminum Filler Metal Chemical Compositions

#6. Set The Parameters

SMAW - uses a direct current (DC) or an alternating current (AC).

DC uses either straight polarity, which is electrode negative or reverse polarity, which is electrode positive. Direct current flows in one direction continuously through the welding circuit. There are several advantages of DC. It works well at low current settings & with small diameters. In addition, igniting the arc & maintaining a short arc is easier.

Welco 26 aluminum electrode is used with DC-reverse polarity.

AMPS - Recommended settings are:

Dia:	3/32 x 14"	1/8 x 14"	5/32 x 14"
Amps:	50 - 85	85 - 135	110 - 165

GTAW - Manual GTAW of aluminum is usually done using alternating current (AC). A high frequency generator is employed for arc starting and stabilization. Pure or zirconiated tungsten electrodes are used for AC welding. Tungsten electrodes should be prepared with a hemispherical shaped tip.

The parameters for manual GTAW are dependent upon plate thickness, weld position and joint design. The following settings should be helpful in establishing a procedure. Settings are for the flat position.

Thickness	Tungsten Size	Filler Rod Size	Amps	Volts	Gas Cup	Gas Flow (cfh)
1/16"	1/16" – 3/32"	1/16" – 3/32"	70 - 100	15	3/8"	20
3/32"	3/32" – 1/8"	1/8"	90 - 120	15	3/8"	20
1/8"	1/8" – 5/32"	1/8" – 5/32"	125 – 175	15	7/16"	20
3/16"	5/32" – 3/16"	5/32" – 3/16"	170 – 225	15	7/16" – 1/2"	25
1/4"	3/16" – 1/4"	3/16"	220 – 275	15	1/2"	30
3/8"	1/4"	3/16" – 1/4"	330 – 380	15	5/8"	35

GMAW-Gas metal arc aluminum welding is done using DC reverse polarity (electrode positive.) Filler metal transfer is in the spray mode. Suggested settings for flat position manual GMAW (argon shielding gas) are:

Thickness	Filler Wire Size	Amps	Volts	Gas Flow (cfh)
1/16"	.030"	70 - 110	15 – 20	25
1/8"	.030" – 3/64"	120 - 150	20 – 24	30
3/16"	.035" – 3/64"	130 – 210	22 – 26	30 – 35
1/4"	3/64" – 1/16"	170 – 225	24 – 28	40
3/8"	1/16"	225 – 300	26 – 29	50

#7. Clean The Base Metal

Cleaning should be done just prior to welding to prevent the formation of oxides. The base metal surface must be free of grease, oil, paint, dirt, etc. A clean surface will provide a smoother, stronger joint. Brush the plate surface & edges with a stainless steel wire brush to remove burrs & oxides. Gloves should be worn to prevent hand oil or dirt from getting on the joining surface.

#8. Preheat If Applicable

Preheat is generally unnecessary in aluminum welding. In some cases it can be helpful when weldig casting to reduce cracking tendency. It may also be useful to equalize weld penetration when welding metals of different thicknesses.

#9. Welding Technique

A good welding technique is developed as a welder gains experience. The following are basic welding tips:

* Use fixtures &/or jigs to help keep work in place.
* Joints should be designed to provide suitable access and to promote weld penetration
* Insure adequate shielding by centering the filler metal in the gas & weld puddle area.
* For GMAW use a forehand welding technique (gun pointed in the travel direction).
* In GTAW filler metal should be dipped into the weld puddle, but should not drip into it.
* Move the torch/gun along the joint at a steady, constant speed to maintain uniformity.
* Hold the torch/gun over the weld until gas stops, to keep work protected.

#10. Cooling/Post Weld Cleaning

Allow the joint to cool slowly. If Welco 26 coated electrodes are used remove slag after welding.